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20. Summary of Assessment

20.1. Summary Table

Within this section, table 20.2 shows the key potential impacts and mitigation measures that have emerged from the assessment, together with recommended future studies and monitoring work. These are also carried forward to the Environmental Action Plan and Regional Monitoring Plan that are discussed in Chapter 21.

20.2. Significance Criteria

The establishment of a common approach to the assessment of the 'Significance', or the relative importance, of impacts has been essential in order to allow a fair comparison of different impacts across the various topic areas studied and to ensure inter observer reliability. In order to ensure that authors could undertake their assessments in a uniform and consistent manner, ensuring a consensus on the magnitude of an impact, a common set of significance criteria were established. The criteria were discussed by the chapter writers prior to commencing the writing of the chapters to ensure they were applicable across all the areas being investigated. They were based on UK best practice, taken from numerous sources, and customised to account for the unique qualities of the Bailiwick. The significance criteria were:

Table 20.1 – Significance Criteria

VALUE OF RECEPTOR	MAGNITUDE OF POTENTIAL IMPACT			
	Negligible	**Low**	**Medium**	**High**
International (UK, France and Channel Islands)	Minor	Moderate	Major	Major
Regional (Channel Islands)	None	Minor	Moderate	Moderate
Local (within study area)	None	None	Minor	Moderate

In reference to the assessment of significance as described in the above table, magnitudes of potential environmental impacts are as follows:

High – Affect to an entire population/habitat/activity causing a decline in abundance and/or change in distribution beyond which natural recovery might not occur. Recruitment would not return to that population/habitat/activity, or any population/habitat/activity dependent upon it, to its former level within several generations of the species being affected.

Medium – Damage or disturbance to populations, habitats or activities above those experienced under natural conditions, over one or more generations, but which does not threaten the integrity of that population or any population dependent on it.

Low – Small-scale or short-term disturbance to populations, habitats or activities. Recovery rates would be rapid, and no long-term noticeable effects would be observed above the levels of existing natural variation. The impacts are not sufficient to be observed at the population level.

Negligible – Minimal impact from the work. Very minor damage, if any, to a population, habitat or activity of low importance, or with immediate recovery.

The Value of the Receptors, shown in the left hand column in the table 20.1 above, indicates the importance of the Receptor in terms of its rareness or its importance to other species, habitats or activities that may depend on it. Where Receptors are of an ecological nature, then national and international species lists (eg. EU BAP Habitats Lists) that may be referenced. Where receptors are of the Human Environment (eg. Fisheries and Navigation), then authors have made their own assessment as to their relative value as of 'International', 'Regional' or 'Local' importance.

20.3. Data Gaps and Uncertainty

The assessment has found a number of areas of investigation that are hampered by a lack of knowledge. As the REA is a desk-study, it is acknowledged that some of these cannot be addressed within the scope of the study. Further investigative work has been recommended for future stages of the environmental planning process.

The results of the REA are presented in tables over the following pages. A number of impacts have been assessed as being of 'unknown significance'. This might be for one or more of the following reasons:

- Lack of baseline information. There might be insufficient information to determine the presence or sensitivity of a key potential receptor. Therefore, the value and impacts cannot be determined. Where there is no properly recorded data, but conditions might be interpreted so that there is a strong possibility that a sensitivity (eg. a protected species) might exist, then the assessment assumes a 'worst-case' scenario. This is known as the 'Precautionary Principle'.
- Lack of information with regard to likely deployment sites. A number of the potential impacts on key receptors is extremely site-specific. In such

cases, it is not possible to identify impacts until potential deployment sites are established.

- Lack of information regarding device characteristics. Most renewable energy devices are still in various stages of prototype testing. As such, there is little useful data regarding their behaviour. Furthermore, it is not clear as to the way that these technologies will be developed as more is learnt about their engineering and environmental performance. The impacts that have been identified are those that may be inferred from the current stage of technology development.
- Lack of information regarding the devices' response to potential impacts. The nascence of the renewable energy industry means that little is known about the manner in which receptors respond to impacts. For example, the behaviour of marine mammals to the presence of underwater obstructions and noise.

The data gaps that have been identified on an area by area basis are identified as future studies and surveys in table 20.2 below, and are also incorporated into an Environmental Action Plan (EAP) and a Regional Monitoring Plan (RMP) in Appendix L and M respectively.

20.4. Decommissioning

Impacts of decommissioning are broadly similar to those incurred during construction. However, there is the potential for long-term impacts from devices, their foundations and cables, if equipment is left on the sea-bed after decommissioning. For this reason, it is anticipated that decommissioning would require the removal of generators, cables, and other sea-bed infrastructure. This may be with the exception of large-gravity-foundation elements, which may be allowed to remain in place to form artificial reef habitats. The benefits of this would need to be balanced with any long-term risks to navigation and fishing safety.

20.5. Geographic Constraints

Many of the specialist assessments have revealed the location-specific nature of many of the potential impacts. This means that the 'Magnitude' or 'Significance' of the potential impacts, as defined in section 20.2 above, will depend primarily on their proximity to sensitive species, habitats or activities.

Numerous geospatial constraints apply to the many aspects of the REA. This indicates the need for the careful selection of deployment sites, and the importance of this as a primary means of mitigating environmental impact. The REA has established a set of environmental data within its Geographical Information System (GIS) that will be very useful in the management of the Zoning process. In combination with appropriate stakeholder and public consultation, this data has the potential to allow informed and rational debate with regard to the selection of preferred deployment zones.

20.6. Impacts and Mitigation Measures that apply to Multiple Topic Areas

The summary table (table 20.2) shown on the following pages indicates that a number of impacts have the potential to affect a network of inter-related receptors. Furthermore, impacts may lead to secondary effects which may be experienced by receptors in other topic areas. For example, mobilisation of sediment during construction could impact on several groups of receptors, such as smothering of benthic species and fish spawning grounds. This scouring could, at the same time, lead to a reduction in visibility within the water column that could affect the hunting and feeding behaviour of large fish and marine mammals. This demonstrates that impacts should not be considered in isolation.

Similarly, mitigation measures might also span several of the REA topic areas, in that a single mitigation measure might reduce impacts across a range of species, habitats or activities.

Under each section of the summary table (table 20.2), direct impacts are listed with their Significance, together with associated mitigation measures. Secondary impacts that may arise from the primary impact are briefly referenced, but not described in detail under the primary impact. For example, under 'Geology', the potential mobilisation of sediment during construction activities has a secondary impact on benthic ecology due to the potential for smothering of habitat. Although briefly referenced under 'Geology', the significance of the impact on benthic ecology is recorded separately in the table under 'Benthic Ecology'.

Table 20.2 – Summary of assessment

Potential Impact (prior to mitigation)	Significance (Prior to mitigation)	Mitigation	Residual Significance (After mitigation)	Future Studies, Surveys and Monitoring
Geology				
Construction and Decommissioning Phases				
Mobilisation of sediment due to installation of device foundations and export cables. Secondary impacts may occur to benthic ecology due to smothering, or to other marine ecology due to increased turbidity.	None	Careful site selection and design of devices, cable routes and foundations to minimise disturbance of sediments	None	Further research, particularly translation and interpretation of French scientific papers. Ground investigation surveys, eg. boreholes. Hydraulic-and-sediment-transition modelling and monitoring
Changes to sub-surface geology from devices and foundations due to installation of device foundations and export cables	None	Careful selection and design of foundations to minimise requirement for excavations or piling	None	
Operation Phase				
Far-field and large-scale mobilisation of sediment due to changes in tidal current regimes and wave energy around arrays, potentially leading to changes in bathymetry, changes to beach profiles and increased coastal erosion. Secondary impacts may occur to benthic ecology due to smothering, or to other marine ecology due to increased turbidity.	Moderate	Careful site selection and design of devices, cable routes and foundations Subsea engineering works to trap sediment Coastal defence works such as groynes Careful design of cable-routes and depth where they cross beaches to ensure that there is a minimal risk of exposure	Unknown	Further research, particularly translation and interpretation of French scientific papers. Ground investigation surveys, eg. boreholes. Hydraulic and sediment-transition modelling and monitoring Beach profile monitoring

Potential Impact (prior to mitigation)	Significance (Prior to mitigation)	Mitigation	Residual Significance (After mitigation)	Future Studies, Surveys and Monitoring
Marine Processes				
Construction and Decommissioning Phases				
None				
Operation Phase				
Reflection and refraction of waves, or reduction in wave energy, due to presence of energy devices, potentially leading to a reduction in heights of surfing waves	Minor	Careful site selection Construction of artificial reefs	Unknown	Wave monitoring Wave energy propagation modelling
Changes in tidal current regimes and wave energy, due to presence of energy devices, potentially leading to secondary impacts on offshore sediment movements (see 'Geology'). Further secondary impacts may affect marine habitats (see 'Pelagic Ecology' and 'Benthic Ecology')	Minor	Careful site selection Consider tuning of devices	Unknown	Hydraulic and sediment transition modelling and monitoring

Potential Impact (prior to mitigation)	Significance (Prior to mitigation)	Mitigation	Residual Significance (After mitigation)	Future Studies, Surveys and Monitoring
Water Quality				
Construction and Decommissioning Phases				
Increased turbidity due to disturbance of sediments	Minor	Minimise dredging, trenching, piling/drilling Use installation methods for cables and devices that minimise sediment disturbance Carry out work in appropriate tidal conditions	Minor	Ground investigation surveys, eg. boreholes. Hydraulic and sediment modelling. Baseline monitoring of sediment and waters away from the beaches. Operational monitoring in order to ensure that there are no adverse effects occurring, and to respond when they do arise.
Release of contaminants from disturbance of existing sediments	Minor	Avoid infrastructure within areas of known or suspected sediment contamination Use installation methods for cables and devices that minimise sediment disturbance	Minor	
Accidental Release of contaminants	Moderate	Use low/nontoxic materials Minimise contact of toxic materials with water Minimise quantity of toxic materials used Preparation of spill kits and emergency plans	Minor	
Operation Phase				
Accidental release of contaminants from devices	Moderate	Regular inspection and maintenance Design devices for minimum risk. Carry out activities in appropriate conditions	Minor	Monitoring of waters away from the beaches.
Erosion of sacrificial anodes	None	Minimise use of sacrificial anodes	None	
Antifouling compound release	Minor	Use low/nontoxic materials	None	

Potential Impact (prior to mitigation)	Significance (Prior to mitigation)	Mitigation	Residual Significance (After mitigation)	Future Studies, Surveys and Monitoring
Benthic Ecology				
Construction and Decommissioning Phases				
Physical disturbance	Major	Careful site selection Construction/Decommissioning work to be timed to avoid impeding species' reproduction/ feeding regimes/ migrations and life cycles Method-related controls to reduce risk of pollution Spill kits and emergency plans	Minor	Baseline surveys and monitoring of benthic ecology throughout the construction / decommissioning works of the project Water-quality monitoring
Pollution during construction	Major		None	
Operation Phase				
Permanent habitat loss in within footprint and in close proximity to deployment sites of devices and cables	Major	Careful site selection Maintenance work to be timed to avoid impeding species' reproduction/ feeding regimes/ migrations and life cycles	Moderate	Monitoring of benthic ecology throughout the operation of the project Water-quality monitoring Wave propagation, hydraulic and sediment-transition modelling during design phase Regional approach to monitoring of benthic habitat changes
Permanent habitat loss remote from site due to changes in wave or tidal energy	Major		Moderate	
Sediment displacement (scour or smothering) due to changes in wave or tidal energy	Major		Moderate	
Physical disturbance due to presence of maintenance vessels for routine operations	Minor		None	
Creation of new habitat through use of structures as artificial reefs	Minor (positive)	Establishment of a Safety Zone that would also act as a no-fishing zone	Minor (positive)	
Pollution from devices	Minor	Regular inspection and maintenance of devices	None	
Electromagnetic fields	None	Armouring of cables	None	

Potential Impact (prior to mitigation)	Significance (Prior to mitigation)	Mitigation	Residual Significance (After mitigation)	Future Studies, Surveys and Monitoring
Pelagic Ecology				
Construction and Decommissioning Phases				
Disturbance during construction	Moderate	Careful site selection Construction work to be timed to avoid impeding species' reproduction/ feeding regimes/ migrations and life cycles	Minor	Monitoring of stock numbers and behaviour
Noise (during construction)	Moderate	Avoid using piling or explosives during excavation and formation of foundations.	None	Observations for large fish prior to and during deployment operations
Pollution during construction	Minor	Method-related controls to reduce risk of pollution Spill kits and emergency plans	None	Water-quality monitoring
Operation Phase				
Physical disturbance due to presence of maintenance vessels for routine operations	Minor	Maintenance work to be timed to avoid impeding species' reproduction/ feeding regimes/ migrations and life cycles	None	Monitoring of stock numbers and behaviour
Creation of new habitat through use of structures as artificial reefs	Minor (positive)	Establishment of a Safety Zone that would also act as a no-fishing zone	Minor (positive)	Monitoring of stock numbers and behaviour
Collision with devices or maintenance vessels	Unknown	None	Unknown	Monitoring of behaviour of large fish in proximity to devices
Pollution from devices	Minor	Careful selection of materials Regular inspection and maintenance of devices	None	
Noise (during operation)	Moderate	Design of devices to be cognizant of sensitivities, and noise-reduced or tuned as appropriate	Minor	Device-specific studies into emissions Baseline and operational noise monitoring
Electromagnetic fields	Minor	Armouring of cables	Unknown	Device-specific studies into emissions Monitoring of stock numbers and behaviour

Potential Impact (prior to mitigation)	Significance (Prior to mitigation)	Mitigation	Residual Significance (After mitigation)	Future Studies, Surveys and Monitoring
Birds				
Construction and Decommissioning Phases				
Visual disturbance due to presence of construction vessels	Moderate	Careful site selection Avoid breeding seasons Use appropriate construction methods	Minor	Monitoring pre and post construction
Noise disturbance	Moderate	Careful site selection Avoid sensitive seasons (especially breeding seasons) Use appropriate construction methods Install minimum infrastructure on the water surface Install devices with low-noise emission	Minor	
Pollution during construction	Moderate	Method-related controls to reduce risk of pollution Spill kits and emergency plans	None	Water-quality monitoring
Operation Phase				
Visual disturbance due to presence of maintenance vessels	Moderate	Careful site selection Avoid breeding seasons Install minimum infrastructure on surface	None	Investigation into locations of offshore feeding areas Monitoring of populations and feeding behaviours at deployment sites
Noise disturbance	Moderate	Install devices with low-noise emissions	Minor	
Displacement from feeding areas	Minor	Avoid locally important feeding areas	Minor	
Collision above surface	None	Locate devices at depths beyond the reach of marine birds Design devices to reduce birds' risk of collision Use coatings and colourings which are visible to birds Use protective grids, mesh or netting as appropriate	None	
Collision below surface	Moderate		Minor	
Changes to feeding behaviour as a result of increased turbidity, due to changes in wave or tidal energy	Minor	Design devices and use construction methods that reduce sediment disturbance	Minor	
Pollution from devices	Minor	Careful selection of materials Regular inspection and maintenance of devices	None	

Potential Impact (prior to mitigation)	Significance (Prior to mitigation)	Mitigation	Residual Significance (After mitigation)	Future Studies, Surveys and Monitoring
Marine Mammals				
Construction and Decommissioning Phases				
Noise Disturbance. A barrier to movement may form through mammals taking avoiding action.	Major	Careful site selection to avoid breeding sites Avoid works in breeding season Soft-start piling techniques. Use a marine Mammal Observer during piling and deployment operations	Minor	Further studies into distribution and abundance of marine mammals, including the use of listening devices
Pollution during construction	Major	Method-related controls to reduce risk of pollution Spill kits and emergency plans	None	Water-quality monitoring
Operation Phase				
Noise (during operation). A barrier to movement may form through mammals taking avoiding action. Noise may also act to mask communication.	Unknown	Reduce or tune noise emissions to levels and frequencies that are not harmful Underwater noise during operation may be beneficial in alerting species to the presence of devices, reducing mammals' risk of collision. This requires further research	Unknown	Further studies into distribution and abundance of marine mammals, including the use of listening devices Consideration of escape-route options in case devices form a barrier to movement Keep up-to-date with ongoing research into the behaviour of marine mammals in the proximity of devices Project-specific monitoring using listening devices Water-quality monitoring
Collision with devices. A barrier to movement may form through mammals taking avoiding action.	Major	Design device for minimal impact Do not site devices in particularly sensitive areas, e.g. not in migration routes, and feeding or breeding areas Increase device visibility, or use acoustic deterrent devices Use protective netting or grids	Unknown	
Permanent loss of habitat at deployment sites and shore stations.	Moderate	Careful site selection	Minor	
Pollution from devices	Minor	Careful selection of materials Regular inspection and maintenance of devices	None	
Changes to feeding behaviour as a result of increased turbidity, due to changes in wave or tidal energy	None	Design devices and use construction methods that reduce sediment disturbance	None	
Increased population of prey species	Minor (positive)	Encourage the establishment of Safety Zones and the creation of artificial reefs	Minor (positive)	

<table>
<tr><th>Potential Impact (prior to mitigation)</th><th>Significance (Prior to mitigation)</th><th>Mitigation</th><th>Residual Significance (After mitigation)</th><th>Future Studies, Surveys and Monitoring</th></tr>
<tr><td colspan="5">Commercial Fisheries and Mariculture</td></tr>
<tr><td colspan="5">Construction and Decommissioning Phases</td></tr>
<tr><td>Temporary displacement from fishing grounds during deployment of devices and cables</td><td>Moderate</td><td>Avoid installation and decommissioning during key fishing seasons</td><td>Minor</td><td rowspan="7">Monitor any changes in LPUE through data held by Sea Fisheries section

Monitor industry research into the effects of renewable energy installations on fish stocks and fishing efforts

Use existing logbook system to record catches in relation to fishing effort as a baseline prior to any development

Industry liaison using the FLOWW procedure (BWEA)

Developer to undertake detailed fisheries' valuation studies on deployment site</td></tr>
<tr><td>Collision/entanglement of boats or equipment with construction vessels, devices or cables</td><td>Moderate</td><td>Notices to Mariners
Developers to open early dialogue with fishing industry
Safety Zones
VHF safety broadcasts
Clear any debris</td><td>Minor</td></tr>
<tr><td>Displacement of fished species, noise, sediment and pollution impacts</td><td colspan="3">As for 'Pelagic Ecology' and 'Benthic Ecology'</td></tr>
<tr><td colspan="4">Operation Phase</td></tr>
<tr><td>Long-term displacement from fishing grounds</td><td>Major</td><td>Avoid key fishing grounds
Dialogue with fishing industry
Encourage developers to offer alternative work to those fishermen who are most affected
Offer compensation to those vessels whose work is affected by development</td><td>Moderate</td></tr>
<tr><td>Displacement of mariculture due to onshore routing of cables</td><td>Minor</td><td>Avoid designated fishery areas
Open dialogue with shellfish farmers in conjunction with Sea Fisheries section</td><td>None</td></tr>
<tr><td>Displacement of fished species, noise, sediment and pollution impacts</td><td colspan="3">As for 'Pelagic Ecology' and 'Benthic Ecology'</td></tr>
</table>

Potential Impact (prior to mitigation)	Significance (Prior to mitigation)	Mitigation	Residual Significance (After mitigation)	Future Studies, Surveys and Monitoring
Recreational Fishing				
Construction and Decommissioning Phases				
Displacement of fished species, noise, sediment and pollution impacts	As for 'Pelagic Ecology' and 'Benthic Ecology'			
Collision/entanglement of boats or equipment with construction vessels, devices or cables	Moderate	Developers to open early dialogue with fishing groups Notices to Mariners Safety Zones VHF safety broadcasts Clear any debris	Minor	
Operation Phase				
Displacement of fished species, noise, sediment and pollution impacts	As for 'Pelagic Ecology' and 'Benthic Ecology'			Early dialogue with recreational fishing groups Pre- and post-deployment monitoring of fish levels around the areas of devices Monitor industry research into the effects of renewable energy installations on fish stocks and fishing efforts Monitor industry research into the effects of EMF on fish
Displacement of fishermen from offshore deployment sites (Safety Zones)	Moderate	Reduced, modified or no restrictions for small vessels	Minor	
Displacement of fishermen from cable landing zones or shore-stations	Moderate	Avoid landing in areas that are heavily used by recreational fishermen. Avoid unnecessary security restrictions that may affect recreational fishermen	Minor	

Potential Impact (prior to mitigation)	Significance (Prior to mitigation)	Mitigation	Residual Significance (After mitigation)	Future Studies, Surveys and Monitoring
Marine and Coastal Historic Environment				
Construction and Decommissioning Phases				
Direct damage to wrecks or artefacts during excavation or deployment of devices or cables	Major	Avoid existing exclusion zones around protected sites Archaeologist to carry out field visits to preferred onshore site locations to determine the need for investigation (trial trenches or geophysical survey) Report any unusual objects found during construction Maintain watching-brief during installation of onshore works	Minor	Archaeological risks, mitigation and survey work to be presented by the developer in a Written Scheme of Investigation (WSI) Carry out sea-bed surveys and investigations in preferred deployment-site locations and along cable routes
Covering of wrecks or artefacts due to use of rock mattresses during installation of devices or cables	Moderate		Minor	
Operation Phase				
Covering or exposure of wrecks or artefacts as a result of sediment displacement (scour or smothering) due to changes in wave or tidal energy	Minor (and possibly positive)	Hydraulic and sediment-transition modelling	Minor (and possibly positive)	Marine renewable energy devices on the sea-bed should be monitored once they are in place. This will provide valuable information on how the structures influence the scouring and/or deposition of sediments and silts around them, which will be relevant to archaeological considerations in the future.
Long-term visual impact affecting the setting of an historic structure	Moderate	Careful site selection	Minor	Project-specific landscape impact assessment

Potential Impact (prior to mitigation)	Significance (Prior to mitigation)	Mitigation	Residual Significance (After mitigation)	Future Studies, Surveys and Monitoring
Existing Submarine Cables, Electrical Grid and Connectivity				
Construction and Decommissioning Phases				
Damage to existing cables	Minor	Use of cable awareness charts and information Careful siting of deployment areas and cable routes	None	Surveys of sea-bed to identify exact cable routing if close to deployment sites
Operation Phase				
Overload of existing grid due to connection of new generating capacity	Minor	Infrastructure upgrades	None	Power systems studies to determine feasibility of connections.

Potential Impact (prior to mitigation)	Significance (Prior to mitigation)	Mitigation	Residual Significance (After mitigation)	Future Studies, Surveys and Monitoring
Shipping and Navigation				
Construction and Decommissioning Phases				
Collision with deployment vessels and deployed devices and cables	Moderate	Notices to Mariners Temporary Safety Zones during deployment VHF safety broadcasts Clear any debris	Minor	
Operation Phase				
Risk of collision with devices	Major	Careful site selection Establishment of a Safety Zone Marking and lighting of devices Notification of UK Hydrographic Office, French Chart providers, Cable Awareness information providers Notices to Mariners Careful design and testing of devices to control electromagnetic interference Surveillance systems	Minor	Hydraulic and sediment transport modelling Marine traffic assessment Project-specific Navigation Risk Assessment Post-deployment monitoring Preparation of an Active Safety Management Plan and an Emergency Response Plan Monitoring of traffic post-construction
Obstruction to Counter Pollution response	Major		Minor	
Obstruction to Search and Rescue activities	Major		Minor	
Reduced visibility due to floating or surface-piercing devices	Minor		Minor	
Electronic/magnetic Interference to radio communications and Radar	Minor		Minor	
Changes to tidal streams, heights and times	Moderate		Minor	
Displacement of shipping leading to increased journey times and distances	Moderate		Moderate	
Displacement of shipping leading to reduced trade opportunities	Minor		Minor	
Displacement of leisure vessels, leading to bypassing of the area	Moderate		Moderate	

Potential Impact (prior to mitigation)	Significance (Prior to mitigation)	Mitigation	Residual Significance (After mitigation)	Future Studies, Surveys and Monitoring
Tourism and Recreation				
Construction and Decommissioning Phases				
Noise during construction	Moderate	Wherever possible, undertake construction outside the peak tourist season (April to September) to minimize disruption to visitors. Avoid main tourist areas e.g. the cliffs on the South coast of Guernsey	Minor	
Water quality	Moderate	As for section on 'Water Quality', but also avoid sensitive areas and main tourist beaches, such as the "blue flag" beaches	Minor	
Operation Phase				
Changes to seascape	As for 'Landscape and Seascape Character'			
Noise generation during operation	Moderate	Reduce or tune noise emissions to levels and frequencies that will not deter tourists	Minor	Research tourists and recreational-users' attitudes to marine renewable energy
Safety and collision risk	Moderate	As for section on 'Shipping and Navigation', but also avoid main cruise routes and water sports' areas. For shoreline devices, avoid recreational areas Where possible, facilitate access through arrays for sailing and water sports, using suitable safety features such as lighting, netting and buoys	Minor	
Restriction of access	Moderate	Careful site selection. Minimise land-take of shore-station	Minor	
Disturbance of wildlife	As for sections on 'Benthic Ecology', 'Pelagic Ecology', 'Birds' and 'Marine Mammals'			
Energy extraction affecting beaches	Moderate	As for section on 'Marine Processes'	Minor	
Creation of tourist attraction	Minor (Positive)	Construction of a visitors' centre	Minor (Positive)	

Potential Impact (prior to mitigation)	Significance (Prior to mitigation)	Mitigation	Residual Significance (After mitigation)	Future Studies, Surveys and Monitoring
Noise				
Construction and Decommissioning Phases				
Increase in underwater noise from construction activities, particularly excavation, piling and drilling. This could lead to temporary or permanent damage to auditory functions of benthic, pelagic, diving-birds and marine mammal species. A barrier to movement may form through animals taking avoiding action. Noise may also act to mask communication.	As for sections on 'Benthic Ecology', 'Pelagic Ecology', 'Birds' and 'Marine Mammals', but particularly: Careful site selection Time the deployment works to avoid interfering with known migration/breeding seasons Use gravity structures for foundations Avoid the use of explosives in excavation Avoid using piling. Failing this the following are mitigation for piling: o Soft start – current best practice o Vibration piling o Resilient pads to reduce sound – might require more force/strokes to compensate Use of deterrents, such as acoustic-avoidance devices, prior to starting work			Baseline noise monitoring and monitoring during construction Keep up-to-date with ongoing research into the behaviour of animals in the proximity of devices
Operation Phase				
Permanent increase in underwater noise from generator devices	As for sections on 'Benthic Ecology', 'Pelagic Ecology', 'Birds' and 'Marine Mammals', but particularly: Reduce or tune noise emissions to levels and frequencies that are not harmful			Baseline noise monitoring and monitoring during operation Project-specific noise assessments Keep up-to-date with ongoing research into the behaviour of animals in the proximity of devices
Permanent low frequency noise disturbance on land from electricity cables and substations affecting the terrestrial environments	Moderate	Ensure all cables are under ground Situate away from population centres, known wildlife breeding sites and livestock areas Utilise noise attenuation measures to reduce noise source released into the environment	Negligible	Baseline noise monitoring and monitoring during operation Ensure continued liaison with people in the area of development.

Potential Impact (prior to mitigation)	Significance (Prior to mitigation)	Mitigation	Residual Significance (After mitigation)	Future Studies, Surveys and Monitoring
Air Quality				
Construction and Decommissioning Phases				
Reduction in air quality due to an increase in marine and shore-side traffic	Minor	Minimise the number and distance of vessel journeys during deployment and operation Undertake maintenance tasks from Guernsey ports Careful selection of site for shore-connection, accounting for local road transport constraints	Minor	Continue existing regime of air-quality monitoring
Operation Phase				
Reduction in air quality due to increased industrial emissions and land transport	Minor	Select devices that require minimal maintenance	Minor	
Improvement in air quality due to reduction of the use of on-island fossil-fuel based electricity generation	Moderate (positive)		Moderate (positive)	

Potential Impact (prior to mitigation)	Significance (Prior to mitigation)	Mitigation	Residual Significance (After mitigation)	Future Studies, Surveys and Monitoring
Landscape and Seascape Character				
Construction and Decommissioning Phases				
Reduction in visual amenity due to increased marine traffic during construction	Minor	Public information about works Optimise vessel and vehicle movements	Minor	Scheme Specific Landscape and Visual Impact Assessment Surveys into public perceptions regarding landscape impact of infrastructure
Operation Phase				
Reduction in visual amenity due to increased marine traffic during construction and maintenance.	Minor	Public information about works Optimise vessel movements	Minor	
Reduction in visual amenity due to permanent visible structures	Moderate	Careful site selection Minimise use of surface-floating or surface-piercing devices	Minor	
Reduction in visual amenity due to presence of maintenance vessels	Minor	Public information about works	Minor	
Reduction in visual amenity due to permanent shore structures	Moderate	Screening of structures with trees	Minor	

20.7. Cumulative Impacts

The scoping report of October 2009 identified the need to investigate the cumulative effects of several energy generation devices, in the form of an array, and also the effects of several arrays in close proximity.

To date, prototype devices have only been deployed singly, or in very small numbers, and for short durations of up to a year. As such, the marine renewable energy industry has not yet been able to present research based on actual measurements taken at array sites.

There are a number of ongoing research projects into some of the impacts of multi-device arrays, for example Project ReDAPT (Reliable Data Acquisition Platform for Tidal), which is being undertaken by a consortium of public and private organisations in the UK.

A key question presented at the scoping stage of the REA was whether there existed any clear thresholds of development, beyond which further deployment would lead to an obviously unacceptable environmental impact (e.g. the loss of an entire species, or activity from Guernsey waters).

There were no clear thresholds that emerged from the assessment. However, the analysis of several of the disciplines was hampered by a lack of baseline information, as well as a lack of prior industry experience of multi-device arrays. Therefore, the REA has concluded that the cumulative effects of multiple devices, or multiple arrays, are unknown at present.

Cumulative impacts may fall into the following categories:

Total development footprint area – The effect of long-term impacts from more than one array. This includes: physical presence, local and far-field effects of energy extraction, permanent loss of habitat, increased operational noise, and the presence of permanently increased levels of marine traffic. As described in section 20.5 above, the significance of these will be highly dependent on the chosen deployment sites and on the types of devices selected. Beyond this, the significance will be broadly proportional to the scale of the development and the proximity of adjacent development areas.

Simultaneous development – The long and short-term effects of the development of two or more arrays simultaneously. This covers the impacts that would occur in addition to those that are purely related to the scale of the development because of concurrent development. An example would be the simultaneous obstruction of multiple migration routes, or feeding areas of key species, which would cause a complete change in species' behaviour.

As little is known about the behaviour of several key species (e.g. marine mammals and large pelagic species), it is difficult to assess the potential impacts of simultaneous development at this time. Therefore, the programming of the deployment of multiple arrays should be approached cautiously. Chapter 21 of this REA stresses the need for a strategic and regional approach to future surveying and monitoring work in order to understand the context of the environmental data obtained in relation to preferred deployment sites. Such research would assist in understanding the impacts of the development of multiple sites.

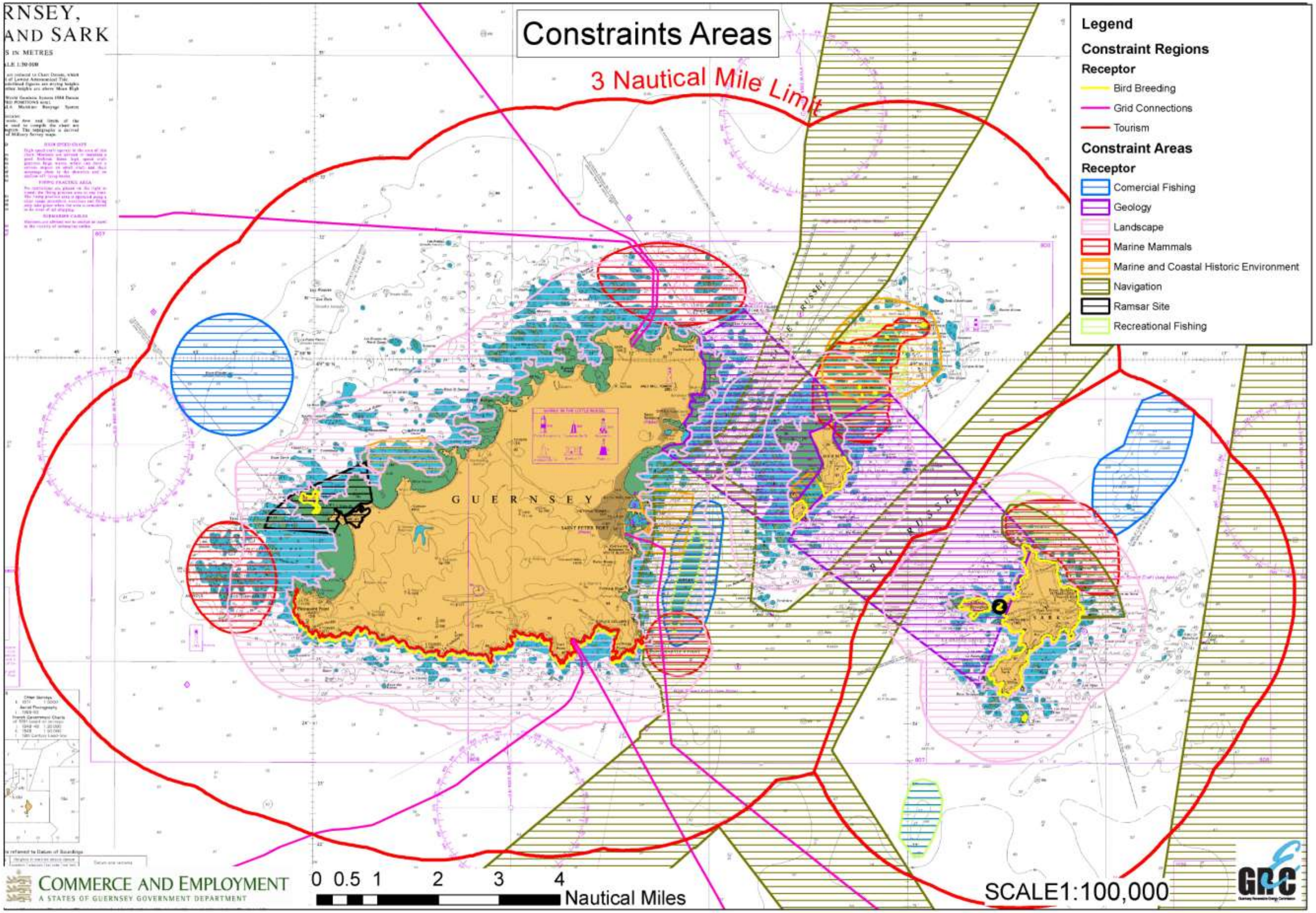
Continuous development – This refers to the impacts that are specific to a protracted deployment programme. Any short-term effects (e.g. the presence of additional marine traffic) extend over several years, possibly affecting (for example) long-term feeding and migrational behaviour. To mitigate this, the duration of the impacts should be reduced wherever possible.

The project should endeavour to keep up-to-date with ongoing industry research, and where appropriate, undertake its own investigations in order to understand cumulative effects better.

20.8 Constrains Mapping

All of the data used in the production of the REA is described in detail in the relevant sections of the main document. Information that can be presented spatially in the form of a map has been stored and reproduced using a Geographical Information System (GIS). This allows data to be filtered and overlaid in various combinations to show different information on nautical charts. On the following pages, the most environmentally sensitive areas are shown.

Figure 5.1 – Constraints map (Image – GREC)



The following explanatory notes relate to the key on the constraints map.

Bird breeding – Cliff areas are identified on all of the islands as potential breeding sites.

Grid connections – Telecommunication cables are shown connecting Guernsey to the UK and France. There is also a power cable coming from the east coast of Guernsey, which connects to France via Jersey.

Tourism / Landscape– Areas of coast on all of the islands are identified as having important landscape value.

Commercial fishing– The most important areas for commercial fishing are focused over sand banks. The Boue Blondel to the west of Guernsey is an important fish spawning ground. The Great Bank off the east coast of Guernsey is extensively fished, as are the sandbanks to the south and north of Sark.

Geology– In the context of sediment dynamics, the most critical areas of the Guernsey REA are the channels of the Big and Little Russel, where there is the highest potential for tidal generation. Although there is a general understanding of the sea bed geology and sediment distribution in these areas, the specific relationships between this and the deployment of energy devices on sedimentation is not established.

Marine mammals– There is a dolphin feeding ground off the southern tip of the Great Bank, which mostly comprises of mackerel. There is also a seal haul-out site at the Humps, north of Herm, which supports a resident population of seals. There are believed to be resident populations of common dolphins off the north of Sark and the north and east coasts of Guernsey.

Marine and coastal historic environment– The areas identified as being of greatest importance are: the area surrounding Vazon Bay on the east of Guernsey; outside Guernsey Harbour;between Herm and Jethou; and to the north of Herm. These areas have been identified as having a high concentration of wrecks.

Navigation– The area through the Little Russel is the key shipping channel into and out of Guernsey. Less sea traffic uses the Big Russel, although it is still an important route.

Recreational fishing – Key sites are the Great Bank to the east of Guernsey and the north coasts of Herm and Sark.

21. Implementation and Monitoring

21.1. Environmental Action Plan

The results of the REA have been used to form an Environmental Action Plan (EAP), which is shown in Appendix L. Together with the Regional Monitoring Plan, the EAP identifies the environmental actions that should be undertaken at every phase of a project's lifetime, including the inception, design, construction, deployment, operation, and decommissioning phases.

The EAP identifies the parties who are considered to be most likely to be responsible for implementation of each of the tasks. However, it is acknowledged that environmental mitigations can only be effectively delivered through close collaboration between all parties involved. With this in mind, it is likely that tasks will be shared between the States of Guernsey and prospective developers by agreement.

In its current form, the EAP applies generically to energy-generation-device types and associated infrastructure that are currently in development. It does not extend to the actions that developers should take in relation to specific technologies.

The EAP should be considered to be a live document that will be updated as more information and understanding is gained about the characteristics of devices, their potential impacts, and the nature of Guernsey's marine environment.

Furthermore, as individual projects are conceived, they may draw upon the strategy of the EAP to form project and device-specific plans. It is likely that these project-specific plans will be used to control and monitor environmental impacts, and to demonstrate compliance with eventual conditions for consent and licensing.

The majority of mitigation measures will be put into action before or during the construction period. The measures mostly relate to the minimisation of negative environmental impacts that would arise from construction activities. However, there are some mitigation measures that are proposed for the operation phase.

Many of the measures that should be implemented during construction are also applicable to the decommissioning phase of a project. It is assumed that there will be considerable technological advances during the lifespan of a renewable energy project (estimated to be 25 years). Therefore, while recommendations can be outlined now, consideration will be given to industry research and best practice that will be available closer to the time of decommissioning.

21.2. Regional Monitoring Plan

In addition to the Environmental Action Plan (EAP) described above, a Regional Monitoring Plan (RMP) has been prepared, which is shown in Appendix M. This covers all the strategic and project-specific survey work and analysis that might be required.

As with the EAP, the RMP is an early draft of a document that should be updated regularly throughout the development of marine renewable energy in Guernsey's waters. It is likely that early, strategic surveys will be undertaken by GREC. These will properly establish constraints prior to the selection of potential deployment sites. Later, details of the monitoring programme and the allocation of specific tasks to involved parties will be discussed, clarified and agreed between the developers, GREC (the planned environmental consenting authority) and its specialist advisors.

This REA stresses the need for a strategic and regional approach to future survey and monitoring work. This is necessary in order to understand the context of the environmental data that will be obtained in relation to preferred deployment sites.

Guernsey's waters are likely to provide unusual deep-water habitats. A current lack of knowledge regarding the nature of these highlights the importance of monitoring at a regional scale. If monitoring were to be only undertaken within the confines of individual deployment sites, without establishing the context of the data that was captured, there would be a risk of misinterpretation. To avoid this, the monitoring plan should maintain a strategic approach.

Therefore, it is important to take every sensible opportunity to gather data about the existing marine environment within the study area. We should follow the development of the industry and the changes occurring in the construction and operation of renewable energy devices in order to understand their impact more fully. However, it is also important to avoid monitoring for the sake of monitoring. This could lead to excessive costs and could unnecessarily limit development opportunities.

The order of priorities for implementation of the monitoring plan should be:

1. Receptors that are most likely to be impacted by marine renewable energy development

2. Receptors that might be impacted, but for which there is currently little research available (e.g. noise emissions of operational devices and the associated behavioural response from key species)

After further strategic research, it might be recognised that the monitoring of some environmental parameters might not distinguish natural variation from that attributable to the presence of a device or activity. In these circumstances, some elements might, in future, be excluded from the monitoring plan.

22. Conclusions and Next Steps

22.1. Conclusions

This Regional Environmental Assessment (REA) has strategically assessed the environmental impact presented by the development and deployment of marine renewable energy devices around the coasts of Guernsey, Herm and Sark.

As a guide to the possible scale of development, the REA has considered a range of deployment capacities from 100MW to 230MW. However, the practicalities of achieving the largest of these deployments will depend on the careful selection of deployment sites and must consider the various geospatial environmental constraints that have been identified.

The REA concludes that, if appropriate mitigation measures are taken, the establishment of a generating capacity of 100MW can be achieved with generally minor effects on the environment. However, there are notable gaps in the knowledge that has been available to the study.

Informing strategic planning and project-level decision-making are the key objectives of the REA. The following key issues require consideration.

- There is a need to obtain better information with regard to:
    - Existing benthic-habitat mapping
    - The behaviour of large fish and mammals in response to the presence of devices
    - The feeding behaviour of seabirds
- The severity of potential impacts has been found to be highly dependent on location. The progression of detailed development proposals requires the careful selection of preferred renewable energy deployment zones.
- The nature and severity of potential impacts is highly dependent on the mode of operation and the characteristics of the devices to be deployed.

22.2. Next Steps

The publication of the Regional Environmental Assessment (REA) and the Non-Technical Summary (NTS) will coincide with the commencement of a period of communication with members of the public. Feedback is welcome from anyone who wishes to comment, although the official period of consultation has ended we are still happy to receive feedback.

Paper copies of the REA will be available for review at the public buildings mentioned in section 1 of the NTS. Copies of the NTS will also be available to take away. Both documents will be available to download from the GREC website (www.guernseyrenewableenergy.com).

The feedback received on this version of the REA will be used to plan future investigations to support the environmental assessment process.

As shown in Figure 3.1, the REA will contribute to the selection of renewable energy deployment zones and to the formation of an environmental consenting process to be applied to development applications.

The REA should be considered as a working document. It may be reviewed and updated as necessary to account for additional survey information or the completion of research. As new technologies are developed, these may be assessed and incorporated into future versions of the REA.

The timescale for the deployment of marine renewable energy devices in Guernsey's waters is difficult to determine. It is clear that an exploitable energy resource exists, particularly with respect to tidal energy. However, the time the industry requires to develop devices to the point that they can be manufactured and deployed at commercial scales is unknown. Furthermore, the cost of renewable energy is still high in relation to that produced from fossil fuels, and this may deter early adoption. Discussions with a number of developers indicate that they anticipate readiness for deployment (machines in the water generating electricity) on a commercial scale by 2015 at the earliest. The 2015 timeline has been reached with regards to Guernsey taking into account the following points:

- The current state of the industry, there are no arrays installed anywhere in the world, just a small number of individual devices. As Guernsey does not wish to deploy prototype or demonstrator devices this is an important constraint;
- The requirement of infrastructure to be deployed, there is an approximate 3 year lead in time to get cables laid;
- The need for a detailed Environmental Impact Assessment to be completed as part of the application process, which would require survey work, amongst other activities.

However, GREC is undertaking work to be prepared for when the industry is ready for full scale deployment, of which this REA forms a part. Once the relevant work is completed Guernsey will be ready to proceed with development, whenever that may be.