DECC

SEVERN TIDAL POWER - SEA TOPIC PAPER

Noise & Vibration

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ABBREVIATIONS

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The following abbreviations are used in this Topic Report:

BS	British Standard
AONB	Areas of Outstanding Natural Beauty
BERR	Department for Business, Enterprise and Regulatory Reform
DECC	Department of Energy and Climate Change
Defra	Department for Environment, Food and Rural Affairs
EC	European Commission
EHO	Environmental Health Office
EIA	Environmental Impact Assessment
END	Environmental Noise Directive
EU	European Union
GIS	Geographical Information System
GW	Gigawatts
HRA	Habitats Regulations Assessment
Hz	Hertz
LA	Local Authority
LNR	Local Nature Reserve
M&E	Mechanical and Electrical
MW	Megawatt
NERC	Natural Environment and Rural Communities Act
NNR	National Nature Reserve
NP	National Park
NPS	National Policy Statement
NSR	Noise Sensitive receptor
ODPM	Office of the Deputy Prime Minister
PB	Parsons Brinckerhoff Ltd
PPG	Planning Policy Guidance
PPG	Planning Policy Guidance
PPS	Planning Policy Statements
PSA	Public Service Agreement
PWS	Public Water Source
RIGS	Regional Important Geological Sites
SAC	Special Area of Conservation
SDC	Sustainable Development Commission
SEA	Strategic Environmental Assessment
SLR	Sea Level Rise
SNCI	Sites of Nature Conservation Importance
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
STP	Severn Tidal Power

STPG	Severn Tidal Power Group
TAN	Technical Advice Note
TAN	Technical Advice Note
TWh	Terrawatt hours
UKCIP	United Kingdom Climate Impacts Programme
UN	United Nations
VDV	Vibration Dose Value
WFD	Water Framework Directive
Wm	Frequency Weighting

NON TECHNICAL SUMMARY

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Introduction

A strategic environmental assessment (SEA) is being conducted as part of the Severn Tidal Power (STP) feasibility study, in accordance with the requirements of the EU SEA Directive and UK Regulations. The SEA comprises two phases: Phase 1, the scoping stage, has already been undertaken. This noise & vibration topic paper forms part of the reporting arising from Phase 2, the main assessment of short-listed options.

Consultation

The following consultation activities have been undertaken:

- Scoping consultation in January 2009
- Technical Workshops (TW)- stakeholders were invited to TW1 (workplans) &TW2 (assessment update)
- Turbine manufacturers were consulted to provide noise data
- Renewable Energy Specialists were consulted for acoustic data
- Environmental & Acoustic Consultancies were also consulted.

SEA Objectives

SEA Objectives have been developed to enable alternative options to be compared. Objectives may not necessarily be met in full by a given alternative option, but the degree to which they do will provide a way of identifying preferences when comparing effects of alternative options. The SEA Objectives for this topic are listed below:

- To avoid adverse effects of negative noise and vibration on (humans) noise sensitive receptors
- To avoid adverse effects on the acoustic quality of the marine environment
- To avoid adverse effects on noise (vibration) sensitive receptors
- To avoid adverse effects through vibration

Baseline Environment

Baseline information provides the basis for predicting and monitoring environmental effects, by describing the area that may be affected. Due to the long timescales associated with the construction and operation of alternative options, baseline information is considered over three time periods, to reflect the predicted changes in the area when considered without the development of a Severn Tidal Power project. The baseline therefore also describes the estuary in a 'do-nothing' scenario.

Baseline environment up to 2009

- Noise Sensitive Receptors (Human & Non-Human): Noise climates in the study area vary considerably from quiet rural areas to noisy urban areas. Sources of noise include transportation, commercial and industrial activities.
- Marine Environment (Underwater receptors): Estuaries by their nature (relatively shallow with large volumes of water movements) are naturally noisy environments. The Severn Estuary is a busy commercial estuary with large tankers and smaller ships brining cargo from around the world. The estuary also supports recreational uses such as motor boats, sailing boats and fishing vessels. The result is that the estuary will be relatively noisy environment, but due to the relatively shallow water, long distance propagation will not be supported, resulting in noise propagation being relatively localised.

Future baseline during construction: 2014-2020

- Noise Sensitive Receptors (Human & Non-Human): Noise levels are predicted to increase gradually over time irrespective of any of the considered alternatives.
- Marine Environment (Underwater receptors): Noise levels are not anticipated to alter greatly from the Baseline environment.

Future baseline during operation 2020-2140, decommissioning and longer term trends

- Noise Sensitive Receptors (Human & Non-Human): Noise levels are anticipated to increase over time, with some local exceptions.
- Marine Environment (Underwater receptors): Very little is known of the specific noise levels within the underwater marine environment. However, noise as a pollutant is likely to be controlled in a similar way to the terrestrial noise environment in the interest of preserving the marine environment, therefore it is likely that over time, noise levels in the marine environment will stabilize and if necessary, fall.

Key Environmental Issues and Problems

The major issues for noise and vibration are construction, operation and decommissioning of the alternatives. Information availability has limited the scope of the assessment, partly due to the Strategic level of the appraisal, as well as a genuine lack of methodology and previous assessments for the underwater aspects. Tidal technology is relatively new, and previous tidal projects have not undergone such thorough environmental appraisals covering noise, resulting in a lack of data availability.

Evaluation of Plan Alternatives

Assessment Methodology

The SEA Directive specifies the criteria that should be taken into account when determining the likely significant effects of the plan and thus these criteria have been adopted throughout the assessment process of this SEA. This topic paper therefore considers the characteristics of the effects and of the area likely to be affected.

This topic has also used the following specific assessment methods. Essentially, due to the above issues, the available data upon which to begin this assessment has required a thorough literature review in order to identify the availability of information relative to tidal technology & underwater noise levels.

- The number of sensitive receptors that will be affected by noise & vibration associated with the alternatives will be identified using the landfall footprint of the proposals;
- Estimation of the number of properties to significant levels of noise & vibration in line with guidance and codes of practice for each option;
- Identification of areas where noise & vibration increases could require measures to prevent or reduce adverse effects;
- Identify buildings likely to be exposed to perceptible vibration as a result of the alternatives;

Alternative Options

There are five shortlisted alternative options that are being assessed within Phase 2 of the SEA for their likely significant effects. These alternative options and key parameters associated with the alternative options are:

Alternative	Location	Length (approx)	Operating mode	Turbine type	No. turbines	Annual energy output	Caissons	Locks
B3: Brean Down to Lavernock Point Barrage	Lavernock Point to Brean Down	16km	Ebb only	Bulb-Kapeller	216 (40MW)	15.1 to 17.0 TWh/year	129	2
B4: Shoots Barrage	West Pill to Severn Beach	7km	Ebb only	Bulb-Kapeller	30 (35MW)	2.7 to 2.9 TWh/year	46	1
B5: Beachley Barrage	Beachley to land directly to the east on the English side	2km	Ebb only	Straflo	50 (12.5MW)	1.4 to 1.6 TWh/year	31	1
L2: Welsh Grounds Lagoon	River Usk to Second Severn Crossing	28km	Ebb only	Bulb	40 (25MW)	2.6 to 2.8 TWh/year	32	1
L3d: Bridgwater Bay Lagoon	Brean Down to Hinckley Point	16km	Ebb & Flood	Bulb-Kaplan	144 (25MW)	5.6 to 6.6 TWh/year	42	1

Assessment of Likely Significant Effects on the Environment

Alternative Option B3: Brean Down to Lavernock Point Barrage (also known as Cardiff to Weston)
Terrestrial Receptors:

- Construction noise may effect up to 22 human NSRs, which lie within 800m of the landfall footprint of the B3 alternative. Ten sites designated for nature conservation are located within 2000m of the landfall points.
- Construction noise levels are predicted to drop to typical background noise levels within 800m of the construction site, with the exception of piling (which is not anticipated to be required during the construction phase).
- Operational noise is not anticipated to result in any significant noise effects due to distances from the landfall footprint to the nearest NSRs.
- Decommissioning is anticipated to result in similar noise effects to that of the construction phase.

Underwater Receptors:

- Construction noise is anticipated to result in some noise effects on underwater receptors.
- Operational Noise levels from turbine and ancillary plant is anticipated to result in some noise effects on underwater receptors, this is most likely to be relatively local in nature.
- There is always some potential for concurrent dredging activity in the location of the B3 alternative option

Alternative Option B4: Shoots Barrage
Terrestrial Receptors:

- Construction noise may effect up to 44 human NSRs, which lie within 800m of the landfall footprint of the B4 alternative. Five sites designated for nature conservation are located within 2000m of the landfall points.
- Construction noise levels are predicted to drop to typical background noise levels within 800m of the construction site, with the exception of piling (which is not anticipated to be required during the construction phase).
- There is some potential for concurrent construction and operational noise due to the proposed Bristol Port Deep Sea Container terminal in the vicinity of the B4 alternative option
- Operational noise is not anticipated to result in any significant noise effects due to distances from the landfall footprint to the nearest NSRs, the closest NSRs being over 400m from the landfall footprint.
- Decommissioning is anticipated to result in similar noise effects to that of the construction phase.

Underwater Receptors:

- Construction noise is anticipated to result in some noise effects on underwater receptors.
- Operational Noise levels from turbine and ancillary plant is anticipated to result in some noise effects on underwater receptors, this is most likely to be relatively local in nature.
- There is potential for concurrent construction and operational noise due to the proposed Bristol Port Deep Sea Container terminal in the vicinity of the B4 alternative option

Alternative Option B5: Beachley Barrage
Terrestrial Receptors:

- This alternative has the greatest number of human NSRs within 200m of the landfall footprint, and thus may result in a greater effect on the receptors, assuming the construction activity occurs at the location of the landfall footprint. Construction noise may effect up to 133 NSRs, which lie within 800m of the landfall footprint of the B5 alternative. Seven sites designated for nature conservation are located within 2000m of the landfall points.
- Construction noise levels are predicted to drop to typical background noise levels within 800m of the construction site, with the exception of piling (which is not anticipated to be required during the construction phase).
- There is also the potential for some concurrent construction noise due to the proposed Oldbury power station.
- Operational noise has the potential to have some effect on the most local NSRs (as there 24 NSRs within 200m of the landfall footprint). However, operational noise levels will be controlled through the use of statutory provisions controlling noise pollution. Noise is therefore not anticipated to result in any significant noise effects due to regulatory control.
- Decommissioning is anticipated to result in similar noise effects to that of the construction phase.

Underwater Receptors:

- Construction noise is anticipated to result in some noise effects on underwater receptors.
- Operational Noise levels from turbine and ancillary plant is anticipated to result in some noise effects on underwater receptors, this is most likely to be relatively local in nature.
- There is always some potential for concurrent dredging activity in the location of the B5 alternative option.

Alternative Option L2: Welsh Grounds Lagoon
Terrestrial Receptors:

- Construction noise may effect up to 14 human NSRs, which lie within 800m of the landfall footprint of the L2 alternative. Eight sites designated for nature conservation are located within 2000m of the landfall points.

- Construction noise levels are predicted to drop to typical background noise levels within 800m of the construction site, with the exception of piling (which is not anticipated to be required during the construction phase).
- Operational noise is not anticipated to result in any significant noise effects due to distances from the landfall footprint to the nearest NSRs.
- Decommissioning is anticipated to result in similar noise effects to that of the construction phase.

Underwater Receptors:

- Construction noise is anticipated to result in some noise effects on underwater receptors.
- Operational Noise levels from turbine and ancillary plant is anticipated to result in some noise effects on underwater receptors, this is most likely to be relatively local in nature.
- There is always some potential for concurrent dredging activity as a result of the proposed locations for further marine aggregate dredging in the location of the L2 alternative option.

Alternative Option L3d: Bridgwater Bay Lagoon
Terrestrial Receptors:

- Construction noise may effect up to 18 human NSRs, which lie within 800m of the landfall footprint of the L3d alternative. Seven sites designated for nature conservation are located within 2000m of the landfall points.
- Construction noise levels are predicted to drop to typical background noise levels within 800m of the construction site, with the exception of piling (which is not anticipated to be required during the construction phase).
- There is also the potential for some concurrent construction noise due to the proposed Steart Coastal Management project along with the decommissioning of Hinckley A & B and the commissioning of Hinckley C. These concurrent proposals may result in an intensification of noise generating activities.
- Operational noise has the potential to have some effect on the most local NSRs (as there 10 NSRs within 200m of the landfall footprint). However, operational noise levels will be controlled through the use of statutory provisions controlling noise pollution. Noise is therefore not anticipated to result in any significant noise effects due to regulatory control.
- Decommissioning is anticipated to result in similar noise effects to that of the construction phase.

Underwater Receptors:

- Construction noise is anticipated to result in some noise effects on underwater receptors.
- Operational Noise levels from turbine and ancillary plant is anticipated to result in some noise effects on underwater receptors, this is most likely to be relatively local in nature.
- There is some potential for concurrent construction and operational noise due to the proposed Steart Coastal Management activity in the vicinity of the L3d alternative option

Assumptions, Limitations and Uncertainty

The most limiting factor relative to this topic assessment is the lack of specific information available from previous similar projects. Tidal technology is relatively new, and previous tidal projects have not covered noise within their environmental appraisals. This has resulted in a lack of data. Due to 'strategic' stage of assessment, limited detailed information relating to construction techniques, exact locations for the alternatives & ancillary works.

Measures to prevent, reduce and as fully as possible offset any significant adverse effects

The measures identified to prevent or reduce likely significant adverse effects identified within this topic are described below.

The greatest noise effect resulting from any alternative is the construction phase within both the marine and terrestrial environment. Various techniques can be applied to reduce noise effects, Consultation with the local authority will be undertaken along with the production of a Construction Environmental Management Plan (CEMP) where measures will be identified as required to minimise noise levels, and ensure noise levels are kept below the construction noise limits. Due to the extended periods of construction noise due to the scale of the project, it would be pertinent to agree acceptable noise levels for the construction phase with the local planning authority, and monitor that noise levels remain within agreed limits.

In order to prevent or reduce effects arising from disturbance (including noise and vibration) identified in the Communties topic, the following measures are proposed:

- Reducing the number of vehicles on local roads through rationalising deliveries and use of larger vehicles.
- Delivery of construction materials by alternative routes, such as by rail or by sea and maximising the use of existing temporary/permanent works arrangements.

Given the potential benefits of such an approach, it is recommended that consideration is given to applying a similar approach to the other two options (B4 and B5) where construction effects would still be felt, but the current predicted effect arising from HGV traffic is lower.

Offsetting measures within this SEA are those measures that make good for loss or damage to an environmental receptor, without directly reducing that loss/damage. In this SEA 'compensation', a subset of offsetting is only used in relation to those measures needed under the Habitats Directive.

The effects of noise are not anticipated to require off-setting measures.

Assessment against SEA Objectives

This topic paper includes a full assessment of how each alternative option performs against each SEA Objective over the course of its entire life-cycle.

In summary:

SEA Objective 1: To avoid adverse negative effects of noise and vibration on (humans) noise sensitive receptors (NSRs).

Using the landfall footprint of each of the alternatives it is clear that some alternatives will have a greater effect due to the proximity of alternative to NSRs.. However, following the adoption of appropriate measure to prevent or reduce adverse effects, noise levels will be reduced to within levels that are not considered to be significant. All alternative options therefore score within a range of no effect (0) to minor negative (-) against this Objective to reflect that even when measure to prevent or reduce are in place noise may still be heard.

SEA Objective 2: To avoid adverse effects on the acoustic quality of the marine environment.

The avoidance of adverse effects on the marine environment is possible through use of careful planning and utilising available measures to prevent or reduce adverse effects. .This is considered further in the Marine Ecology and Migratory & Estuarine Fish topic paper.

Given the uncertainty in the baseline noise environment and turbine noise it is not possible to determine the level of compliance against this objective for any of the alternative options. The performance against this Objective has therefore been scored as Uncertain. An underwater noise

baseline assessment would be required along with detailed information on acoustic data for the operational noise levels.

The effects in relation to this objective are discussed in more detail in the Marine Ecology (STP 2010i) and Migratory & Estuarine Fish (STP 2010k) topic papers.

SEA Objective 3: To avoid adverse effects on noise (vibration) sensitive receptors.

SEA Objective N&V 3 relates to adverse effects on noise & vibration sensitive terrestrial ecology receptors.

Following consideration and implementation of measures to prevent or reduce adverse effects, the effects of the alternative options on terrestrial ecology receptors are expected to be reduced to a level where this objective can met. Consequently, a minor positive score for performance against this objective has been attributed for all alternative options.

The effects of this objective are discussed in more detail in the Terrestrial & Freshwater Ecology topic paper (STP 2010o).

SEA Objective 4: To avoid adverse effects through vibration.

No building structures have been identified at distances considered to expose them to significant vibration. Therefore, a no effect score has been attributed.

Plan Implementation

Legislation and policy compliance

This paper contains a review of legislation and policy that is specifically relevant to this topic. An assessment has been made as to whether each alternative option would be compliant with existing relevant legislation and policy.

All of the alternatives will be fully compliant with the existing legislation and policies detailed in section 2.3.

Monitoring of significant environmental effects

The SEA Directive requires that monitoring measures are described within the environmental reporting. The monitoring proposals contained within this paper are applicable to all of the alternative options under consideration.

There are no significant environmental noise effects anticipated with any of the alternatives. However, it should be stated that there is a requirement to undertake monitoring of the baseline noise environment within the area of the selected alternative, should this feasibility study go forward to EIA stage in order to quantify the underwater noise environment. This will be required in order to assess any potential effects that may arise as a result the implementation of this feasibility study.

It must also be noted that for large-scale construction projects, it is often a requirement that noise monitoring occurs throughout the construction process to ensure that noise levels are within those agreed and / or recommended. This is often a requirement of the local authority within whose jurisdiction the construction works occur.

SECTION 1

INTRODUCTION

1 INTRODUCTION

1.1 Introduction

1.1.1 The Government announced a two-year feasibility study on harnessing the renewable energy from the tidal range in the Severn Estuary in January 2008. This work is being carried out by a cross-Government team led from the Department for Energy and Climate Change (DECC), including representatives of the Welsh Assembly Government (WAG) and the South West Regional Development Agency (SWRDA), taking external advice as necessary and engaging stakeholders and the wider public. The aim of the Severn Tidal Power (STP) Feasibility Study is to investigate whether Government could support a tidal power scheme in the Severn and, if so, on what terms.

1.1.2 The Feasibility Study is split into two phases:

- Phase One: Examining the scope of work and analysis required to make an evidence-based decision on whether to support a tidal power project in the Severn and what potentially feasible schemes exist for converting this energy. Phase one ended with the publication of the consultation document in January 2009.

- Phase Two: Work on environmental, regional, economic, commercial, technical and regulatory issues to inform the study conclusions including whether any of the potentially feasible schemes are feasible.

1.1.3 A Strategic Environmental Assessment (SEA) is being carried out in support of the Feasibility Study, in accordance with EU Directive 2001/42/EC (the SEA Directive), implemented in England and Wales through the Environmental Assessment of Plans and Programmes Regulations (SI 2004/1633 and Welsh SI 2004/1656), to predict and analyse the environmental effects of alternative short-listed Severn tidal power options over their entire lifetime, in order to inform decision making at the end of the Feasibility Study.

1.1.4 In parallel to the Feasibility Study, the Severn Embryonic Technologies Scheme is helping developers of emerging technologies map their development path. They are not being assessed as part of this SEA currently, as they are not at the stage whereby they can be considered reasonable alternatives.

1.1.5 The scope of the SEA, published by the Government in January 2009 (DECC, 2009a) is based on the assessment of a defined set of issues within 'topic papers'. These papers will be aggregated into 'theme' papers to ensure that the interrelationships between effects are considered and understood – see Section 1.2. The topic and theme papers will provide supporting information to the Environmental Report that is needed to fulfil the requirements of the SEA Directive.

1.1.6 This is the Noise & Vibration topic paper within the Society & Economy theme. This topic will establish the key noise and vibration issues produced by the development of the main options under consideration. Key noise and vibration issues will be identified and quantified in terms of the potential magnitude of the effect. This information will be used to determine what can be done to address and mitigate against the effects of the various options, and will also inform the ecological aspects of the process in order to provide a fully informed response. It should be noted that only a qualitative assessment can be made at the strategic level.

1.2 Interfaces between topics and other work conducted within Feasibility Study

1.2.1 Each SEA topic paper sits within a theme of related topics – see Table 1.1 below. The theme papers reflect the many inter-relationships associated with the Severn estuarine system, and provide an additional tier of technical reporting to ensure that the many complex issues that are not self-contained within a given topic are recognised and their implications understood.

Table 1.1 SEA themes and topics

SEA Theme	SEA Topics
Physicochemical	Hydraulics & Geomorphology; Marine Water Quality; Freshwater Environment & Associated Interfaces; Flood Risk & Land Drainage
Biodiversity	Waterbirds; Terrestrial & Freshwater Ecology; Marine Ecology; Migratory & Estuarine Fish
Landscape & Historic Environment	Landscape & Seascape; Historic Environment
Society & Economy	Communities; Navigation; Other Sea Uses; Noise & Vibration
Air, climatic factors, Resources & waste	Air & Climatic factors (including Carbon Footprint); Resources & Waste

1.2.2 The SEA, and its supporting studies captured within each topic paper, comprises part of the Feasibility Study. Other relevant studies within the Feasibility Study but not contained within the SEA include supply chain, electricity grid connection, and ecosystem goods and services valuation studies.

1.3 Consultation

1.3.1 Both the Feasibility Study and the SEA within it have included a programme of formal and informal consultation activities. These include the public consultation exercise in early 2009, technical workshops during both Phase 1 and 2, and informal meetings and other communications. These are summarised for this topic below.

Scoping Consultation

1.3.2 In January 2009, Government launched a consultation on the conclusions of the first phase of the Feasibility Study (DECC, 2009a). The consultation included a recommended short-list of schemes for more detailed analysis, and provided the scope of the SEA. The Government's consultation response published in July 2009 confirmed the shortlist of alternative options, and the scope of the SEA (DECC, 2009b).

1.3.3 Contact with a number of individuals and organisations involved in the marine or energy industry was made in order to talk through the methodology and available information relating to the subject of this topic paper, particularly in the field of underwater acoustics.

Technical Workshops

1.3.4 A series of 'Technical Workshops' was convened during phase 1 and 2 of the Feasibility Study, principally to provide the opportunity for technical specialists across many organisations to input to the developing SEA. Table 1.2 below summarises the workshops offered in support of this topic.

Table 1.2 SEA Technical workshops for Noise & Vibration SEA topic

Phase, date	Workshop purpose
Phase 1, [23/07/08]	To undertake a preliminary scoping of issues and the assessment approach needed within phase 1 of the SEA.
Phase 2, [17/06/09]	Workplan, Data collection for baseline & future baseline, Assessment of significant effects & Value, vulnerability & magnitude of effect and Uncertainties of prediction/ assessment.
Phase 2, [13/01/10]	Assessment update: feasibility study, handling uncertainty, baseline & future baseline and results & predicted effects

1.3.5 Consultation was offered at each stage along with the other topic papers and workshop slides were produced. The number of Consultees interested in noise was much lower than that for other topics.

Other Consultation

1.3.6 A number of individuals and organisations involved in the marine or energy industry were contacted as part of the consultation process. Input provided from the workshops held has also been included.

1.3.7 The Feasibility Study Workstreams have also had the opportunity to comment on the developing papers through the circulation of working papers at various point during the phase 2 work.

1.4 SEA Objectives

1.4.1 SEA Objectives are a recognised tool for comparing alternative options. This technique is proposed in the SEA Practical Guide (ODPM et al., 2005). SEA Objectives usually reflect the desired direction of change. It therefore follows that these objectives may not necessarily be met in full by a given option, but the degree to which they do will provide a way of identifying preferences when comparing options.

1.4.2 This approach requires judgments to be made on the performance of alternative options against each SEA Objective. 'Assessment criteria' and 'indicators' have also been developed to aid these judgements. The assessment criteria are a series of questions developed to guide the judgement of objective compliance. An indicator is measure of a variable over time, often used to measure achievement of objectives.

1.4.3 The SEA Objectives, assessment criteria and indicators were drafted and consulted upon as part of the Phase 1 SEA scoping stage. The Government response to the consultation for the most part confirmed the SEA Objectives and in some cases made some minor modifications (DECC, 2009b).

1.4.4 The SEA Objectives for noise and vibration are listed in Table 1.3 below.

Table 1.3 SEA Objectives, Assessment Criteria and Indicators for Noise & Vibration

SEA Objective	Assessment Criteria	Indicators
NV.1 To avoid adverse negative effects of noise and vibration on (humans) Noise sensitive receptors.	Noise & vibration levels	Distance from noise & vibration source to receiver
NV.2 To avoid adverse effects on the acoustic quality of the marine environment.	Noise & vibration levels	Distance from noise & vibration source to receiver
NV.3 To avoid adverse effects on noise (vibration) sensitive receptors.	Noise & vibration levels	Distance from noise & vibration source to receiver
NV.4 To avoid adverse effects through vibration.	Noise & vibration levels	Distance from noise & vibration source to receiver

1.4.5 Objective NV1 is concerned with the avoidance of effects on humans, and NV2 is concerned with the avoidance of effects on the marine environment. NV3 looks at the effects on wildlife, and NV4 the effects on buildings. It is noted that whilst the input and background information for each objective is contained in this topic paper, the effects under objectives NV.2 & 3 are discussed in other topic papers.

1.4.6 For the purposes of understanding the context of this topic paper, it may help to make the reader aware that the scope of this paper for humans and for buildings will be in the main set against defined statutory targets which are identified later in Section 2. These tools consider, for humans, what would be a typical community response to noise based on human health effects and the average response to noise and vibration. The effects on the non-human environment is outside the scope of this topic paper, however, the magnitude of noise and vibration can be quantified in order to allow other topics to assess the effects of noise and vibration on marine ecology, birds, fish etc.

SECTION 2

BASELINE ENVIRONMENT

2 BASELINE ENVIRONMENT

2.1 Introduction

2.1.1 Baseline information provides the basis for predicting and monitoring environmental effects. Both qualitative and quantitative information can be used for this purpose.

2.1.2 The baseline information is described for the area that may be affected in terms of a range of 'receptors'. A receptor is an entity that may be affected by direct or indirect changes to an environmental variable. Relevant receptors were identified and consulted upon during the SEA scoping stage.

2.1.3 Alternative options considered within this Feasibility Study would only be developed several years into the future and would have a long life. It is therefore necessary to project a 'future baseline' against which to compare effects, rather than using the present day baseline. This is an especially important concept when considering dynamic systems such as estuaries that are subject to climate change effects such as sea level rise.

2.1.4 The approach taken is therefore to describe baseline information in the following stages:

- Baseline environment and receptors up to 2009, including environmental problems and opportunities;
- Future baseline during construction: 2014-2020, including anticipated problems and opportunities;
- Future baseline during operation 2020-2140, decommissioning and longer term trends, including anticipated problems and opportunities.

2.1.5 This paper describes the baseline for the relevant receptors with this topic. It will thereby inform the description of the baseline environment for the affected area as a whole, contained within the SEA Environmental Report.

Study areas

2.1.6 The noise and vibration topic study area was defined on a geographical basis (as noise spreads geographically from a noise source). A study area of 2km was considered sufficient for the purposes of the assessment of significant effects. This area is considered sufficient for options appraisal, but it is acknowledged that in rural environments, noise could have the potential to affect receptors at greater distances, although the effects are minimal.

Receptors

2.1.7 Noise and Vibration has the potential to affect people, wildlife and in extreme cases buildings. The potential effects range from mild irritation to structural damage. Describing receptors and assessing their sensitivity in the manner prescribed under the SEA Objectives is necessarily complex.

2.1.8 Initially the noise and vibration topic defined receptors in such a way that the description provided the reader with some understanding of the sensitivity of the receptor to change. For example, 'urban areas near major transportation

infrastructure' would suggest a relatively noisy environment, less sensitive to changes in noise levels in comparison to 'rural areas' suggesting a quieter environment that would be more sensitive to change. During the process of defining a receptor's value and vulnerability, it became apparent that a more 'specific' definition was required. It was therefore considered appropriate to amend the receptor definition to that contained within the Institute of Environmental Management & Assessment (IEMA) / Institute of Acoustics (IoA) guidance document, Draft Guidelines for Noise Impacts Assessment, 2002.

2.1.9 Where the baseline environment has been described, receptors have been summarised as either residential, or non-residential. This is due to the way in which noise affects the residential environment more in the evening and night, and non-residential receptors are generally more affected during the daytime. This definition does not extend to the marine environment which is dealt with later.

Table 2.1 Table of Receptors for Noise & Vibration

Classification	Receptor
Residential	Residences
Non Residential	Schools & Colleges
	Hospitals
	Places of Worship
	Commercial
	Industrial
	Farms, kennels and wildlife sites
	Open Air Amenities

2.2 Methodologies used to develop the baseline

Sources of Data

2.2.1 For the purposes of this study, the baseline data has been gathered by way of desk-top study using the landfall footprint of the short-listed options.

2.2.2 In order to identify the noise baseline environment, the noise & vibration topic reviewed the following sources of data:

- Environmental Noise Maps produced for England and Wales as part of the Environmental Noise (England) / (Wales) Regulations 2006 (END), as published;
- Local Authorities (LA's) held data – information has been requested relating to regional planning framework policies, pending development that may affect, or be affected by the proposals, noise complaints that the development may give rise to, noise sensitive receptors that the local authority is aware of, and any other issues the LA considers pertinent to the proposals;
- Historical Reports & Studies - relevant published information relating to the proposal options, and related texts;
- Literature Review – relevant published information relating to the proposal options, and related texts.

2.2.3 These sources provided some data covering the study area, but not all areas were covered, the data was out of date in some cases, and only presented a snapshot of the likely noise environment. No vibration data was available. What data was available has been detailed in the cumulative effects sections of the alternatives.

Assumptions, limitations and uncertainty

2.2.4 It is important to acknowledge the assumptions, limitations and uncertainties inherent in predicting changes to complex systems at a strategic level. Where possible, generalised assumptions and approaches for dealing with uncertainty have been developed to be applied consistently across the topics, as is the case with Climate Change and Policy. Where this is not possible and topic-specific consideration is required, the assumptions, limitations and uncertainty are clearly identified. Further detail is given below.

General Climate Change Assumptions

2.2.5 In developing the future baseline projections, assumptions are made about environmental trends, and policy responses to these trends. It has been assumed that UK Climate Projections (UKCP09) central estimate projections for the medium emissions scenario apply for most topics (UKCP09, 2009).

General Assumptions Concerning Application of Government Policy

2.2.6 It also has been assumed that, in general, existing Government policies relating, for example, to climate change response and biodiversity, will continue to apply into the future. .

Topic Specific Assumptions, Limitations and Uncertainty

2.2.7 At this high level, strategic stage, where little data is available to determine environmental noise levels without undertaking noise measurements, a qualitative assessment is made involving the use of the maps, standard guidance documents and professional judgement. This method of identifying appropriate noise levels relative to the environment is considered appropriate for the purpose of identifying the land-based environment. Future trends in noise levels again are not expressly defined or documented; however, it is clear that environmental noise is on the increase.

2.2.8 It should also be noted that due to the relatively remote location of the land surrounding the Severn Estuary, much of the area does not have any associated mapping. Some small sections of the Estuary near the motorway network, rail links and some of the larger industrial areas do have associated maps. However, due to the partial coverage, these are of limited use, and where they are available, they offer predicted 'average' noise levels.

2.3 Links to existing legislation and policy

2.3.1 A review has been conducted of relevant national, regional and local policies, plans and programmes, to assist with the identification of synergies and potential inconsistencies with the Feasibility Study, and thus contributing to the development of SEA Objectives (STP, 2009a). Existing legislation and policy of particular relevance to this topic are summarised below.

2.3.2 The Department of the Environment (DoE) document *Planning Policy Guidance note 24 (PPG24): Planning and Noise*, and the Welsh Assembly Government *Technical Advice Note 11 (TAN11)* give guidance to local authorities on the use of their planning powers to minimise the adverse effects of noise. The documents outline the considerations that should be taken into account when determining planning applications for noise sensitive developments and for activities that will generate noise.

2.3.3 The British Standards Institution (BSI) document *BS 8233: 1999; Sound Insulation and Noise Reduction for Buildings – Code of Practice* gives recommendations for the control of noise in and around buildings, and suggests appropriate criteria and limits for different situations. The code is primarily intended to guide the design of new or refurbished buildings, but it does provide a source of noise levels for common situations, such as typical traffic noise levels at the facades of buildings.

2.3.4 The British Standards Institution document *BS 5228-1: 2009 Code of Practice for Noise and Vibration Control on Construction and Open Sites. Part 1: Noise* gives recommendations for basic methods of noise control relating to construction and open sites where work/activities generate significant noise levels. Part 1 provides guidance concerning methods of predicting and measuring noise and assessing its effects.

2.3.5 The British Standards Institution document *BS 5228-2: 2009 Code of Practice for Noise and Vibration Control on Construction and Open Sites. Part 2: Vibration* gives recommendations for basic methods of vibration control relating to construction and open sites where work/activities generate significant vibration levels. Part 2 provides guidance concerning methods of predicting and measuring vibration and assessing its effects.

2.3.6 *The Environmental Noise (England) / (Wales) Regulations 2006* are the transposition of the EU Directive 2002/49/EC into English and Welsh legislation respectively. These Regulations require Member States to produce noise maps for large urban areas, major transport sources (road, rail and air traffic), and significant industrial sites. Following production of the maps, Action Plans are required to be produced and consulted upon which aim to mitigate areas exposed to the highest noise environments, or where the highest population densities are affected. At time of writing, the Action Planning process for Round 1 Mapping is underway.

2.3.7 There is currently a void in available good practice guidance for Environmental noise impact assessment. The Institute of Environmental Management and Assessment (IEMA) / IoA document *'Guidelines for Noise Impact Assessment' (Draft)* was issued in 2002 for consultation, but has yet to be formally finalised and published. However, this draft document is widely used and accepted as being as close to good practice as is currently available.

2.3.8 The World Health Organisation (WHO) document *Guidelines for Community Noise 1999,* acknowledges that a in contrast to many other environmental problems, noise pollution continues to grow, accompanied with an increasing number of complaints from affected individuals stating that *'Noise is likely to continue as a major issue well into the next century'*. WHO through their own research and the research of others, identified noise exposure levels within the population that were considered to have harmful effects on health. Based on this research, WHO developed a number of recommended noise levels that should prevent adverse health effects. This document is widely referenced in the field of acoustics, however, it has not been adopted into any subsequent guidelines or UK regulation.

2.4 Baseline Environment

2.4.1 This SEA baseline environment describes the area that may be affected in terms of 'receptors', and has examined the potential for significant effects in relation to these. The receptors were developed during Phase 1 SEA scoping. The list of receptors was subsequently consulted upon as part of the Phase 1 consultation.

2.4.2 A review has been conducted of other projects in and around the Severn Estuary that may have an influence on the future baseline (STP, 2009b). Those projects that are considered to be reasonably foreseeable as implemented by 2014, have been considered part of the future baseline environment.

2.4.3 The Severn Estuary corridor is an area consisting largely of rural landscape, some of high ecological importance, along with a number of roads, some of which are major national motorway trunk routes. There are many areas of urban development which vary greatly in size and areas of industry and residential developments, both new and old that occupies land on the banks of the estuary. Baseline receptors that could be adversely affected by any change in the noise climate are both humans and wildlife. Further detail of the areas ecological and landscape importance is provided in the Terrestrial and Freshwater Ecology & the Landscape and Seascape topic papers (STP 2010o and STP 2010h).

2.4.4 It should be noted that the definition of receptor has been amended from that detailed in the Noise and Vibration Scoping paper in order to be more specific. The scoping paper initially introduced receptors as an area, and described the nature of the area. Whilst this gave an indication as to the level of sensitivity of receptor to change, it is far less specific. The receptor descriptions detailed in the Scoping report still hold, in that, they detail the local circumstances, and therefore the sensitivity of the receptor to change, however, it was felt that identifying the receptors in greater detail would be beneficial.

Noise Sensitive Receptors (Residential Dwellings)

Baseline environment (up to 2009)

2.4.5 The study area is made up of a combination of urban and rural areas, with a mixture of residential, industrial and commercial uses. The noise climate is varied, transportation noise and industrial being the largest noise producers. The closer a receptor is to these sources, the more they will be affected by noise. Conversely, the further a receptor is from these noise sources, the less they will be affected by noise.

2.4.6 Residential dwellings are the most sensitive to noise, particularly at night where it is desirable to prevent sleep-disturbance. UK legislation seeks to prevent significant impacts on residential dwellings.

Baseline during construction (2014 – 2020)

2.4.7 A number of trends are expected to increase environmental noise pollution, and are considered to be unsustainable in the long term. The Organisation for Economic Cooperation and Development (OECD), 1991 identified that increasingly powerful sources of noise, a wider geographical dispersion of noise sources together with greater individual mobility and the spread of leisure activities, the increasing invasion of noise particularly early morning and night time, coupled with increasing public expectations linked to increases in income and educational level has lead to an increased perception of noise pollution. Most current noise sources in the study area are anticipated to gradually increase in level due to intensification of use.

2.4.8 The World Health Organisation document ‘Guidelines for Community Noise’ acknowledges that about half of all European Union citizens live in zones that do not ensure acoustical comfort to residents. Furthermore, the document also states that ‘In contrast with many other environmental problems, noise pollution continues to grow accompanied by an increasing number of complaints from affected individuals. Most people are typically exposed to noise sources, with road traffic being the most

dominant source'. Population growth, urbanisation and to a large extent, technological development, the future enlargements of highways & rail systems and air transport growth continues to increase the problem (WHO, 1995).

2.4.9 However, despite noise being acknowledged as a major issue, little is known of the actual levels of growth anticipated, particularly at the local level.

2.4.10 The Environmental Noise Directive (END) is concerned with noise from road, rail, air traffic and industry. Exposure to environmental noise has been determined through noise mapping which will in turn give rise to noise action plans. The Environmental Noise (England)/(Wales) Regulations 2006, addresses the requirements of END to inform the production of noise action plans for large urban areas, major transport sources, and significant industrial sites in England and Wales..The action plans are intended to manage noise issues and effects to ensure the noise environment is preserved or noise levels are reduced where possible.

2.4.11 This topic paper therefore acknowledges that noise levels are anticipated to increase, however, the scale of these anticipated increases have not been estimated. It is also acknowledged that measures such as the END are in place to determine noise exposure, and that where feasible, controls are in place to monitor, manage and where possible, reduce noise levels. Noise levels in general can be expected to increase in the short-term.

Baseline during operation (2020 – 2140), Decommissioning and Longer Term Trends

2.4.12 The previous sections recognise that noise is considered a pollutant and unlike many other pollutants, noise is generally anticipated to continue to grow. Having said that, whilst it is expected for transportation noise to grow which will affect the major transportation routes, local changes could bring about isolated reductions in noise, e.g. the introduction of a by-pass or the closing of an industrial facility. Therefore for the majority of the study area, noise levels are expected to gradually increase over time.

Noise Sensitive Receptors (Non-residential)

2.4.13 It is expected that non-residential receptors will experience the same gradual increase in noise as for residential receptors.

Marine Environment (Underwater receptors)

Baseline environment (up to 2009)

2.4.14 The Severn Estuary is an active natural estuarine environment with strong tidal changes (having the second largest tidal range in the world) moving large volumes of water. It is also a relatively busy commercial shipping channel and has a number of leisure and fishing vessels using the area.

2.4.15 Noise in the estuarine environment is fairly local in nature as the water is too shallow to support long range propagation. Noise sources include impact noise (breaking waves and water hitting solid surfaces such as rocks); bubble noise (noise generated through processes such as rain hitting the surface or breaking waves. The oscillation of these bubbles occurs in the range of 15Hz-300kHz); turbulent noise (generated by surface disturbance and in particular for the Severn estuary, tidal flow); seismic (generating low frequency noise by movement of the seabed); as well as biological and anthropogenic noise.

2.4.16 The resulting effect is that noise in the estuary will vary greatly with each contributing noise source. The noise sources can be continuous, intermittent or transient, and may vary with the tide, diurnally, weekly, monthly, seasonally or annually. These variables are infinite, resulting in great uncertainties in prediction.

2.4.17 The above will result in the need to undertake an underwater baseline noise study at the Environmental Impact Assessment (EIA) stage to take account of the particular and unique environment of the Severn Estuary. The underwater noise study, as with any noise study should be undertaken with a knowledge of the contributing factors within the environment. An understanding of the underwater noise environment will ensure measurements are taken when the noise climate is least likely to result in unusually high ambient noise levels.

Future Baseline

2.4.18 Without an understanding of the current noise baseline environment, a future noise baseline cannot be suggested. However, with increasing populations, and increasing affluence, the intensification of leisure activities within the Severn Estuary is likely to occur. If one of the tidal schemes is realised, (in the absence of the actual noise associated with the tidal power scheme), there may be a reduction in the natural noise sources in certain areas of the estuary due to reduced water movement, but these gains are likely to be offset by increasing anthropogenic noise sources related to leisure use.

2.5 Key Environmental Issues and Problems

2.5.1 A number of assumptions were made during the earlier stages of this study (as detailed in the STP SEA Scoping topic paper Noise & Vibration). Some of the assumptions remain along with data gaps resulting in some key issues. Therefore a number of assumptions have been made in undertaking this noise and vibration assessment, which could lead to limitations in the level of accuracy for the study. These are:

- Information relating to the underwater acoustic effects of the proposals is not available. This is due to this project being at the investigational forefront of tidal power technologies. The tidal power projects that have occurred in the past such as the La Rance barrage did not have baseline data gathering. Therefore there are no comparable studies that can be used in order to establish any significant underwater acoustic issues relative to the options being appraised.

- With the significant data gaps discussed above, the prediction of the long-term effects on the underwater ecosystems of the Severn cannot be assessed with much accuracy. However, it may be possible to give some indication of the effects from the construction phase of the options based on a desk study/peer review of data available in the public domain.

- At this stage of the project, as this study is strategic, the design and methods of construction are not finalised. For example, some of the major construction elements for the barrages such as the production of each of the caissons will take place at unconfirmed locations throughout the UK, and possibly Europe. The SEA is based on available information and at this stage some assumptions will need to be made.

2.5.2 Critically, engineering descriptions are required for each option to include the alignment of any structures, devices which pass flows (e.g. turbines, sluices, locks,

fish passes, etc) and operating modes with associated acoustic data. These details will be collated for input into the options appraisal stage.

2.5.3 The most significant issues relating to the noise and vibration subject is the lack of information available. The lack of information in order to quantify:

- The underwater baseline environment;
- The lack of information available from the manufacturers of the underwater turbines relating to each of the options; and
- Previous tidal power schemes have not been assessed to include the effect of the noise associated with the scheme. They therefore have not produced an underwater noise impact assessment.

2.6 Value and Vulnerability of Receptors

2.6.1 The SEA seeks to identify those environmental effects which are likely to be significant. In forming a judgement on effect significance, in line with the SEA Directive, it is necessary to take into account the attributes of the affected area. In this SEA, the area likely to be affected is described in terms of receptors; and the most relevant receptor attributes are their value and vulnerability. These are defined as:

- **Value**: based on the scale of the geographic reference, rarity, importance for biodiversity, social or economic reasons, and level of legal protection;
- **Vulnerability**: the potential for a pathway for exposure of a receptor to a given environmental effect, brought about by a Severn Tidal Power option, together with the sensitivity of the receptor to that effect.

A standardised approach has been adopted across all topics of this SEA to the assignment of receptor attributes. Nonetheless this approach did allow for some flexibility to reflect the needs of each topic area. This is discussed further below for this topic.

2.6.2 The value of a receptor is based on the scale of the geographic reference, rarity, importance for biodiversity, social or economic reasons, and level of legal protection.

Table 2.2 Value of Receptors

Receptor	Assigned Value
Receptor A: Residential	**High**
Receptor B: Non-residential (including building structures)	**High**
Receptor C: Marine	**High**

2.6.3 The vulnerability of a receptor has been assigned in relation to the distance receptors will be to noise generating activities associated with the tidal power option.

Table 2.3 Vulnerability of Receptors

Receptors proximity to an activity site (in metres)	Proposed Vulnerability
0 – 200m	High
200 – 400m	Moderate
400 – 800m	Low
800 – 2000m	None

2.6.4 The value and vulnerability of a receptor is discussed in greater detail in the Value, Vulnerability and Magnitude of Effect note which is included in appendix A.

SECTION 3

EVALUATION OF PLAN ALTERNATIVES

3 EVALUATION OF PLAN ALTERNATIVES

3.1 Introduction

3.1.1 The SEA Directive requires the preparation of an Environmental Report on the 'likely significant effects' of implementing the plan, and reasonable alternatives. The main purpose of this topic paper is to inform the SEA Environmental Report and its assessment of likely significant environmental effects. This is by providing an assessment of effects in relation to the topic paper's relevant receptors. The Environmental Report will then consolidate the individual topic assessments to provide a description of all likely significant effects across the affected area.

3.1.2 The SEA Directive instructs that SEA is to be based on information that can reasonably be required, taking into account *inter alia* current knowledge and methods of assessment.

3.1.3 For the purposes of this SEA, the plan alternatives are the shortlisted options currently under consideration following the phase 1 consultation (DECC, 2009a). These are described as the alternative options in this document.

3.2 Assessment Methodology

3.2.1 The SEA Directive specifies in Annex II the criteria that should be taken into account when determining the likely significant effects of the plan. The criteria for identifying these significant effects are defined in the Directive in relation to determining whether an SEA is needed. These criteria will also be adopted for this assessment. In line with the SEA Regulations, the Practical Guide advises the use of these criteria for assessing significant environmental effects.

3.2.2 This topic paper therefore considers, the characteristics of the effects and of the area (i.e. relevant receptors) likely to be affected, having regard in particular to:

- the probability, duration, frequency and reversibility of the effects;
- the cumulative nature of the effects;
- the transboundary nature of the effects;
- the risks to human health or the environment (for example, due to accidents);
- the magnitude and spatial extent of the effects (geographical area and size of the population likely to be affected);
- the value and vulnerability of the area likely to be affected due to:
    - special natural characteristics or cultural heritage;
    - exceeded environmental quality standards or limit values; or
    - intensive land-use; and
- the effects on areas or landscapes which have a recognised national, Community or international protection status.

3.2.3 The SEA Directive (Annex I) also states that these effects should include secondary, cumulative, synergistic, short, medium and long-term permanent and temporary, positive and negative effects. The Practical Guide recognises that some of these terms are not always mutually exclusive and for the avoidance of doubt, within this SEA the following approaches are adopted.

3.2.4 Indirect effects are those which are not a direct result of a Severn Tidal Power alternative option, but occur away from the original effect or as a result of a complex pathway. There are many such interactions within estuarine systems that need to be taken into account in this assessment. The SEA does not use the term 'secondary effects' as this is covered by indirect effects.

3.2.5 There is the potential for effects to extend large distances from the Severn estuary. The assessments of these 'far field' effects will have greater uncertainty attached and are described separately.

3.2.6 Cumulative effects arise, for instance, where several developments each have insignificant effects but together have a significant effect. The plans and projects taken into account in the cumulative effects assessment have been identified and agreed (STP, 2009b). These are discrete projects or programmes which are expected to be implemented during the planned Severn Tidal Power project construction period (2014-2020) or during the operation period (2020-2140).

3.2.7 For simplicity, this SEA does not use the term 'combined' effects, as these are considered to be included within cumulative effects, nor does it use the term 'synergistic' effects, as these are considered within direct, indirect and cumulative effects.

3.2.8 A major tidal power scheme may facilitate or attract other developments, which may themselves pose significant environmental effects. These developments are described as 'consequential developments'. The types of consequential development considered throughout the assessment have also been identified (STP, 2009b). These consequential developments are not well-defined and only a concise high level qualitative assessment of the likely effects is possible.

3.2.9 A suitable study area has been identified, surrounding the landfall footprint of each of the options. The study area is defined as the area over which "measurable" changes are likely to occur in response to any short-listed option. As detailed at the Scoping stage, a land-based assessment would require noise sensitive receptors being identified within 2000m of the source of noise. However, this 'suitable study area' could vary as it is dependant on the level of the noise, and the sensitivity of each receptor.

3.2.10 The number of human noise sensitive receptors has been identified within distance bands of the land fall footprints in order to identify the population at risk of potential noise effects from the various options. In discussion with the Terrestrial & Freshwater Ecology topic (STP 2010o), the designated wildlife sites within 2000m of the landfall points were also identified. Aquatic receptors are as defined in the Marine Ecology (STP 2010i) and Migratory & Estuarine Fish (STP 2010k) topic papers.

3.2.11 A desk-top study has then identified the nature of the areas and the sources of noise within this area. Construction noise levels have been taken from standard construction equipment detailed in British Standard 5228 and the noise associated with each option has been identified through information provided by the engineering topic paper such as the ODR, Definition of Ancillary, Temporary & Onshore

Permanent Works, Barrage Construction Methods & Sequence (Chapter 13) and the Construction Sequence for Barrages & Lagoons documents.

3.2.12 The following sections discuss the alternative options, and make assessments of the likely significant effects. A number of these effects are common to more than one of the alternatives and have therefore been detailed within a 'generic alternative' in order to avoid repetition.

3.2.13 The noise effects associated with the generic alternative will relate to the distances the landfall footprint falls and the proximity of this location to Noise Sensitive Receptors (NSR)s. The effects of the alterntive options on the human NSRs will be discussed where relevant within the alternative sections of this report; discussion of wider noise effects upon the population associated with the alternative options (e.g. effects associated with transport) is provided in the Communities topic paper (STP 2010d). This topic also informs the assessment of noise effects upon wildlife receptors within the Marine Ecology (STP 2010i), Migratory & Estuarine Fish (STP 2010k) and Terrestrial & Freshwater Ecology topics (STP 2010o).

3.2.14 It is the construction phase of the project that will have the greatest effects on terrestrial NSRs. Potential effects are discussed in the generic alternative in section 3.6. Limits were first suggested by the Wilson Committee (HMSO, 1963) which proposed daytime (07:00 – 19:00 hrs) limits in terms of noise levels outside the windows of the nearest occupied buildings of:

- 70 dB(A) in rural, suburban and urban areas away from main road traffic and industrial noise
- 75 dB(A) in urban areas near main roads and heavy industrialised areas

3.2.15 Advisory Leaflet 72, "*Noise Control on Building Sites*" (DoE, 1976) also reproduces these levels, adding that for an evening period of 19:00 – 22:00, a limit 10 dB below the daytime limit may be appropriate. These have been reproduced in the latest versions of BS5228, and are therefore considered to represent current practice.

3.2.16 For the purposes of this assessment, it must be noted that construction is anticipated to last for considerable periods of time, therefore, the limits proposed above may not be considered appropriate in view of the extended periods of time that receptors will experience the effect of construction noise. It may be appropriate in some instances to adopt a limit relative to the background noise level, with the exceptions of noises that will occur for shorter durations, such as piling noise, should the construction require piling for the construction of foundations. Piling is likely to be of a relatively short period in comparison to noise from generators, or Loading Lorries which may be required for considerable periods.

3.2.17 Construction Noise Limits are usually agreed at the project commencement with the relevant Environmental Health Officer, and detailed in a Construction Environmental Management Plan (CEMP). This would occur at a later stage after further detailed assessment at the EIA Stage. With a view to the duration of the construction period, and the variation in construction activities over this time, a pragmatic approach should be agreed with the local Environmental Health Department.

3.2.18 British Standard *BS5228: Code of Practice for noise and vibration control on construction and open sites* provides sound level data for various construction activities. Construction noise levels are predicted as a 'free field' equivalent continuous noise level averaged over a one-hour period ($L_{Aeq,1h}$), and then averaged over a 12 hour working day to produce the $L_{Aeq,12h}$.

3.2.19 Table 3.1 below summaries some of the typical plant associated with construction activities, and the noise levels produced by such plant.

Table 3.1: Construction Site Noise Levels

Construction Activity / Associated Plant	Typical A-weighted Sound Pressure Level (L_A) at 10m	Estimated Sound Pressure Level (L_A) at 200m	Estimated Sound Pressure Level (L_A) at 400m	Estimated Sound Pressure Level (L_A) at 800m	Estimated Sound Pressure Level (L_A) at 2000m
Site Preparation					
Dozer	75	49.0	43.0	36.9	29.0
Tracked Excavator	78	52.0	46.0	39.9	32.0
Wheeled Backhoe Loader	68	42.0	36.0	29.9	22.0
Excavation					
Dozer	81	55.0	49.0	42.9	35.0
Tracked Excavator	79	53.0	47.0	40.9	33.0
Loading Lorry	80	54.0	48.0	41.9	34.0
Articulated Dump Truck	81	55.0	49.0	42.9	35.0
Rolling and Compaction					
Roller	79	53.0	47.0	40.9	33.0
Vibratory Plate	80	54.0	48.0	41.9	34.0
Piling					
Hydraulic Hammer Rig	89	63.0	57.0	50.9	43.0
Large Rotary Bored Piling Rig	83	57.0	51.0	44.9	37.0
Welding/Cutting Steel					
Welder (Welding Piles)	73	47.0	41.0	34.9	27.0
Generator for welder	57	31.0	25.0	18.9	11.0
Cutter (Cutting Piles)	68	42.0	36.0	29.9	22.0
Other					
Large Lorry Concrete Mixer	77	51.0	45.0	38.9	31.0
Concrete Pump (Discharging)	67	41.0	35.0	28.9	21.0
Tower Crane	77	51.0	45.0	38.9	31.0
Total L_{Aeq}	92.6	66.6	47.2	41.2	33.2

3.2.20 Based on the cumulative noise calculated in Table 3.1, it is apparent that construction noise is unlikely to exceed the assessment limits unless a receptor is within 100m of construction activities at which point measures to prevent or reduce adverse effects will be required.

3.2.21 The assessment of underwater noise is very complex, and there is no standard model for determining the underwater baseline. An extensive literature review and consultation on the subject has been undertaken to identify any standard methodologies used to determine typical baseline noise levels. However, this search has confirmed that a common agreed methodology is not available as a result of the infinite complexities to the variables making up the underwater noise environment.

Also the lack of a need, relative to other noise standards, for this underwater noise data has resulted in no commonly accepted methodology.

3.2.22 It is therefore necessary to acknowledge this data gap as a requirement for the EIA stage of the tidal power scheme, and also the need to adopt an accepted methodology for this assessment amongst peers and stakeholders.

3.2.23 The underwater noise effects will be detailed for the activities associated with the generic Tidal Power Scheme, in terms of construction noise, and operational noise levels, where known. However, specific impacts of the underwater noise levels, and other effects associated with the Severn Tidal Power Scheme Alternatives are discussed in the Marine Ecology and Migratory & Estuarine Fish topic papers.

3.3 Alternative Options

3.3.1 Five options for the development of tidal power using the tidal range of the Severn Estuary have been identified as the preferred candidates for more detailed study. The five options comprise three tidal barrages and two tidal lagoons. The details of these options are described below.

Alternative Option B3: Brean Down to Lavernock Point Barrage

3.3.2 B3 Brean Down to Lavernock Point barrage is the largest of the barrage short-listed options being an approximately 16km long structure impounding the Bristol Channel between Lavernock Point near Cardiff and Brean Down, adjacent to Weston-Super-Mare. The deepest point of this barrage location is at its centre, reaching between 30 to 40m deep. The chosen variant (original) functions in ebb only mode. In total there are 216 Bulb-Kapeller type turbines with a rated output of 40MW. The estimated annual energy output for the variant (including 5% outages) is 15.1 to 17.0 TWh/year.

3.3.3 Key features include a total of 129 caissons of which 29 are plain caissons, 46 are sluice caissons and 54 are turbine caissons, spread across the length of the barrage. The central point includes a 778m long embankment flanked by two sets of the turbine caissons. The barrage also includes two locks, one main shipping lock towards Lavernock Point side and a small ship lock towards Brean Down.

Alternative Option B4: Shoots Barrage

3.3.4 The B4 Shoots Barrage is an approximately 7km long structure impounding the Inner Bristol Channel between land adjacent to West Pill on the Welsh side and Severn Beach on the English side. The proposed structure comprises a combination of embankments within the shallow water and caissons within the deeper channel. Variant 3 was chosen as the short-listed option. It operates in ebb only mode with 30 Bulb-Kaplan type turbines, with a rated output of 35MW. The estimated annual energy output for the variant (including 5% outages) is 2.7 to 2.9 TWh/year.

3.3.5 The barrage consists of a total of 46 caissons (6 plain, 25 sluice and 15 turbine/sluice caissons), enclosed on both sides by 2 embankments totalling approximately 5km (3km approximate length of embankment to the Welsh Side and 2.2km approximate length to the English side). A 40m wide shipping lock has been placed at the deepest section of the channel.

Alternative Option B5: Beachley Barrage

3.3.6 The B5 Beachley Barrage is the smallest of the short-listed barrage schemes. It is a 2km long structure running from Beachley on the Welsh side of the River Severn to

land directly to the east on the English side. The original variant was chosen as the short-listed option, operating in ebb only mode with 50 Straflo type turbines with a rated output of 12.5 MW. The estimated annual energy output for the variant (including 5% outages) is 1.4 to 1.6 TWh/year.

3.3.7 Its key features include a total of 31 caissons (9 plain, 9 sluice and 13 turbine/sluice) spread across approximately 1.5km of the length of the barrage and flanked by two embankments. A 40m wide shipping lock is located on the English side of the barrage.

Alternative Option L2: Welsh Grounds Lagoon

3.3.8 L2 Welsh Grounds Lagoon is the largest of the lagoon short-listed options with an approximate length of 28km starting from land adjacent to the mouth of the River Usk, running in a general easterly direction across an area referred to as Welsh Grounds, continuing to the south of Denny Island and reaching land fall adjacent to the Second Severn Crossing. L2 variant 8 was based on a turbine selection proposed by the Fleming group. It was unique in this respect compared to other variants whose turbine selections have all been made by PB. Variant 8 operates in ebb only mode with 40 Bulb Turbines with a rated output of 25MW. The estimated annual energy output for the variant (including 5% outages) is 2.6 to 2.8 TWh/year.

3.3.9 Key features include a total of 32 caissons (8 plain, 14 sluice & 10 turbine caissons), and one shipping lock.

Alternative Option L3d: Bridgwater Bay Lagoon

3.3.10 L3D Bridgwater Bay Lagoon is a land connected tidal lagoon comprising approximately 16km long embankment, proposed to run from land falls at Brean Down in the north to just east of Hinckley Point in the south. The short-listed Variant 9 option is the only scheme to operate in ebb & flood mode, with a total of 144 Bulb-Kaplan turbines with a rated output of 25MW. The estimated annual energy output for this variant (including 5% outages) is 5.6 to 6.6 TWh/year.

3.3.11 Key features include a total of 42 caissons (6 plain and 36 turbine caissons), a 40m wide shipping lock and approximately 12km of embankment.

3.4 Summary of Potentially Significant Issues

3.4.1 During Phase 1 SEA Scoping, a review was conducted of the environmental issues that should be considered within the scope of the SEA (DECC, 2009a). The scope of issues was for the most part confirmed through the Government response to the consultation (DECC, 2009b). These issues formed the starting point for the assessment of likely significant environmental effects, and are discussed further for this topic below.

3.4.2 The SEA Scoping for the noise and vibration topic acknowledged that all of the alternatives would result in noise effects, but that these would vary with the scale of the alternative, the proximity to noise sensitive receptors, and the sensitivity of those receptors locally. These significant issues are further discussed below.

3.4.3 Noise is not considered to be the cause of significant issues. It is estimated that noise and vibration during the construction phase are potentially the highest, and therefore the most significant. There will be scope for measures to prevent or reduce adverse effects for some of this noise and vibration. Operational noise and vibration is not

considered to be significant due to the increased distances to the noise sensitive receptors.

3.5 Assessment of Likely Significant Effects on the Environment

3.5.1 This section considers, within this topic, the likely significant effects on the environment for each alternative option. These may arise from direct, indirect, far-field, cumulative and consequential development effects during construction, operation and decommissioning phases.

3.6 Generic Alternative Barrage/Lagoon.

3.6.1 This following section provides details that are common to all the proposed alternatives for the Severn Tidal Power Scheme. To avoid repetition, alternatives may refer back to this generic section on occasions when there is either insufficient detail at this early stage to differentiate between the alternatives or when there simply is no variation between the alternatives. This section also provides information regarding the likely noise effects for use by the Communities, Terrestrial & Freshwater Ecology and Waterbirds topic papers.

Shore-based Noise Effects

3.6.2 The Table 3.2 below documents the number of human NSRs in proximity to the landfall footprint.

Table 3.2: Number of Noise Sensitive Receptors in proximity to landfall footprint of alternative options

Distance Bands (m)	Alternative Option									
	B3 Brean Down to Lavernock Point Barrage (West/East side)		B4 Shoots Barrage (West/East side)		B5 Beachley Barrage (West/East side)		L2 Welsh Grounds Lagoon (East/West side)		L3d Bridgwater Bay Lagoon (North / South side)	
	West	East	West	East	West	East	East	West	North	South
0-200	0	0	0	0	24	0	0	0	10	0
201-400	2	2	0	0	5	39	89	0	10	0
401-800	15	7	0	48	125	8	149	0	11	7
801-2000	1039	103	3382	966	1124	81	1205	45	245	65

The Terrestrial & Freshwater Ecology topic (STP 2010o) has identified a number of designated wildlife sites within 5km of each landfall point. Table 3.3 summarises those within the Noise & Vibration 2000m study area.

Table 3.3: Summary of nature conservation designations within 2000m Noise & Vibration study area

Designation	Alternative Option				
	B3 Brean Down to Lavernock Point Barrage	**B4 Shoots Barrage**	**B5 Beachley Barrage**	**L2 Welsh Grounds Lagoon**	**L3d Bridgwater Bay Lagoon**
Ramsar	Severn Estuary/ Môr Hafren Ramsar	Severn Estuary/ Môr Hafren Ramsar	Severn Estuary/ Môr Hafren Ramsar	Severn Estuary/ Môr Hafren Ramsar	Severn Estuary/ Môr Hafren Ramsar
Natura 2000 (SAC/SPA)	Severn Estuary/Môr Hafren SAC	Severn Estuary/Môr Hafren SAC	Severn Estuary/Môr Hafren SAC River Wye/Afon Gwy SAC	Severn Estuary/Môr Hafren SAC	Severn Estuary/Môr Hafren SAC
SSSI	Severn Estuary/Môr Hafren SSSI Cosmeston Park SSSI Penarth Coast SSSI Sully Island SSSI Brean Down SSSI Bridgwater Bay SSSI Uphill Cliff SSSI	Severn Estuary/Môr Hafren SSSI Gwent Levels – Magor and Undy SSSI Nedern Book Wetlands SSSI, Caldicot	Severn Estuary/Môr Hafren SSSI River Wye (Lower Wye)/Afon Gwy (Gwy Isaf) SSSI Aust Cliff SSSI Pennsylvania Fields SSSI, Sudbury	Severn Estuary/Môr Hafren SSSI Bushy Close SSSI Gwent Levels – Magor and Undy SSSI Gwent Levels – Nash and Goldcliff SSSI Gwent Levels – St Brides SSSI	Severn Estuary/Môr Hafren SSSI Brean Down SSSI Bridgwater Bay SSSI Uphill Cliff SSSI
National Nature Reserves				Newport Wetlands National Nature Reserve	Bridgwater Bay National Nature Reserve
Local Nature Reserves	Uphill Local Nature Reserve				

Underwater Noise Impact

3.6.3 The underwater noise effects will be detailed in the generic alternative below. However, specific effects of the underwater noise levels, and other effects associated with the Severn Tidal Power Scheme Alternatives will be discussed in the Marine Ecology and Migratory & Estuarine Fish Topic Papers (STP 2010i and STP 2010k).

Direct Effects

Construction Phase

3.6.4 It is considered that the construction stage will result in the greatest disturbance to residential receptors. However, the exact location of construction activities is approximated at this 'strategic' appraisal stage.

3.6.5 This early stage of 'strategic' appraisal provides for sufficient time to consult with stakeholders in order to address potential issues, and explore measures to prevent or reduce adverse effects options to reduce any potential disturbances to a minimum.

3.6.6 It is anticipated that a number of activities associated with the construction of the alternative will occur, namely:

- Caisson construction and installation;
- Caisson foundations;
- Embankment and breakwater construction; and
- Completion of civil works.

3.6.7 Some of the above construction work will occur at remote locations at new purpose built sites away from the alternative option's location; this may include utilising existing facilities developed in Scotland for North Sea structures. In order to create the caisson foundations, embankment and breakwater construction, there will be a requirement for extensive dredging and work to prepare the foundations of the caissons:

- Drilling and blasting of the harder rock strata to create purpose built jack-up platforms;
- Trailer suction hopper dredgers for loose sediment;
- Large cutter section dredgers for firmer sediments and softer rock; and
- Grab dredgers to remove the fragments after blasting.
- There will also be a requirement for some short-piles to be 'fixed' to the caissons in the fabrication yards.

Construction Phase – Noise

Shore-based

3.6.8 Typical construction activity noise levels have been estimated for the constructional phase, and these can provide a guide as to the noise levels that could be broadly expected.

3.6.9 Greater detail of the sequence of construction is available in the Engineering topic paper. Construction of the 'alternative' is assumed to require a site as close as possible to the landfall point. The precise location of the landfall footprint is currently undetermined, however, a suggested location has been assumed for early assessment purposes.

3.6.10 The noise associated with the proposed activities at sea, may impact upon the shore-based noise environment. BS5228 does provide noise levels for a grab hopper dredging ship. A 2kt dredging vessel at 10m produces a sound pressure level of 82dB L_{Aeq}. Other noise levels associated with the marine based construction activities may also impact on the shore-based noise environment, however the surface noise levels associated with activities such as blasting and drilling underwater are not available in the reports detailing these underwater noise levels. Variables such as distance from the shoreline and the depth of the activity will make comparisons complex and imprecise.

3.6.11 The noise climate during construction will consist of the current baseline environment along with increased noise from traffic on local roads, and the noise associated with the above detailed construction activities.

Underwater Noise Impact

Dredging

3.6.12 Marine dredging of the Severn Estuary has been occurring for many years to maintain the shipping channels through to the Ports of Bristol, Portbury and Sharpness. However, the need for significant areas of dredging in preparation for the caisson foundations will result in an intensification of dredging activities in the area. Richardson *et al* cited a number of studies reporting. broadband 20-1000Hz underwater sounds from the dredging plant to be used (suction hopper, cutter-section and grab dredgers) normally diminish below the typical broadband ambient noise level (about 100db re 1 µPa) within 25km of the dredgers. Adding that some dredgers emit strong tones that may be detectable at ranges >25km in some situations. However, as previously stated, the shallow water of the estuarine environment is unlikely to support noise propagation over great distances. (Richardson, 1995).

3.6.13 Nedwell et al, 2004 conducted a review of offshore windfarm related underwater noise sources and conducted measurements in shallow waters suggesting measurements of suction and hopper dredgers show a Peak Spectral Source Level of up to 177 dB re 1 µPa @ 1 m between 80-200 Hz.(Nedwell, 2004)

Drilling

3.6.14 Richardson *et al* noted studies of various drilling activities (predominantly related to the drilling associated with oil and gas production). Richardson acknowledged that noise levels associated with conventional drilling platforms is relatively unstudied. One noise study cited, suggested that noise was so weak that it was nearly undetectable even alongside the platform during seas states of ≥3. Another study cited, concluded that the strongest tones were at very low frequencies, near 5Hz at levels of 119-127dB re 1 µPa at near field measurement locations. A more recent study undertaken by Urquhart and Hall predicted a mean sound level of 177.8 dB re 1 µPa at 1m, with a dominant frequency of 150Hz. However, it should be noted, that this source related to both drilling and dredging noise together, thus suggesting, the main noise source related to the dredging activity as per Nedwell et al 2004, above. (Urquhart and Hall,2005).

Blasting

3.6.15 Marine explosives, as might be expected are the strongest point sources of man-made underwater noise. Richardson *et al* stated that 'pressure pulses from high explosives are the one type of 'noise' known to be able to cause physical injury or death to marine mammals Richardson 1995). Urick stated that underwater explosives yield a short high-power broadband non-directional pulse of acoustic energy (Urick,

1983). Richardson *et al* added that underwater demolition employing the use of explosives is common, typically involving 10-1000kg of high explosives per blast. When a high explosive detonates underwater Richardson states, pressure rises within a microsecond. This rapid pressure increase is related to the extent of biological damage. A complex equation can derive sound levels based on the relationship between the charge mass, the peak pressure and the range (distance), enabling an estimation of the impact of an explosion. The impulsive waveforms created may have peak source levels as high as 279dB re: 1 µPa at 1m. (Vella, 2001).

Operational Phase

Shore-based

3.6.16 The shore-based facilities are unlikely to result in excessive levels of noise being generated; however, there may be some noise effects from plant associated with the facilities, namely; air conditioning units, machinery and vehicle noise. However, planning controls will reduce the effects of noise associated with these facilities to within acceptable levels, preventing noise disturbance to local noise sensitive receptors.

Underwater Noise Effects

3.6.17 It should be noted that there is very little published data available that quantifies the underwater effects of tidal power schemes. The available information must also be considered in the knowledge that there is no agreed standard for quantifying underwater noise levels, therefore the underwater baseline environment, and the operational noise levels, whilst measured by skilled practitioners; there may be differences in technique, resulting in difficulties in making comparisons. Additionally, the noises and / or the effects cited in available studies relate to a variety of locations, which may not be directly comparable to the environment of the Severn Estuary.

3.6.18 Further, the noises and or, effects cited are also not necessarily directly comparable due to the method of quantifying the environmental impact – for example, Richards (2007) relates the impact in terms of the hearing thresholds of fish, which is particularly useful for quantifying the impact in terms of fish, but not allowing like-for-like comparison with another study using another method of quantifying noise effects.

3.6.19 Richards et al (2007) identified a number of noise sources associated with tidal current devices in a report produced for the Scottish Executives SEA on marine renewables. Namely:

- Rotating Machinery: creates broadband noise associated with frictional loss and tonal noise associated with the rotational rate of the rotor or turbine blades which can be further complicated with additional tonal noise associated with additional parts such as gearboxes. The hydraulics used to couple energy from the device at various stages will also generate tonal and flow noise.

- Moving water noise: underwater in the form of gurgling and splashing, and in extreme conditions, cavitation noise may result. If there are incidences when the turbine device has a ‘surface presence’, low frequency noise associated with surface wave interaction will be generated.

- Structural Noise: structural resonances may occur through surface interaction or by the mechanical systems used to generate electricity, resulting in tonal or narrowband low frequency noise of <20Hz.

3.6.20 Richards et al (2007) also describes the mechanisms by which noise can be coupled into the marine environment. Direct coupling being the most efficient due to the noise generating mechanisms being in direct contact with the sea. Mechanical coupling where noise is brought into direct contact with the sea through the mechanical coupling of sources not in direct contact. This will result in changes to the spectral content of the original source. Seabed coupling for example from the caissons secured to the seabed transferring noise into the substrate and thereafter into the sea. Air coupling as a result of noise generated above sea level being transferred through the sea/air interface and into the sea. This form of coupling is very poor.

3.6.21 In addition to 'normal operating conditions', there will obviously be times when the tidal device operates under fault conditions, and also times when maintenance is required.

3.6.22 Subacoustech Ltd undertook operational noise monitoring of the Marine Current Turbines tidal current device in the Bristol Channel just off Lynmouth. This tidal device was in position at the time that measurements were undertaken; however, some measurements were taken when the device was off to get an estimate of the underwater baseline ambient noise environment. Subacoustech Ltd took measurements over a four hour period on the 9th March 2005 at a number of locations surrounding the turbine. There were some large fluctuations in the levels taken even at comparable ranges. Subacoustech have calculated from these recordings GPS locations, assuming spherical geometry an effective source level of 166dB re. 1 µPa at 1m. This study noted that at some of the greater distances from the turbine that the ambient noise level is higher than the noise levels resulting from the turbine. The recordings indicated that at these locations, the ambient noise contained shore and surface noise due to the proximity of the coastline and shipping noise. Subacoustech concluded that at a range of 250m, the spectrum level of noise from the turbine was significantly higher than the ambient noise over most of the spectrum (Nedwell, 2004). It is important to note that the type of turbine at Lynmouth is very different in nature to those being considered in the alternative options for the Severn,

Decommissioning Phase

3.6.23 Detailed information relating to the decommissioning phase is unavailable, however, the engineering assumption is that the decommissioning phase will essentially utilise many of the activities occurring during the constructional phase, such as blasting to remove foundations, dredging to remove rock and sediment etc. It is therefore assumed that at this stage, noise levels will be very closely associated with those experienced during the construction phase. The decommissioning phase is unlikely to occur within this century, and it is probable that technological developments may offer beneficial alternatives to those suggested above, and thus reduce the environmental effect of the decommissioning phase. Further, the effects from the decommissioning phase will be relative to the environmental noise levels both underwater and shore-based. This future baseline level is likely to be very different at the decommissioning phase.

Indirect Effects

Construction, Operational & Decommissioning Phases

3.6.24 Identification of the indirect effects of a tidal power scheme on noise and NSRs are not documented within the literature consulted. There is insufficient information, and a lack of documented evidence within previous tidal power schemes to enable the prediction of indirect effects.

Far-field Effects

Construction Phase

3.6.25 It is anticipated that all alternatives will result in significant construction requirements. It is envisaged that much of this construction activity will utilize existing facilities sites remote to the Severn Estuary such as those developed in Scotland for North Sea structures. The noise associated with such sites will not result in significant changes to those noises occurring (either currently or previously) at these locations, and therefore noise is not considered to have an adverse effect on the local noise climate. However, further consideration would need to be given to local noise effects associated with construction operations remote to the alternative option's location should any of the options be taken forward beyond the feasibility study stage.

Operational Phase

3.6.26 The operation of the turbines and associated devices will give rise to noise. It is possible that the underwater noise associated with these devices will travel significant distances. However, shallow water is unlikely to support noise propagation over a great distance. Indeed, in the operational noise monitoring undertaken for MCT's device at Lynmouth, at some of the greater distances from the turbine, the ambient noise level was higher than the noise levels resulting from the turbine. The recordings indicated that at these locations, the ambient noise contained shore and surface noise due to the proximity of the coastline and shipping noise (Nedwell, 2004). This suggests that far-field noise associated with the alternative is unlikely, although without specific information relating to the types of turbines and operation proposed for the STP alternative options this is highly uncertain. .

Decommissioning Phase

Cumulative Effects

3.6.27 The cumulative effects on marine mammals of noise from multiple activities have not been studied specifically, let alone the cumulative effects of noise plus non-acoustic phenomena. The presence of multiple noise sources in an area might increase the severity of any deleterious noise effects resulting from single sources. There is evidence of considerable tolerance of repeated exposure to noisy human activities that do not pose a direct threat. Habituation is probably a major factor in these cases. However, there are also cases of seemingly reduced numbers of marine mammals in areas with many human activities. It is difficult to obtain evidence about the cause, let alone the occurrence of long-term displacements and population trends. Cumulative effects of acoustic and non-acoustic components of human activities are a further consideration. In uncontrolled field experiments it is difficult to isolate the stimuli to which marine mammals are responding. Richardson (1995).

Construction Phase

3.6.28 A number of projects are currently proposed for areas of the Severn Estuary. These will be considered with the alternative, where relevant, and discussed in the construction phase of the 'alternative's section below.

Operational Phase

3.6.29 Where relevant, cumulative effects will be discussed within the relevant individual 'alternative' section.

Decommissioning Phase

3.6.30 Where known, this will be discussed where relevant to an 'alternative' in the section below.

Consequential Development Effects

Construction Phase

3.6.31 Development that is facilitated or attracted by the relevant alternative will be discussed in that alternative's section.

Operational Phase

3.6.32 Where relevant, cumulative effects will be discussed within the relevant individual 'alternative' section.

Decommissioning Phase

3.6.33 Where known, this will be discussed within the alternative sections.

Assumptions, Limitations and Uncertainties

3.6.34 A number of assumptions have been made in order to provide some useful data for assessing the potential effects of this alternative. These assumptions are based on the limited information and uncertainties at this early stage of assessment. Namely:

- Landfall points are provisional, and therefore must be considered in the knowledge further information will be provided at a more detailed stage.
- For considering the noise effects of the construction phase, based on professional experience of large construction sites, a suggested list of construction equipment has been assumed, and calculations of noise levels at distances have been made to provide for some construction impact information, Again, it must be stated that this will be considered in greater detail at a later stage when further information is available.
- Underwater noise levels have been provided by reviewing available literature in the public domain, and information provided from relevant studies made available to the author. The information on the types of turbines and operating proposed for the STP alternative options in particular is very limited, making any assessment judgement for the marine environment highly uncertain.
- The development of tidal power schemes are still at a relatively early stage of development, and the available data with which assessments can be made is extremely limited, as detailed in the Noise Scoping Paper. It must also be stated that the Underwater Noise Baseline level has not been measured at this early stage, making the impact assessment indicative at best.

Alternative Option B3: Brean Down to Lavernock Point Barrage

Direct Effects

Construction Phase

3.6.35 Refer to generic section for construction information relating to underwater noise effects.

3.6.36 There are no noise sensitive receptors (NSR) within 200m of the construction site. (in the absence of exact locations, the construction site is assumed to be located at the landfall footprint for the purposes of this assessment). Only 2 NSR's are located within 400m of Brean Down and 2 NSR's within 400m of Lavernock Point. 15 NSRs are located within 800m of Brean Down and 7 NSR's within 800m of Lavernock Point. As can be seen from Table 3.1 in the generic information, construction noise levels drop to typical background noise levels at 800m distance, with the exception of piling noise.

Operational Phase

3.6.37 Due to the distances to the nearest NSR, and the statutory provisions controlling noise pollution, it is unlikely that the operational phase will have any significant noise effects.

Decommissioning Phase

3.6.38 Refer to generic section for noise effects.

Indirect Effects

3.6.39 Refer to generic section for noise effects.

Far-field Effects

Construction Phase

3.6.40 Refer to generic section for noise effects.

Operational Phase

3.6.41 Refer to generic section for noise effects.

Decommissioning Phase

3.6.42 Refer to generic section for noise effects.

Cumulative Effects

3.6.43 A number of projects are proposed for development within the area of the Severn Estuary, some of which may impact upon the B3 alternative. It is not possible at this stage to identify if the proposed projects will have any associated cumulative effects in relation to noise due to the need for locations to be provided in detail. There is insufficient detail at this stage of the development process, and thus further comment cannot be made.

Construction, Operational and Decommissioning Phases

3.6.44 On consideration of the available information, none of the proposals appear likely to give rise to any significant noise effects. It is again not possible to identify potential effects due to the lack of detailed location information.

Consequential Development Effects

Construction, Operational and Decommissioning Phases

3.6.45 On consideration of the available information, none of the proposals appear likely to give rise to any significant noise effects.

Summary of Likely Significant Effects on the Environment

3.6.46 The following summarises the likely significant effects (direct, indirect, far-field, cumulative and consequential development effects) of the alternative option on the receptors during construction, operation and decommissioning phases.

3.6.47 There are no significant shore-based noise effects associated with the B3 alternative.

Assumptions, Limitations and Uncertainties

3.6.48 Refer to generic section.

Table 3.4: Assessment summary - Alternative Option B3: Brean Down to Lavernock Point Barrage

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
Receptor A – Noise Sensitive Receptor - Residential	*Increase in noise levels due to construction*	*Direct*	*High*	*Construction - Variable*	*Temporary*	*L-VL. Construction noise is not anticipated to be above background noise levels beyond 800m from site.(Only 22 NSRs within 800m)*	*Mainly local noise effects with some far-field (off-site construction however, minimal effects anticipated)*	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of assessment*	*No*
	Potential increase in noise if concurrent construction as a result of neighbouring proposals	*Cumulative*	*Low, although this will depend on location and level of any concurrent activity*	*Construction – short & occasional. Although this will depend on location and level of any concurrent activity*	*Temporary*	*L-VL. Construction noise is not anticipated to be above background noise levels beyond 800m from site.(Only 22 NSRs within 800m)*	*Local*	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of assessment*	
Receptor B Noise Sensitive Receptor – Non-Residential	*Increase in noise levels due to construction*	*Direct*	*High*	*Construction - Variable*	*Temporary*	*L-VL. Construction noise is not anticipated to be above background noise levels beyond 800m from site*	*Mainly local noise effects with some far-field (off-site construction however, minimal effects anticipated)*	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of assessment*	*No*
	Potential increase in noise if concurrent construction as a result of neighbouring proposals	*Cumulative*	*Low, although this will depend on location and level of any concurrent activity*	*Construction – short & occasional. Although this will depend on location and level of any concurrent activity*	*Temporary*	*L-VL. Construction noise is not anticipated to be above background noise levels beyond 800m from site*	Local	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of assessment*	*No*
Receptor C – Marine – Underwater Environment	*Temporary increase in noise levels due to construction*	*Direct*	*High*	*Construction - Variable*	*Temporary*	*See Migratory & Estuarine Fish Topic Paper for effects*	*Only local noise effect anticipated, although possible trans-boundary impact. See Fish topic paper for effects*	*Negative*	*Underwater baseline, unknown. Noise levels of Tidal turbines unknown*	*See Migratory & Estuarine Fish Topic Paper for effects*

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
	Operational Noise levels from turbine and ancillary plant	*Direct and Indirect*	*High*	*Long-tern throughout operation*	*Permanent*	*Irreversible for lifetime of scheme*	*Only local noise impact anticipated although possible trans-boundary effect. See Migratory & Estuarine Fish topic paper for effects*	*Negative*	*Underwater baseline, unknown. Noise levels of Tidal turbines and ancillary plant unknown*	*See Migratory & Estuarine Fish Topic Paper for effects*
	Potential increase in noise if concurrent dredging activity as a result of neighbouring proposals	*Cumulative*	*Medium*	*Construction - Variable*	*Temporary*	*See Migratory & Estuarine Fish Topic Paper for effects*	*Only local noise effect anticipated although possible trans-boundary effect. See Migratory & Estuarine Fish topic paper for effects*	*Negative*	*Proposal stage of activity, uncertainty as to whether it will proceed*	*See Migratory & Estuarine Fish Topic Paper for effects*

Alternative Option B4: Shoots Barrage

Direct Effects

Construction Phase

3.6.49 There are no NSRs within 400m of the B4 alternative. The closest NSRs are 4 properties on the English side within 600m of the landfall footprint. Another 44 properties lie between 600-800m on the English side of the B4 alternative. As can be seen from table 3.1 in the generic information, construction noise levels drop to typical background noise levels at 800m distance, with the exception of piling noise. However, noise levels are well below the limits for construction noise limits detailed above in paragraph 3.6.2. even at 200m.

Operational Phase

3.6.50 Due to the distances to the nearest NSR, and the statutory provisions controlling noise pollution, it is unlikely that the operational phase will have any significant noise effects.

Decommissioning Phase

3.6.51 Refer to generic section for noise effects.

Indirect Effects

Construction, Operational & Decommissioning Phases

3.6.52 Refer to generic section for noise effects.

Far-field Effects

Construction Phase

3.6.53 Refer to generic section for noise effects.

Operational Phase

3.6.54 Refer to generic section for noise effects.

Decommissioning Phase

3.6.55 Refer to generic section for noise effects.

Cumulative Effects

3.6.56 A number of projects are proposed for development within the area of the Severn Estuary, however, only a very limited number may impact upon the B4 alternative as described below.

Construction Phase

3.6.57 There is the potential for cumulative construction phase effects from, for example, the proposed Deep Sea Container Terminal (DSCT) at Avonmouth, should the construction sites be located near the B4 construction site. However, the shore-based effects from increased traffic and additional construction activities are not likely to be significant in terms of noise effect, although the marine effects are uncertain.

Operational Phase

3.6.58 The proximity of the DSCT to the B4 scheme may result in cumulative noise effects in the marine environment.

Decommissioning Phase

3.6.59 On consideration of the available information, none of the proposals appear likely to give rise to any significant noise effects.

Consequential Development Effects

Construction, Operational and Decommissioning Phases

3.6.60 On consideration of the available information, none of the proposals appear likely to give rise to any significant noise effects.

Summary of Likely Significant Effects on the Environment

3.6.61 The following summarises the likely significant effects (direct, indirect, far-field, cumulative and consequential development effects) of the alternative option on the receptors during construction, operation and decommissioning phases.

3.6.62 There are no significant shore-based noise effects associated with the B4 alternative.

Assumptions, Limitations and Uncertainties

3.6.63 Refer to generic section.

Table 3.5: Assessment Summary - Alternative Option B4: Shoots Barrage

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
Receptor A – Noise Sensitive Receptor - Residential	*Temporary increase in noise levels due to construction*	*Direct*	*High*	*Construction - Variable*	*Temporary*	*L-VL. Construction noise is not anticipated to be above background noise levels beyond 800m from site.(Only 8 NSRs within 800m)*	*Mainly local noise effects with some far-field (off-site construction however, minimal effects anticipated)*	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of assessment*	*No*
	Potential increase in noise if concurrent construction as a result of neighbouring proposals	*Cumulative*	*V.Low, although this will depend on location and level of any concurrent activity*	*Construction – short & occasional. Although this will depend on location and level of any concurrent activity*	*Temporary*	*VL. Construction noise is not anticipated to be above background noise levels beyond 800m from site.(Only 48 NSRs within 800m)*	*Local*	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of assessment*	
Receptor B Noise Sensitive Receptor – Non-Residential	*Temporary increase in noise levels due to construction*	*Direct*	*High*	*Construction - Variable*	*Temporary*	*L-VL. Construction noise is not anticipated to be above background noise levels beyond 800m from site.(Only 48 NSRs within 800m)*	*Mainly local noise effects with some far-field (off-site construction however, minimal effects anticipated)*	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of assessment*	*No*
	Potential increase in noise if concurrent construction as a result of neighbouring proposals	*Cumulative*	*V. Low, although this will depend on location and level of any concurrent activity*	*Construction – short & occasional. Although this will depend on location and level of any concurrent activity*	*Temporary*	*VL. Construction noise is not anticipated to be above background noise levels beyond 800m from site.(Only 48 NSRs within 800m)*	Local	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of assessment*	*No*
Receptor C – Marine – Underwater Environment	*Temporary increase in noise levels due to construction*	*Direct*	*High*	*Construction - Variable*	*Temporary*	*See Migratory & Estuarine Fish Topic Paper for effects*	*Only local noise effect anticipated, although possible trans-boundary effect. See*	*Negative*	*Underwater baseline, unknown. Noise levels of Tidal turbines unknown*	*See Migratory & Estuarine Fish Topic Paper for effects*

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
							Migratory & Estuarine Fish topic paper for effects			
	Operational Noise levels from turbine and ancillary plant	*Direct and Indirect; potentially cumulative with operation of DSCT.*	*High*	*Long-tern throughout operation*	*Permanent*	*Irreversible for lifetime of scheme*	*Only local noise effect anticipated although possible trans-boundary effect. See Migratory & Estuarine Fish topic paper for effects*	*Negative*	*Underwater baseline, unknown. Noise levels of Tidal turbines and ancillary plant unknown*	*See Migratory & Estuarine Fish Topic Paper for effects*

Alternative Option B5: Beachley Barrage

Direct Effects

Construction Phase

3.6.64 This alternative has the greatest number of properties within 200m of the landfall footprint with 24 NSR's on the Welsh side. At this proximity to a construction site, noise from the some of the plant will be heard at some of the receptors, however, these levels will be well within the construction noise levels discussed in section 3.6.2., At a distance of 400m there are 5 NSR's on the English side and 39 on the Welsh side. At 800m there are 8 properties on the English side and 125 on the Welsh side of the B5 alternative. Again, as can be seen from Table 3.1 in the generic information, construction noise levels drop to typical background noise levels at 800m distance, with the exception of piling noise. However, noise levels are well below the limits for construction noise limits detailed above in paragraph 3.6.2. even at 200m.

Operational Phase

3.6.65 Due to the distances to the nearest NSR, and the statutory provisions controlling noise pollution, it is unlikely that the operational phase will have any significant noise effects.

Decommissioning Phase

3.6.66 Refer to generic section for noise effects.

Indirect Effects

Construction, Operational & Decommissioning

3.6.67 Refer to generic section for noise effects.

Far-field Effects

Construction Phase

3.6.68 Refer to generic section for noise effects.

Operational Phase

3.6.69 Refer to generic section for noise effects.

Decommissioning Phase

3.6.70 Refer to generic section for noise effects.

Cumulative Effects

Construction Phase

3.6.71 The decommissioning of the Oldbury Power Station and any new development of the Oldbury Power Station site should the construction/decommissioning sites be located in close proximity of the 'alternatives' construction site. However, these effects are not likely to be significant in terms of noise effect.

Operational Phase

3.6.72 On consideration of the available information, none of the proposals appear likely to give rise to any significant noise effects.

Decommissioning Phase

3.6.73 On consideration of the available information, none of the proposals appear likely to give rise to any significant noise effects.

Consequential Development Effects

Construction, Operational and Decommissioning Phases

3.6.74 On consideration of the available information, none of the proposals appear likely to give rise to any significant noise effects.

Summary of Likely Significant Effects on the Environment

3.6.75 The following summarises the likely significant effects (direct, indirect, far-field, cumulative and consequential development effects) of the alternative option on the receptors during construction, operation and decommissioning phases.

3.6.76 There are no significant shore-based noise effects associated with the B5 alternative.

Assumptions, Limitations and Uncertainties

3.6.77 Refer to generic section above.

Table 3.6: Assessment Summary - Alternative Option B5: Beachley Barrage

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
Receptor A – Noise Sensitive Receptor - Residential	*Temporary increase in noise levels due to construction*	*Direct*	*High*	*Construction - Variable*	*Temporary*	*L - M. Construction noise is not anticipated to be above background noise levels beyond 800m from site.(Only 133 NSRs within 800m)*	*Mainly local noise effects with some far-field (off-site construction however, minimal effects anticipated)*	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of assessment*	*No*
	Operational noise levels may impact upon NSR's in proximity to the shore-based infrastructure	*Direct*	*High*	*Permanent*	*Permanent*	*L-VL. 24 NSRs within 200m of the shore-based infrastructure*	*Local*	*Negative*	*Assumption that there may be noise generating plant with shore-based infrastructure*	
	Potential increase in noise if concurrent construction as a result of Oldbury Power station plans	*Cumulative*	*Medium-High, due to proximity of location. and potential for concurrent activity*	*Construction – short & occasional. Although this will depend on location and level of any concurrent activity*	*Temporary*	*L - M. Construction noise is not anticipated to be above background noise levels beyond 800m from site.(Only 133 NSRs within 800m)*	*Local*	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of assessment*	
Receptor B Noise Sensitive Receptor – Non-Residential	*Temporary increase in noise levels due to construction*	*Direct*	*High*	*Construction - Variable*	*Temporary*	*L - M. Construction noise is not anticipated to be above background noise levels beyond 800m from site.(Only 133 NSRs within 800m)*	*Mainly local noise effects with some far-field (off-site construction however, minimal effects anticipated)*	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of assessment*	*No*
	Potential increase in noise if concurrent construction as a	*Cumulative*	*Medium-High, due to proximity of location. and potential for*	*Construction – short & occasional. Although this will depend on location and level of*	*Temporary*	*L - M. Construction noise is not anticipated to be*	Local	*Negative*	*Limited locational information. Construction*	*No*

	result of Oldbury Power station plans		*concurrent activity*	*any concurrent activity*		*above background noise levels beyond 800m from site.(Only 133 NSRs within 800m)*			*activity have been assumed to be 'typical' for purposes of assessment*	
Receptor C – Marine – Underwater Environment	*Temporary increase in noise levels due to construction*	*Direct*	*High*	*Construction - Variable*	*Temporary*	*See Migratory & Estuarine Fish Topic Paper for effects*	*Only local noise effect anticipated, although possible trans-boundary effects. See Migratory & Estuarine Fish topic paper for effects*	*Negative*	*Underwater baseline, unknown. Noise levels of Tidal turbines unknown*	*See Migratory & Estuarine Fish Topic Paper for effects*
	Operational Noise levels from turbine and ancillary plant	*Direct and Indirect*	*High*	*Long-tern throughout operation*	*Permanent*	*Irreversible for lifetime of scheme*	*Only local noise effects are anticipated although possible trans-boundary effect. See Migratory & Estuarine Fish topic paper for effects*	*Negative*	*Underwater baseline, unknown. Noise levels of Tidal turbines and ancillary plant unknown*	*See Migratory & Estuarine Fish Topic Paper for effects*

Alternative Option L2: Welsh Grounds Lagoon

Direct Effects

Construction Phase

3.6.78 There are no NSR within 200m of the landfall footprint of this alternative. The Eastern (Upstream) landfall foot has 89 properties within 400m, rising to 149 NSRs within 800m. The Western (Downstream) site doesn't have any NSRs within 800m, and only 45 NSRs within 2km. Again, as can be seen from Table 3.1 in the generic information, construction noise levels drop to typical background noise levels at 800m distance, with the exception of piling noise. However, noise levels are well below the limits for the construction noise limits detailed above in section 3.6.2. even at 200m.

Operational Phase

3.6.79 Due to the distances to the nearest NSR, and the statutory provisions controlling noise pollution, it is unlikely that the operational phase will have any significant noise effects.

Decommissioning Phase

3.6.80 Refer to generic section for noise effects.

Indirect Effects

Construction, Operational & Decommissioning Phase

3.6.81 Refer to generic section for noise effects.

Far-field Effects

Construction Phase

3.6.82 Refer to generic section for noise effects.

Operational Phase

3.6.83 Refer to generic section for noise effects.

Decommissioning Phase

3.6.84 Refer to generic section for noise effects.

Cumulative Effects

Construction Phase

There is one proposed project that may impact upon this L2ii alternative, namely the application for further marine dredging in areas 455, 459, 470a and 470b,. These effects are not likely to be significant in terms of noise effect.

Operational Phase

3.6.85 On consideration of the available information, none of the proposals appear likely to give rise to any significant noise effect.

Decommissioning Phase

3.6.86 On consideration of the available information, none of the proposals appear likely to give rise to any significant noise effects.

Consequential Development Effects

Construction, Operational and Decommissioning Phases

3.6.87 On consideration of the available information, none of the proposals appear likely to give rise to any significant noise effects.

Summary of Likely Significant Effects on the Environment

3.6.88 The following summarises the likely significant effects (direct, indirect, far-field, cumulative and consequential development effects) of the alternative option on the receptors during construction, operation and decommissioning phases.

3.6.89 There are no significant shore-based noise effects associated with the L2ii alternative.

Assumptions, Limitations and Uncertainties

3.6.90 Refer to generic section above.

Table 3.7: Assessment Summary - Alternative Option L2: Welsh Grounds Lagoon

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
Receptor A – Noise Sensitive Receptor - Residential	*Temporary increase in noise levels due to construction*	*Direct*	*High*	*Construction - Variable*	*Temporary*	*L - M. Construction noise is not anticipated to be above background noise levels beyond 800m from site.(Only 149 NSRs within 800m)*	*Mainly local noise effects with some far-field (off-site construction however, minimal effects anticipated)*	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of assessment*	*No*
	Potential increase in noise if concurrent construction as a result of the M4 widening proposal which will result in concurrent construction activities	*Cumulative*	*Medium-High, due to proximity of location. and potential for concurrent activity*	*Construction – short & occasional. Although this will depend on location and level of any concurrent activity*	*Temporary*	*L - M. Construction noise is not anticipated to be above background noise levels beyond 800m from site.(Only 149 NSRs within 800m)*	*Local*	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of assessment*	
Receptor B Noise Sensitive Receptor – Non-Residential	*Temporary increase in noise levels due to construction*	*Direct*	*High*	*Construction - Variable*	*Temporary*	*L - M. Construction noise is not anticipated to be above background noise levels beyond 800m from site.(Only 149 NSRs within 800m)*	*Mainly local noise effects with some far-field (off-site construction however, minimal effects anticipated)*	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of assessment*	*No*
	Potential increase in noise if concurrent construction as a result of the M4 widening proposal which will result in concurrent construction activities	*Cumulative*	*Medium-High, due to proximity of location. and potential for concurrent activity*	*Construction – short & occasional. Although this will depend on location and level of any concurrent activity*	*Temporary*	*L - M. Construction noise is not anticipated to be above background noise levels beyond 800m from site.(Only 149 NSRs within 800m)*	Local	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of assessment*	*No*
Receptor C – Marine – Underwater Environment	*Temporary increase in noise levels due to construction*	*Direct*	*High*	*Construction - Variable*	*Temporary*	*See Migratory & Estuarine Fish Topic Paper for effects*	*Only local noise effect anticipated, although possible*	*Negative*	*Underwater baseline, unknown. Noise levels of*	*See Migratory & Estuarine Fish Topic Paper for effects*

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
							trans-boundary effect. See Migratory & Estuarine Fish topic paper for effects		*Tidal turbines unknown*	
	Operational Noise levels from turbine and ancillary plant	*Direct and Indirect*	*High*	*Long-tern throughout operation*	*Permanent*	*Irreversible for lifetime of scheme*	*Only local noise effect anticipated although possible trans-boundary effects. See Migratory & Estuarine Fish topic paper for effects*	*Negative*	*Underwater baseline, unknown. Noise levels of Tidal turbines and ancillary plant unknown*	*See Migratory & Estuarine Fish Topic Paper for effects*
	Potential increase in noise if concurrent dredging activity as a result of Marine aggregate proposals for areas 455, 759, 470a and 470b.	*Cumulative*	*Medium*	*Construction - Variable*	*Temporary*	*See Migratory & Estuarine Fish Topic Paper for effects*	*Only local noise effect anticipated although possible trans-boundary effects. See Migratory & Estuarine Fish topic paper for effects*	*Negative*	*Proposal stage of activity, uncertainty as to whether it will proceed*	*See Migratory & Estuarine Fish Topic Paper for effects*

Alternative Option L3d: Bridgwater Bay Lagoon

Direct Effects

Construction Phase

3.6.1 There are 10 NSRs within 200m of the Northern landfall footprint, rising to 11 within 800m on the Northern (Upstream) location, and 7 NSR within 800m of the Southern landfall footprint. Again, with reference to Table 3.1 in the generic information, construction noise levels drop to typical background noise levels at 800m distance, with the exception of piling noise. However, noise levels are well below the limits for the construction noise limits detailed above in section 3.6.2. even at 200m.

Operational Phase

3.6.2 Due to the distances to the nearest NSR, and the statutory provisions controlling noise pollution, it is unlikely that the operational phase will have any significant noise effects.

Decommissioning Phase

3.6.3 Refer to generic section for noise effects.

Indirect Effects

Construction, Operational & Decommissioning Phases

3.6.4 Refer to generic section for noise effects.

Far-field Effects

Construction Phase

3.6.5 Refer to generic section for noise effects.

Operational Phase

3.6.6 Refer to generic section for noise effects.

Decommissioning Phase

3.6.7 Refer to generic section for noise effects.

Cumulative Effects

Construction Phase

3.6.8 There are a couple of proposals that may impact upon the L3d alternative, namely the Steart Coastal Management Project (which is the creation of a 200ha site with the potential to increase to 800ha habitat creation scheme), the construction of which may result in noise effects to neighbouring NSR's. Additionally, the decommissioning of Hinkley A&B and the commissioning of Hinkley C is likely to result in an intensification of noise generating activities which may have the potential to result in some noise effects on neighbouring NSR's, particularly should these activities run concurrently. A detailed EIA will be required as part of such developments, at which time a full and thorough assessment will be undertaken.

Operational Phase

3.6.9 On consideration of the available information, none of the proposals appear likely to give rise to any significant noise effects.

Decommissioning Phase

3.6.10 On consideration of the available information, none of the proposals appear likely to give rise to any significant noise effects.

Consequential Development Effects

Construction, Operational and Decommissioning Phases

3.6.11 On consideration of the available information, none of the proposals appear likely to give rise to any significant noise effects.

Summary of Likely Significant Effects on the Environment

3.6.12 The following summarises the likely significant effects (direct, indirect, far-field, cumulative and consequential development effects) of the alternative option on the receptors during construction, operation and decommissioning phases.

3.6.13 There are no significant shore-based noise effects associated with the L2ii alternative.

Assumptions, Limitations and Uncertainties

3.6.14 Refer to generic section above.

Table 3.8: Assessment Summary - Alternative Option L3d: Bridgwater Bay Lagoon

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
Noise Sensitive Receptor - Residential	*Temporary increase in noise levels due to construction*	*Direct*	*High*	*Construction - Variable*	*Temporary*	*L-VL. Construction noise is not anticipated to be above background noise levels beyond 800m from site.(Only 18 NSRs within 800m)*	*Mainly local noise effects with some far-field (off-site construction however, minimal effects anticipated)*	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of assessment*	*No*
	Operational noise levels may impact upon NSR's in proximity to the shore-based infrastructure	*Direct*	*High*	*Permanent*	*Permanent*	*L-VL. 10 NSRs within 200m of the shore-based infrastructure*	*Local*	*Negative*	*Assumption that there may be noise generating plant with shore-based infrastructure*	*No*
	Potential increase in noise if concurrent construction of Hinkley Power Station	*Cumulative*	*Low, although this will depend on location and level of any concurrent activity*	*Construction – short & occasional. Although this will depend on location and level of any concurrent activity*	*Temporary*	*L-VL. Construction noise is not anticipated to be above background noise levels beyond 800m from site.(Only 18 NSRs within 800m)*	*Local*	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of assessment*	*No*
Noise Sensitive Receptor – Non-Residential	*Temporary increase in noise levels due to construction*	*Direct*	*High*	*Construction - Variable*	*Temporary*	*L-VL. Construction noise is not anticipated to be above background noise levels beyond 800m from site.(Only 18 NSRs within 800m)*	*Mainly local noise effects with some far-field (off-site construction however, minimal effects anticipated)*	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of assessment*	*No*
	Potential increase in noise if concurrent construction as a result of neighbouring proposals	*Cumulative*	*Low, although this will depend on location and level of any concurrent activity*	*Construction – short & occasional. Although this will depend on location and level of any concurrent activity*	*Temporary*	*L-VL. Construction noise is not anticipated to be above background noise levels beyond 800m*	Local	*Negative*	*Limited locational information. Construction activity have been assumed to be 'typical' for purposes of*	*No*

Receptor (value (H/L)and vulnerability (H/M/L/None))	Description of effect	Direct or Indirect; Far-field effect; Cumulative effect; or effect resulting from Consequential Development	Probability (H/M/L/VL)	Duration (occurs during construction, operation or decommissioning phase and L/M/S/VS term) and frequency	Irreversible/ reversible; temporary/ permanent	Magnitude (H/M/L/VL)	Spatial extent & trans-boundary	Positive/ Negative	Assumptions, Limitations, Uncertainties	Significant (Y/N)
						from site.(Only 18 NSRs within 800m)			*assessment*	
Marine – Underwater Environment	*Temporary increase in noise levels due to construction*	*Direct*	*High*	*Construction - Variable*	*Temporary*	*See Migratory & Estuarine Fish Topic Paper for effects*	*Only local noise effect anticipated, although possible trans-boundary effects. See Migratory & Estuarine Fish topic paper for effects*	*Negative*	*Underwater baseline, unknown. Noise levels of Tidal turbines unknown*	*See Migratory & Estuarine Fish Topic Paper for effects*
	Operational Noise levels from turbines and ancillary plant	*Direct and Indirect*	*High*	*Long-tern throughout operation*	*Permanent*	*Irreversible for lifetime of scheme*	*Only local noise effect anticipated although possible trans-boundary impact. See Migratory & Estuarine Fish topic paper for effects*	*Negative*	*Underwater baseline, unknown. Noise levels of Tidal turbines and ancillary plant unknown*	*See Migratory & Estuarine Fish Topic Paper for effects*
	Potential increase in noise if Steart Coastal Management plan is realised	*Cumulative*	*Medium*	*Construction - Variable*	*Temporary*	*See Migratory & Estuarine Fish Topic Paper for effects*	*Only local noise effects anticipated although possible trans-boundary effects. See Migratory & Estuarine Fish topic paper for effects*	*Negative*	*Proposal stage of activity, uncertainty as to whether it will proceed*	*See Migratory & Estuarine Fish Topic Paper for effects*

3.7 Measures to prevent, reduce and as fully as possible offset any significant adverse effects on the environment

3.7.1 The SEA Directive requires that information is provided on the measures envisaged to prevent, reduce and as fully as possible offset any significant adverse effects on the environment of implementing the plan or programme (Annex I). These measures are considered within this topic, and will thereby inform an overall assessment of such measures within the SEA Environmental Report.

3.7.2 In this SEA, and in line with UK practice, these measures are split into those measures to prevent or reduce effects, and measures to as fully as possible offset any significant adverse effects on the environment.

Measures to prevent or reduce effects

3.7.3 No significant adverse effects have been identified for this topic. However the following measures to prevent or reduce likely adverse environmental effects within this topic are described below and will need to be considered in the further development of any of the options.

3.7.4 Construction measures to prevent or reduce adverse effects has already been discussed in this topic paper in section 3.2 for the avoidance of effects on humans and buildings. Other receptors are dealt with in their respective topic papers.

3.7.5 As discussed in the generic alternative section, the greatest noise disturbance resulting from any alternative is the construction phase within both the marine, and the shore based environment.

Shore-based Environment

3.7.6 Insufficient detail is available to provide for any specific information relating to the actual sites and the specific activities that will occur at this stage. Further information would be available when an alternative is selected and a more detailed assessment is undertaken at the EIA stage.

3.7.7 During the EIA study, typical construction activity noise levels can be anticipated during the construction phase, and these can provide a guide as to the noise levels that could be broadly expected. In order to minimise the effects of any shore-based construction noise, it is understood that 24hour working will be in operation at these sites, which will require careful management to prevent and avoid noise generating activity which would impact upon NSRs locally. Consultation with the local planning authority would be undertaken, and noise levels could be predicted and agreed with the local environmental health officer. If any of the options proceed, Noise and other significant environmental effects would be managed and documented within a Construction Environmental Management Plan (CEMP) which would be produced in full consultation with the relevant local authority and NSR's likely to be affected.

3.7.8 The British Standards Institution document BS 5228-1: 2009 Code of Practice for Noise and Vibration Control on Construction and Open Sites. Part 1: Noise gives recommendations for basic methods of noise control relating to construction and open sites where work/activities generate significant noise levels. Part 1 provides guidance concerning methods of predicting and measuring noise and assessing its impact.

3.7.9 Advisory Leaflet 72 (AL72), "*Noise Control on Building Sites*" (DoE, 1976) also provides guidance on noise levels / noise control on construction sites, additionally suggesting a limit for evening construction noise levels.

3.7.10 Adherence to the above standard documents for construction working namely; BS 5228:2009, and AL72, and the guidance given therein will ensure noise emissions from any of the construction sites will be minimised.

3.7.11 The following measures should be adopted as a minimum:

- All vehicles and mechanical plant used for construction of the works would be fitted with effective exhaust silencers, and regularly maintained.
- Inherently quiet plant would be used where appropriate. All major compressors would be sound-reduced models fitted with properly lined and sealed acoustic covers which would be kept closed whenever the machines are in use, and all ancillary pneumatic percussive tools would be fitted with mufflers or silencers of the type recommended by their manufacturers.
- All ancillary plant such as generators, compressors and pumps would be positioned so as to cause minimum noise disturbance. If necessary, acoustic barriers or enclosures would be provided.
- Any inherently noisy activities that occur at the construction sites should be located in areas furthest from NSR's. All inherently noise generating activities should occur during core working hours, not during the evening and night periods. Where this is not possible, this should be agreed with the local environmental health department, and in full consultation with any NSRs that may be affected.

3.7.12 Operational noise levels may again result in noise disturbance to nearby NSRs, however, at this stage, details of the locations of workshops, plant and noise generating operations is unavailable. Therefore I would recommend further noise assessment is undertaken at the design stage in order to assess all potential noise effects and recommend appropriate measures to prevent or reduce adverse effects.

3.7.13 BS 8233: 1999; Sound Insulation and Noise Reduction for Buildings – Code of Practice gives recommendations for the control of noise in and around buildings, and suggests appropriate criteria and limits for different situations. The code is primarily intended to guide the design of new or refurbished buildings, but it does provide a source of noise levels for common situations, such as typical traffic noise levels at the facades of buildings.

3.7.14 Adherence to the above standard documents for controlling noise effects will ensure noise emissions from any of the shore-based operations will be controlled, and prevent noise disturbance to both residential and non-residential NSRs.

3.7.15 In addition, the Communities topic (STP 2010d) has identified potentially significant effects arising from cumulative construction related effects, including noise & vibriation, on population receptors for some of the alternative options.

3.7.16 A large proportion of the effect will result from the disruption caused by a large increase in regular HGV traffic delivering materials to site.

3.7.17 In order to prevent or reduce these effects the following measures are proposed:

- Reducing the number of vehicles on local roads through rationalising deliveries and use of larger vehicles. This would require consideration of logistical management, including timing and location of deliveries, and may require the use of materials transfer hubs to maximise the efficacy of the measure.
- Delivery of construction materials by alternative routes, such as by rail or by sea and maximising the use of existing temporary/permanent works arrangements. It is already planned to bring in embankment/rock fill material by rail to a railhead for transfer to ship for delivery to site. It is proposed that this approach could be extended to include other construction materials that would otherwise be brought by road. As part of this measure it is proposed that the small shipping lock for B3 and locks in L2 and L3 are utilised as a temporary dock for offloading materials for construction. The structure itself would be used as a haul road.

3.7.18 Both measures require forward thinking and good planning but could help streamline

3.7.19 It is considered that second approach, if fully adopted, could be very effective in the prevention of the significant effect predicted, both to the human populations but all to terrestrial ecology receptors.. Partial adoption of this approach would serve to reduce the effects; the extent of this reduction will depend on how many HGVs are diverted. Given the potential benefits of such an approach, it is recommended that consideration is given to applying a similar approach to the other two options (B4 and B5) where construction effects would still be felt, but the current predicted effect arising from HGV traffic is lower.

Marine Environment

3.7.20 The construction phase of this project will result in the greatest disturbance to the marine environment However operational noise levels, despite being significantly lower than the much of the construction noise, will be permanent resulting in long-term exposure, and offer little flexibility as it will be controlled by tidal movement.

3.7.21 A number of measures are discussed in Richardson (1995) to reduce or avoid noise effects on the marine environment, namely;

- Appropriate choice or design of equipment and facilities;
- Timing of noise generating activities;
- Locations of noise generating activities, and;
- The adjustment of operational procedures to reduce the effects.

3.7.22 In order to achieve an optimum strategy for measures to prevent or reduce adverse effects, an integrated approach utilising the above options should be considered.

3.7.23 Choosing the most appropriate design of equipment to undertake activities should incorporate a decision as to the degree of disturbance caused during use, and the location of the activity in relation to fish and marine mammals. Specific designs of equipment can have a significant influence on acoustic emissions.

3.7.24 The timing and location of noise generating activities is a consideration that can significantly influence the marine environment. It is important to consider the level of natural and anthropogenic activity occurring at a particular time and/or location in relation to the activities of fish and marine mammals to reduce the effects on the marine environment. For example, making use of a period when the weather

conditions and sea state support higher organic noise levels masking anthropogenic noise. Or utilising periods of the year, or tidal calendar when less biological activity is occurring resulting in minimising disturbance.

3.7.25 Alternatively, monitoring the marine environment, and adjusting operations in accordance with biological activity. Some marine projects have resorted to monitoring marine mammal activity, and ceasing noise generating activities to prevent disturbance to marine mammals until the marine mammals are out of the range of the effects. This option is more common for preventing harm from activities such as blasting. A safe distance is designated, and monitored to prevent marine mammals coming to any harm. This safe distance can also be created in certain situations using an appropriate noise source to deter fish and marine mammals from entering 'danger zones'.

3.7.26 The efficacy of the measures to prevent or reduce adverse effects options will vary with the consequence of a certain noise generating activity on the marine environment and the degree of effectiveness of the measures to prevent or reduce adverse effects options, or combination of measures to prevent or reduce adverse effects options. This will require consideration in relation to the cost (both financial and timeliness).

Measures needed to offset effects

3.7.27 The identification of offsetting measures is a requirement of the SEA Directive. For the purposes of this SEA, these are measures to as fully as possible offset any significant adverse environmental effects. Such measures make good for loss or damage to an environmental receptor, without directly reducing that loss/damage. In this SEA, 'compensation', a subset of offsetting, is only used in relation to those measures needed under Directive 92/43/EEC (the Habitats Directive).

3.7.28 The need for offsetting measures is identified within this topic. However, it is not be possible to describe full details of offsetting measures, such as geographic locations, at this strategic level. Therefore, generic suggestions will be made. Compensation measures are even more indefinite in scope, being dependent on preceding tests within the Habitats Directive. Thus it will only be possible to describe the need for such measures under the Habitats Directive, rather than scope them in any detail.

3.7.29 No offsetting measures are identified for this topic.

Assumptions, Limitations and Uncertainty

3.7.30 In identifying measures to prevent, reduce and as fully as possible offset any likely significant adverse effects on the environment and making suggestions, there are some limitations, and assumptions have been made. Furthermore, particularly because the suggestions made are high level, uncertainty is inherently associated with the assessment of the effects of the measures. These issues are discussed for this topic below.

3.7.31 In the above sections where measures to prevent or reduce adverse effects has been discussed, it must be acknowledged that at this stage of the appraisal definitive information regarding locations, timelines and equipment and methodology is insufficiently detailed to allow for detailed comments in relation to this topic. Therefore the measures to prevent or reduce adverse effects discussed are at a generic level, and offer suggested methods, current thinking and practice for reducing the environmental effects of noise on a receptor. Detailed measures to prevent or reduce adverse effects will be required as and when specific details are known. Assurances

and confidence can be gained with the knowledge that there are measures that can be taken to reduce the environmental effects of noise, however, the degree by which this can be achieved is not know due to the availability of details relating to the specific noise sources.

SECTION 4

ASSESSMENT AGAINST SEA OBJECTIVES

4 ASSESSMENT AGAINST SEA OBJECTIVES

4.1 Introduction

4.1.1 While not specifically required by the SEA Directive, the Practical Guide (ODPM et al., 2005) recommends that SEA Objectives are used to compare the effects of alternative options. The SEA Objectives, assessment criteria and indicators were drafted and consulted upon as part of the Phase 1 SEA scoping stage.

4.1.2 SEA Objectives reflect a desired direction of change. It therefore follows that these objectives may not necessarily be met in full by a given alternative option, but the degree to which they do will provide a way of identifying preferences when comparing alternative options.

4.1.3 This topic paper informs the Environmental Report and its assessment of alternative options against SEA Objectives. This is by providing an assessment specifically in relation to the topic's SEA Objectives. The Environmental Report will then consolidate each topic assessment to provide a description of the assessment in relation to all SEA Objectives.

4.2 Assessment Methodology

4.2.1 An SEA Objective compliance methodology requires judgements to be made on the performance of alternative options against each SEA Objective. The 'assessment criteria' and 'indicators' which accompany the SEA Objectives aid these judgements. The effects on receptors presented in section 3 are aggregated and related back to the SEA Objectives so that the environmental performance of each alternative option can be compared.

4.2.2 The SEA Objectives assessment summary table (table 4.1) shows how each alternative option performs over its entire life-cycle against each SEA Objective, and whether this is major or minor, positive or negative or a combination of the two. For instance, some receptors covered by an SEA Objective may benefit from an alternative option, whereas others would be adversely affected. Furthermore, the judgement of whether the alternative option performance is minor or major depends on the number or proportion of receptors for each objective that are significantly affected, and their value. In addition to the SEA Objectives assessment summary table, the SEA Objectives are also discussed in relation to assessment criteria and indicators.

4.2.3 It recognised that there is a degree of judgement related to alternative option performance, and the assessment criteria are intended as an aid to these judgements. This activity has also been informed by inputs from the Technical Workshops and the Environment and Regional Workstreams.

4.3 Objectives-led Assessment Summary

4.3.1 Table 4.1 sets out the summary of the SEA Objectives assessment which is described in detail below.

<u>SEA Objective 1: To avoid adverse effects of negative noise and vibration on (humans) noise sensitive receptors (NSRs).</u>

4.3.2 Using the landfall footprint of each of the alternatives as a basis for assessment, it is clear that some alternatives will have a greater effect due to the proximity of

alternative to NSRs. On this basis, it is clear that alternative B5: Beachley barrage (having 24 NSR's), and alternative L3d: Bridgewater Bay lagoon (having 10NSRs) within 200m may result in the greatest levels of noise to those NSRs. However, on considering the overall number of NSRs within proximity to the alternatives over a 2km, thus resulting in potentially relatively lower effects, alternative B4: Shoots barrage has the greatest overall number (having 4348 NSRs), followed by alternative L2: Welsh grounds lagoon (having 1250 NSRs), followed closely by B3: Beachley barrage having (1142 NSRs).

4.3.3 Following the adoption of appropriate measures to prevent or reduce adverse effects, noise levels could be reduced to within levels that are not considered to be significant. However, whilst it can be said that noise levels will not be considered 'significant', there will still be some environmental effects as a result of increased noise levels. For example, noise from distant traffic, or distant machinery may not result in levels of noise considered to be 'significant', nevertheless, noise will be heard. On this basis alone, there will be some environmental effect.

SEA Objective 2: To avoid adverse effects on the acoustic quality of the marine environment.

4.3.4 Given the uncertainty in the baseline noise environment it is not possible to determine the level of compliance against this objective for any of the alternative options. The performance against this Objective has therefore been scored as Uncertain.

4.3.5 The effects of this objective are discussed in more detail in the Marine Ecology (STP 2010i) and Migratory & Estuarine Fish (STP 2010k) topic papers.

SEA Objective 3: To avoid adverse effects on noise (vibration) sensitive receptors.

4.3.6 SEA Objective N&V 3 relates to adverse effects on noise & vibration sensitive terrestrial ecology receptors.

4.3.7 Following consideration and implementation of measures to prevent or reduce adverse effects, the effects of the alternative options on terrestrial ecology receptors are expected to be reduced to a level where this objective can met. Consequently, a minor positive score for performance against this objective has been attributed for all alternative options.

4.3.8 The effects of this objective are discussed in more detail in the Terrestrial & Freshwater Ecology topic paper (STP 2010o).

SEA Objective 4: To avoid adverse effects through vibration.

4.3.9 The effect on building structures is not considered at this stage to be significant. Therefore, a no effect score has been attributed.

Assumptions, Limitations and Uncertainty

4.3.10 In undertaking the assessment of the alternative options against the SEA objectives, there are assumptions, limitations and uncertainties, particularly as there is a degree of judgement related to option performance. These issues are discussed for this topic below.

4.3.11 As discussed throughout this topic paper, at this stage of a 'strategic' assessment, a number of assumptions will be made in the absence of specific details. The landfall footprints for the alternatives have been used to guide on the locality of noise effects,

and thus the numbers of NSRs affected. This will result in changes when further details of for example, construction techniques, and exact locations.

4.3.12 The underwater assessment has been made without knowledge of the underwater baseline noise environment, and limited information available for the noise levels of the tidal turbines. A review of relevant literature has been undertaken in order to provide some outline environmental effects, however, with such limited information available at this stage, the degree to which environmental effects can be anticipated is low.

Table 4.1 SEA Objective Assessment Summary Table

Key

Performance is based on number or proportion of receptors linked to each SEA Objective for which significant effects have been predicted, and informed by consideration of SEA Assessment Criteria.			
Major negative performance against SEA Objective	--	Major positive performance against SEA Objective	++
Minor negative performance against SEA Objective	-	Minor positive performance against SEA Objective	+
No Effects	0	Uncertain	?

SEA Objective	Relevant Receptors	Alternatives Performance against SEA Objectives over entire life-cycle				
		Alternative Option B3: Brean Down to Lavernock Point Barrage	**Alternative Option B4: Shoots Barrage**	**Alternative Option B5: Beachley Barrage**	**Alternative Option L2: Welsh Grounds Lagoon**	**Alternative Option L3d: Bridgwater Bay Lagoon**
SEA Objective 1: To avoid adverse effects of negative noise and vibration on (humans) noise sensitive receptors.	Noise sensitive Receptors (NSR) Residential. And Noise sensitive Receptors (NSR) Non-Residential.	(0 to -) All the alternatives will meet this objective in terms of there being no significant noise effect following noise measures to prevent or reduce adverse effects, however, there will still be noise 'heard' which can be considered an effect, however insignificant that may be.				
		Has 4 NSRs within 400m, 22 NSRs within 800m, and only 1142 within 2km. Therefore very few receptors will experience high levels of noise, and relatively few will experience distant noise.	Has the greatest number of NSRs within 2km (4348), however, has no receptors within 400m, and only 48 NSRs within 800m. Thus very few receptors will experience high levels of noise.	Has 24 NSRs within 200m, 44 within 400m, 133 NSR at 800m, and 1200 at 2km. Resulting a greater number of NSRs experiencing greater noise levels, but relatively few NSRs experiencing any noise effects.	Has 89 NSRs within 400m, 149 NSRs within 800m, rising to 1250 NSRs at 2km, therefore relatively more NSRs will experience some effects from the level of noise, but a relatively low number overall	Has 10 NSRs within 200m, 18 NSRs within 800m, and only 273 NSRs within 2km resulting in few NSRs experiencing some noise effect.
SEA Objective 2: To avoid adverse effects on the acoustic quality of the marine environment.	Fish, Marine mammals and the marine environment	(? Uncertain) Following consideration and implementation of noise measures to prevent or reduce adverse effects measures, the effects of the alternatives should be reduced in significance. However, for further detailed assessment reference should be made to the Migratory & Estuarine Fish topic paper.				
SEA Objective 3: To avoid adverse effects on noise (vibration) sensitive receptors.	Noise sensitive Receptors (NSR) Wildlife	(+) Following consideration and implementation of noise measures to prevent or reduce adverse effects measures, the effects of the alternatives should be reduced in significance. However, for further detailed assessment reference should be made to the Terrestrial & Freshwater Ecology topic paper.				
SEA Objective 4: To avoid adverse effects through vibration.	Noise sensitive Receptors (NSR) Residential. And Noise sensitive Receptors (NSR) Non-Residential.	(+) All the alternatives will meet this objective in terms of there being no significant vibration effect following noise measures to prevent or reduce adverse effects,				
		There are no NSRs within close proximity to the landfall footprint therefore there will be no NSRs within a range to experience the effects of vibration	There are no NSRs within close proximity to the landfall footprint therefore there will be no NSRs within a range to experience the effects of vibration	There are 24 NSRs within 200m. It is therefore possible that some effect from vibration may result, should there be significant levels of vibration occurring. (For example during piling activities during construction). However, following measures to prevent or reduce adverse effects, these levels will not be significant	There are no NSRs within close proximity to the landfall footprint therefore there will be no NSRs within a range to experience the effects of vibration	There are 10 NSRs within 200m. It is therefore possible that some effect from vibration may result, should there be significant levels of vibration occurring. (For example during piling activities during construction). However, following measures to prevent or reduce adverse effects, these levels will not be significant

SECTION 5

PLAN IMPLEMENTATION

5 PLAN IMPLEMENTATION

5.1 Introduction

5.1.1 This section assesses whether each alternative may be compliant with existing legislation and policy relevant to this topic as set out in section 2.3. This section also sets out suggestions for the framework for the monitoring of the plan against the predicted effects within this topic. It will thereby inform the development of the overall monitoring suggestions contained within the SEA Environmental Report.

5.2 Legislation and policy compliance

5.2.1 Identification of compliance with existing legislation and policy is not a requirement of the SEA Directive but will assist with suggestions to Government by DECC. The assessment considers legislation and policy relevant to this topic; and does not consider the overall consenting route that would apply to alternative options. Consenting is the subject of a separate Feasibility Study workstream.

5.2.2 It is anticipated that all of the alternatives would be fully compliant with the existing legislation and policies detailed in section 2.3.

5.3 Monitoring of significant environmental effects

5.3.1 The SEA Directive requires that monitoring measures are described within the environmental reporting. Monitoring allows the actual significant environmental effects of implementing a Severn Tidal Power alternative option to be tested against those predicted.

5.3.2 There are no significant environmental noise effects anticipated with any of the alternatives. However, it should be stated that there is a requirement to undertake monitoring of the baseline noise environment within the area of the selected alternative, should this feasibility study go forward to EIA stage in order to quantify the underwater noise environment. This will be required in order to assess any potential effects that may arise as a result the implementation of this feasibility study.

5.3.3 It should also be noted that for large-scale construction projects, it is often a requirement that noise monitoring occurs throughout the construction process to ensure that noise levels are within those agreed and / or recommended. This is often a requirement of the local authority within whose jurisdiction the construction works occur.

SECTION 6

GLOSSARY

6 GLOSSARY

Term	Definition
A – Weighting	A-weighting has been found to give the best correlation between perceived and actual loudness. Measurement to which this weighting has been applied are described as being in dB (A).
Ambient Noise	The total sound in a given situation at a given time, usually composed of sound form may sources near and far.
Ancillary development	Other works beyond a Severn Tidal Power scheme but are needed to build or operate the scheme, including measures to prevent, reduce or as fully as possible offset significant environmental effects, e.g. dredging, bypasses etc.
Appropriate Assessment	A process required by the Habitats Regulations (SI 1994/ 2716) to avoid adverse effects of plans, programmes and projects on Natura 2000 sites and thereby maintain the coherence of the Natura 2000 network and its features.
Background Noise	The noise level at a given location and time, measured in the absence of any alleged noise nuisance or sound sources being studied. It is also referred to as the ambient or residual noise
Background Noise Level, $L_{A90,T}$	The dB level exceeded for 90% of a given time interval, T.
Barrage	A manmade obstruction across a watercourse to retain a head of water on the rising tide, and then run the water through turbines when the tide level drops.
Bristol Channel	The area seaward of the headlands at Lavernock Point on the Welsh coast and Brean Down on the English coast (see Severn Estuary and also Inner Bristol Channel and Outer Bristol Channel)
Bulb Kapeller type turbines	The Kapeller Bulb turbine is a turbine regulated only by its adjustable runner blades (single regulation). It has fixed wicket gates. It is adaptable to pumping as well as generation but only suited to one way generation. Kapeller Bulb turbine technology has largely been superseded by Bulb Kaplan turbines.
Bulb Kaplan turbines	The Kaplan turbine is a propeller-type water turbine that has adjustable blades and adjustable wicket gates (double regulation). It is adaptable to pumping as well as generation. Kaplan turbines are now widely used throughout the world in high-flow, low-head power production. The Kaplan turbine is an inward flow reaction turbine, which means that the working fluid changes pressure as it moves through the turbine and gives up its energy. The Kaplan turbine is suited to one or two way generation.
Bulb turbines	The generator is mounted in a bulb on the main turbine axis upstream of the runner blades for one way generation. Bulb turbines can be used for one or two way generation depending on the type (see above).
Caissons	Prefabricated concrete units used to construct parts of a barrage, lagoon or other offshore structures. Caissons can be used to house turbines, sluices or to construct navigation locks, or they may just be plain units used for impoundment construction.
Coastal Squeeze	Process whereby the coastal margin is squeezed between a fixed landward boundary and the rising sea level.
Consequential development	It is conceivable that a major tidal power scheme will facilitate or attract other developments, which may themselves pose significant environmental effects. These developments are described as ‘consequential developments’.

Term	Definition
Cumulative effects	Effects arise, for instance, where several developments each have insignificant effects but together have a significant effect, or where several individual effects of the plan have a combined effect.
Decibel (dB)	A logarithmic unit for measuring the relative loudness of noise, i.e. the sound level.
Direct effects	The original effect as a result of an option (see indirect effects)
Ebb	When the sea or tide ebbs, it moves away from the coast and falls to a lower level.
Ebb mode	One way generation on ebb tides only i.e. during the period between high tide and the next low tide in which the sea is receding.
Ebb and flood mode	Two way generation during the ebb and flood tides
Effect	Used to describe changes to the environment as a result of an option (see also direct effects, indirect effects, far-field effects and cumulative effects)
Environmental Noise	Noise governed by environmental legislation, and usually enforced by local authorities. Also termed “nuisance”.
Facade Effect	The phenomenon of sound energy (noise) being reflected form the hard rigid, external surface of a building or structure. Where a facade is present, this effect adds approximately 2.5 or 3 dB (A) to the free field noise level (at a distance of 1 metre from the facade).
Far-field effects	Effects that are felt outside the Severn Estuary study area.
Flood	The inward flow of the tide - This is the opposite of ebb. This refers to a mode of operation for a STP alternative option.
Free Field Noise Level	The noise level measured away from any reflecting surfaces.
Future baseline	Baseline during construction (2014-2020) and operation (2020-2140), decommissioning and longer term trends.
Geomorphology	The study of the changing form of the estuarine environment and its components in relation to physical forcing.
Hertz (Hz)	Unit of frequency, equal to one cycle per second. Frequency is related to the pitch of the sound.
Hydrodynamics / hydraulics	The science of physical forces acting on the water.
Hypertidal	A tidal range in excess of 6m.
Impoundment	A body of water, such as a reservoir, made by impounding
Indicator	A measure of variables over time often used to measure achievement of objectives.
Indirect effects	Those effects which occur away from the original effect or as a result of a complex pathway.
Inner Bristol Channel	The downstream limit extends from Nash Point in Wales to the west of Minehead along the English coast. The upper limit extends from Swanbridge on the Welsh coast to Brean Down along the English coast.
Irreversible	If the timescale for a receptor’s return to baseline condition is greater than 50 years then it will be considered irreversible.
$L_{Aeq, T}$	The equivalent continuous sound level. It provides an “average” sound level over a defined period of time (T). The L_{Aeq} is the main measurement used in making assessments according to Planning Policy Guidance 24.

Term	Definition
$L_{A10, 18h}$	The L_{A10} is the sound level exceeded 10 per cent of the time and it is used to define road traffic noise. The L_{10} (18 hour) dB (A) is the arithmetic average of the values of L_{10} hourly dB (A) for each of the eighteen one-hour periods between 0600 and 2400 hours.
Lagoon(s)/ Land-connected lagoons	A man-made enclosed body of water that retains a head of water on the rising tide and then runs the water through turbines when the tide level drops. A land connected lagoon uses the shoreline to make the enclosure.
L_{Amax}	The maximum sound level measured.
Long-listed options	All options identified in the SDC report, Call for Proposals and other strategically selected proposals as well as the Interim Options Analysis Report.
Measures to prevent or reduce effects	Measures to prevent or reduce any significant adverse effects on the environment.
Negative effects	Changes which are unfavourable for a receptor. Can sometimes be referred to as 'adverse'.
Noise Sensitive Receptor	A potential receiver of noise. This term usually refers to residential dwellings in most instances. In the context of this paper, this term also includes wildlife and other receptors as included in Table 2.1.
Offsetting	Measures to as fully as possible offset any significant adverse effects on the environment. Such measures will aim to make good for loss or damage to an environmental receptor, without directly reducing that loss/damage. Not used in relation to the Habitats Directive (see compensation, above).
One way generation	The operating mode whereby power is generated on only one phase of the tidal cycle. For Severn tidal power, one way generation is typically ebb mode.
Original scheme	The form of the scheme when it was shortlisted at the end of phase 1.
Outer Bristol Channel	The outer limit extends from St. Govans Head in Pembrokeshire to Hartland Point in Devon, which traditionally defines the lower limit of the Bristol Channel. The upper limit extends from Nash Point in Wales to the west of Minehead along the English coast.
Permanent effect	An effect which will last at least for 50 years.
Phase 1	The first stage of the STP Feasibility Study - i.e. the Decision Making Assessment Framework (to develop a short-list of options) and SEA Scoping.
Phase 2	The second stage of the STP Feasibility Study - i.e. short-listed options appraisal and main assessment stage of the SEA.
Planning Policy Guidance Note	A series of planning policy statements produced by Central Government to local planning authorities, applicants, the public and consultees on a range of planning matters.
Positive effects	Changes which are favourable for a receptor. Can sometimes be referred to as 'beneficial'.
Pumping	Operating turbines in reverse to pump water from lower to higher levels. Pumping can be used during one way generation to raise impounded water levels so that more energy can be generated when the ebb tide is receding.
Rating Level	The specific noise level plus any adjustment for the characteristic features of the noise.
Receptor	An entity that may be affected by direct or indirect changes to an environmental variable.

Term	Definition
Reversible	If the timescale for a receptor's return to baseline condition is less than 50 years then it will be considered reversible.
Scoping	The process of deciding the scope and level of detail of an SEA, including the environmental effects and alternatives which need to be considered, the assessment methods to be used, and the structure and contents of the Environmental Report.
SEA objective	A statement of what is intended, specifying the desired direction of change in trends.
Seabed	The areas permanently covered by the sea, i.e. Lowest Astronomical Tide. Sometimes referred to as sub-tidal.
Severn Estuary	This is the physical extent of the Estuary and does not reflect the Study Area (see below) or nature conservation designations.
Severn Tidal Power Study Area	The general study area used for the project broadly extends downstream on the Estuary as far as Worm's Head to Morte Point. It includes the landward fringe and tributaries such as the River Wye and the River Usk.
Short-listed options	Options screened from long-listed options, to be taken forward for analysis in the SEA following the public consultation conducted in 2009.
Significant environmental effects	Effects on the environment which are significant in the context of a plan or programme. Criteria for assessing significance are set out in Annex II of the SEA Directive (2001/42/EC).
Site of Special Scientific Interest (SSSI)	Designated under the Wildlife and Countryside Act 1981, any land considered by Natural England to be of special interest because of any of its flora, fauna, or geological and physiographical features.
Sluice caissons	Prefabricated concrete structures placed into the water to house a sluice.
Special Area of Conservation (SAC)	Strictly protected site designated under the EC Habitats Directive 92/43/EEC. Article 3 of the Habitats Directive requires the establishment of a European network of important high-quality conservation sites that will make a significant contribution to conserving the 189 habitat types and 788 species identified in Annexes I and II of the Directive (as amended). The listed habitat types and species are those considered to be most in need of conservation at a European level (excluding birds).
Special Protection Area (SPA)	Strictly protected site classified in accordance with Article 4 of the EC Directive on the Conservation of Wild Birds (79/409/EEC), also known as the Birds Directive.
Specific Noise	The noise source under investigation for assessing the likelihood of complaints.
Straflo type turbines	A more compact turbine compared to Bulb turbine technology. Instead of containing the generator in a bulb, it is located and designed for ebb only operation and not suited to pumping.
Strategic Environmental Assessment (SEA)	Term used to describe environmental assessment as applied to policies, plans and programmes. 'SEA' is used to refer to the type of environmental assessment required under the SEA Directive.
Sub tidal	Areas (particularly with reference to habitats) that lie below the level of the lowest astronomical tide.
Synergistic effects	Effects which interact to produce a total effect greater than the sum of the individual effects, so that the nature of the final effects is different to the nature of the individual effects. Included within cumulative effects (see above).
Temporary effects	An effects which only lasts part of the project lifetime, e.g. is confined to the construction period.

Term	Definition
The Shoots	The downstream boundary extends from Undy along the Welsh coast to Severn Beach along the English coast, just to the south of the M4 motorway crossing. The upstream limit extends just to the north of the M46 motorway crossing, between Beachley on the Welsh coast and Aust on the English coast.
Tidal bore	A tidal phenomenon in which the leading edge of the incoming tide forms a wave (or waves) of water that travel up a river or narrow bay against the direction of the current.
Tidal Prism	The difference between the mean high-water volume and the mean low-water volume of an estuary.
Transboundary Effects	An environmental effect upon another EU Member State.
Turbine caissons	Prefabricated concrete structures placed into the water to house turbines.
TWh/year	A unit used to describe how much energy generated, sold, consumed, etc. A terawatt-hour refers to generating or using power at a capacity of 1 terawatt (1012 watts) for one hour. A terawatt-hour per year means the equivalent amount of power sometime within the period of a year.
Two way generation	The operating mode whereby power is generated on both phases of the tidal cycle (ebb and flood)
Upper Severn Estuary	Upstream from the M46 motorway crossing, between Beachley on the Welsh coast and Aust on the English coast, to the tidal limit along the River Severn at Maisemere, Gloucestershire.
Variant	A modified version of the original shortlisted scheme.
Vibration	Mechanical oscillations about an equilibrium point. The oscillations may be periodic such as the motion of a pendulum or random.

SECTION 7

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7 REFERENCES

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SECTION 8

APPENDICES

APPENDIX A

VALUE, VULNERABILITY AND THRESHOLDS FOR MAGNITUDE OF EFFECT

Briefing Paper Ref	Baseline Receptor: Value, Vulnerability and Thresholds for Magnitude of Effect
Status	Template for use in report writing
Subject	Severn Tidal Power – Baseline Receptor: Value, Vulnerability and Thresholds for Magnitude of Effect
Date	12 August 2009
Author	Hannah Kent
Reviewer	Richard Perkins, Tom Matthewson, Delyth Toghill
Circulation	Topic Leads
File Name	121320 STP SEA Phase 2 Template for Value, Vulnerbaility & Thresholds for Magnitude.doc

Summary

The Strategic Environmental Assessment for the Severn Tidal Power Feasibility Study is founded on the assessment of effects upon receptors; to inform the identification of those effects which are likely to be significant.

In forming a judgement on effect significance, it is necessary to assign attributes to each receptor, some of the most important of these being their value and vulnerability. In addition, it is necessary to take the magnitude of effect into consideration. In advance of identifying the effects of the short-listed options, it is necessary to determine the thresholds for this magnitude of effect.

This document sets out the proposed levels of both value and vulnerability of those receptors under consideration during the Phase 2 assessment as well as proposed thresholds for magnitude of effect.

In view of the complex susceptibilities of Marine Receptors to noise and vibration, Marine receptors will be dealt with separately by the topic specialist in the Marine Ecology Topic

1. OVERVIEW

1.1 Introduction

The Severn Tidal Power (STP) Strategic Environmental Assessment (SEA) is founded on the assessment of effects upon receptors; to identify those effects which are likely to be significant. A receptor is defined as an entity that may be affected by direct or indirect changes to an environmental variable.

In forming a judgement on effect significance, it is necessary to assign attributes to each receptor, some of the most important of these being their value and vulnerability. One purpose of this document is to set out the proposed levels of both value and vulnerability to those receptors under consideration during the Phase 2 assessment.

In addition, when forming a judgement of effect significance, it is necessary to take the magnitude of effect into consideration. In advance of identifying the effects of the short-listed options, it is necessary to determine the thresholds for this magnitude of effect. This document sets out the proposed thresholds for magnitude of effect for those receptors under consideration during the Phase 2 assessment.

1.2 Requirements of the Strategic Environmental Assessment Directive

When determining the likely significance of effects on the environment, the Annex II of the Strategic Environmental Assessment Directive includes the following criteria (as presented in Phase 2 SEA Env. 4 Process Note p11)[1]:

> Characteristics of the effects and of the area likely to be affected, having regard, in particular, to;
>
> (a) the probability, duration, frequency and reversibility of the effects;
> (b) the cumulative nature of the effects;
> (c) the transboundary nature of the effects;
> (d) the risks to human health or the environment (for example, due to accidents);
> (e) the magnitude and spatial extent of the effects (geographical area and size of the population likely to be affected);
> (f) the value and vulnerability of the area likely to be affected due to -
> (i) special natural characteristics or cultural heritage;
> (ii) exceeded environmental quality standards or limit values; or
> (iii) intensive land-use; and
> (g) the effects on areas or landscapes which have a recognised national, Community or international protection status.

For each receptor, an assessment will therefore be provided that reviews the effects against these criteria. In many cases this will be based on qualitative rather than quantitative information and where necessary make use of expert judgement. The findings will be reviewed at a Technical Workshop in each case.

1.3 Definitions of Value and Vulnerability

The Strategic Environmental Assessment Directive does not define value or vulnerability. For the purpose of the Severn Tidal Power Feasibility Study SEA, the following definitions are being used.

[1] Parsons Brinckerhoff Ltd in association with Black & Veatch Ltd (2009) *Phase 2 SEA: Env. 4 Process Note*

- Value the value of a receptor is based on the scale of the geographic reference, rarity, importance for biodiversity, social or economic reasons, and level of legal protection.
- Vulnerability the potential for a pathway for exposure of a receptor to a given environmental effect, together with the sensitivity of the receptor to that effect. (The sensitivity is the tolerance of a receptor to a given environmental effect and its ability to recover from that effect).

It is not readily possible to develop a 'one size fits all' definition that applies consistently to all topics of the STP SEA. Therefore specific definitions and judgements on receptor value and vulnerability have been developed for each topic in consultation with the relevant technical groups.

A guideline framework for these classifications is provided in table 1.1 below:

Table 1.1 Guidelines for identifying receptor value and vulnerability

	Sample receptor definitions	
	Value	**Vulnerability**
High	e.g. receptor is rare, important for social or economic reasons, legally protected, of international or national designation.	e.g. potential pathways for environmental change exist between options (sources) and receptors, receptor is in declining condition, dependent on a narrow range of environmental conditions.
Moderate*	N/A	e.g. few pathways for environmental change exist between options (sources) and receptors, receptor is only expected to recover from disturbance over a prolonged period of time, if at all.
Low	e.g. receptor is common, of local or regional designation.	e.g. limited or no pathways from between options and receptors, receptor is in stable or favourable condition and dependent on a wide range of environmental conditions.
None	N/A	e.g. no pathways exist between environmental changes and receptors, receptor is insensitive to disturbance.

*'Moderate' vulnerability will only be assigned if analysis of receptors indicates that it is essential to make a further distinction between High and Low vulnerability attributes,

For each receptor, an assessment will therefore be provided that reviews the effects against these criteria. In many cases this will be based on qualitative rather than quantitative information and where necessary make use of expert judgement. The findings will be reviewed at a Technical Workshop in each case.

1.4 Definitions of Thresholds for Magnitude of Effect

The magnitude of the effect considers the receptor affected and categorises this as high, medium, low or very low. The Strategic Environmental Assessment Directive does not provide classification thresholds. Therefore specific definitions on classification thresholds for magnitude of effect have been developed for each topic receptor in consultation with the relevant technical groups.

Guidelines for determining thresholds for magnitude of effect are provided in table 1.2 below. It should be noted that the thresholds may be quantitative or qualitative.

Table 1.2 Guidelines for determining thresholds for magnitude of effect

	Magnitude of effect			
Classification	**High**	**Medium**	**Low**	**Very Low**
Quantitative Guideline	90%+ of receptor or capacity of estuary to support receptor affected	50-90% of receptor or capacity of estuary to support receptor affected	10-50% of receptor or capacity of estuary to support receptor affected	<10% of receptor or capacity of estuary to support receptor affected
Qualitative Guideline (note that these are primarily focused on the natural environment and should be adapted for other topics as appropriate)	A permanent or long-term effect on the extent or size or integrity of a site, habitat, species assemblage or community, population or group. If adverse, this is likely to threaten its sustainability/favourable conservation status; if beneficial, this is likely to enhance its conservation status.	A permanent or long-term effect on the extent or size or integrity of a site, habitat, species assemblage or community, population or group. If adverse, this is unlikely to threaten its sustainability sustainability/favourable conservation status; if beneficial, this is likely to be sustainable but is unlikely to enhance its conservation status.	A permanent or long-term reversible effect on a site, habitat, species assemblage or community, population or group whose magnitude is detectable but will not threaten its integrity.	A short-term but reversible effect on the extent or size or integrity of a site, habitat, species assemblage or community, population or group that is within the normal range.

It should be noted that the thresholds for magnitude of effect may differ for each receptor or group of receptor.

2. ASSIGNING VALUE

Based on the above guidance and information, table 2.1 below sets out the proposed values for the noise and vibration receptors. Further discussion on the value assigned to each receptor is provided below.

- For the purposes of this brief, it should be noted that the definition of receptor has been amended from that detailed in the Noise and Vibration Scoping paper in order to be more specific. The scoping paper initially introduced receptors as an area, and described the nature of the area. Whilst this gave an indication as to the level of sensitivity of receptor to change, it is far less specific. The receptor descriptions detailed in the Scoping report still hold, in that, they detail the local circumstances, and therefore the sensitivity of the receptor to change, however, it was felt that identifying the receptors in greater detail would be beneficial. The following receptors are detailed in the document 'Guidelines for Noise Impact Assessment' (Draft) – IEMA/IoA.

Table 2.1 Receptor Value

Receptor	Proposed Value
Residences	High
Schools & Colleges	High
Hospitals	High
Places of Worship	High
Commercial	High
Industrial	High
Farms, kennels and wildlife sites	High
Open Air Amenities	High

The effects on human beings are usually the principal consideration in assessing noise impacts. However, noise can also be an important contributor to other indirect environmental effects. Noise can disturb wildlife to varying degrees; noise can have a significant impact upon the character of a landscape, and noise, particularly low frequency noise & vibration can have a material effect on buildings, in that, at a certain threshold, noise can have a damaging effect on the structure of a building. Table 2.1 therefore includes not only residential receptors as detailed in the above standards and guidance documents but also commercial or educational buildings, places of interest, amenity areas and animals.

The value of a receptor has been assigned based primarily on the level of legal protection inferred in the documents referenced in section 5, but also to some extent on a receptors rarity, and social and economic reasons.

With such a wide range of receptors and sensitivities, and a distinct lack of accepted practice in assigning a value to non-residential land-uses, identification of sites, for the purposes of assigning value in terms of noise will require consultation with the local authority and local stakeholders. Consultation should provide a sufficiently comprehensive method of identification of various land-uses and, in this way, receptors such as sites of local historic interest and nationally designated footpaths and beauty spots can be included in addition to identifying buildings detailed through mapping layers.

Additionally, in assigning a value to a receptor, it is necessary to consider the use of the receptor. Internal and external noise levels will affect the value of any receptor. For example, hospitals may be less sensitive to external noise levels due to their high internal noise levels.

3. ASSIGNING VULNERABILITY

'Vulnerability' is not expressly discussed or detailed in the documents detailed in section 5. Based on the guidance and information available table 3.1 below sets out the proposed vulnerabilities for the noise and vibration receptors. Further discussion on the vulnerability assigned to each receptor is provided below.

Professional judgement and current best practice in line with the documents in section 5 has been followed in determining the vulnerability of a receptor to change. The vulnerability of receptors to change has been assigned in relation to the distance receptors will be to noise generating activities associated with the project.

Table 3.1 Receptor Vulnerability

Receptors proximity to an activity site (in metres)	Proposed Vulnerability
0 – 200m	High
200 – 400m	Moderate
400 – 800m	Low
800 – 2000m	None

The statutory requirements, codes of practice and guidance above offer some degree of protection for noise sensitive receptors such as residences from potential noise sources that may affect them. Additionally, the measures to prevent or reduce adverse effects of a noise source is also potentially available as an option to reduce the impacts of noise. Construction and operational noise limits will be applied in all appropriate circumstances.

Much of the most significant sources of noise anticipated with this project are from the construction phase. Construction noise is temporary in nature, and whilst the construction phase will last for a number of years, the specific areas of construction work may be managed in such a way so as to limit the noise by reducing the level and / or duration, noise measures to prevent or reduce adverse effects, or moving construction to areas where receptors will be less sensitive to its effects. With a number of mechanisms in place to aid and control the effects of noise on receptors, the vulnerability of receptors to change can be managed in such a way that the effects of noise and vibration could be reduced.

In view of the complex susceptibilities of Marine Receptors to noise and vibration, Marine receptors will be dealt with separately by the topic specialist in the Marine Ecology Topic.

4. ASSIGNING THRESHOLDS FOR MAGNITUDE OF EFFECT

In assessing significance, factors such as whether the effect is temporary, permanent, direct or indirect, secondary, cumulative, short-medium or long term and whether an impact is positive or negative will be considered alongside the magnitude of the effect.

In assessing the magnitude for environmental effects, again the proximity to the source of noise has been used to determine the magnitude of the noise and vibration impact. The Severn Tidal project may potentially invoke unique and controversial situations, real and perceived effects, and these must also be considered and weighted in order to fully address the magnitude of the anticipated effect. For this reason, the magnitude of effects has been determined solely using the proximity of a receptor to a noise and / or vibration source.

Again 'magnitude of environmental effect' is not expressly discussed or detailed in the documents in section 5. The most recent DMRB Advice Note published by the Highways Agency (HA) in August 2008, HA205/08 does provide some guidance on determining significance of environmental effects, however, the HA have confirmed that this guidance is not to be used for the purposes of determining the significance of noise effects. It is therefore appropriate to base the magnitude of effects on sound reasoned argument, professional judgement and current best practice in line with established levels detailed in the documents in section 5.

Based on the guidance and information detailed in documents in section 5 table 4.1 below sets out the proposed thresholds for magnitude of effect for the noise and vibration receptors.

Table 4.1 Thresholds for Magnitude of Effects

Receptors proximity to an activity site (in metres)	Thresholds for Magnitude of Effect
0 – 200m	High
200 – 400m	Moderate
400 – 800m	Low
800 – 2000m	None

The above thresholds have been determined using professional judgement and current best practice. They cannot be based on based on any standard or accepted practice; however, in the absence of specific guidance, they provide a method of assessing the magnitude of effects for a variety of receptors.

5. DOCUMENTS REVIEWED

The following documents have been used in the production of this briefing paper:

- STP SEA Phase 2 Env 4 Process Note
- Guidelines for Noise Impact Assessment (Draft) – IEMA/IoA
- Planning Policy Guidance; PPG Note 24: Planning & Noise (PPG24) in England, Technical Advice Note 11 (TAN11) in Wales;
- British Standard BS4142 1997: Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas;
- British Standard BS5228: Code of Practice for basic information procedures for Noise and vibration Control;
- Design Manual for Roads and Bridges – Volume 11, Section 3, Part 7 Traffic Noise and Vibration (HA 213/08 or DMRB);
- British Standard BS6472: Evaluation of Human Response to Vibration in Buildings;
- Noise Insulation Regulations 1975 (As Amended 1988);
- Land Compensation Act 1973; and
- Advisory Leaflet 72, "*Noise Control on Building Sites*" (DoE, 1976)
- Severn Tidal Power SEA Noise and Vibration Work Plan for Phase 2 (Draft), April 2009
- Severn Tidal Power – Scoping Topic Paper Noise and vibration, October 2008