9 Physical Environment

9.1 Hydrodynamics (Wave Climate and Tidal Regime)

9.1.1.1 This chapter considers the likely significant effects of the offshore transmission infrastructure (OfTI) on the physical hydrodynamic environment (the tidal and wave regimes). A more detailed description may be found in the supporting Technical Appendix 3.4 A: Metocean and Coastal Processes ABPmer (2011a).

9.1.1.2 This assessment is informed the following baseline chapters:

- Chapter 3.1 (Bathymetry);
- Chapter 3.2 (Geology);
- Chapter 3.3 (Wind Climate);
- Chapter 3.4 (Hydrodynamics: Wave Climate and Tidal Regime); and
- Chapter 3.5 (Sedimentary and Coastal Processes).

9.1.1.3 This impact assessment is also used to inform the following assessments:

- Chapters 6.1, 9.1 and 13.1 (Hydrodynamics: Wave Climate and Tidal Regime);
- Chapters 6.2 and 13.2 (Sedimentary and Coastal Processes);
- Chapters 7.1, 10.1 and 14.1 (Benthic Ecology);
- Chapters 7.2, 10.2 and 14.2 (Fish and Shellfish Ecology); and
- Chapters 8.5, 11.5 and 15.5 (Archaeology and Visual Receptors).

9.1.1.4 This chapter comprises the following:

- EIA Methodology;
- Primary Impact Assessment;
- Monitoring and Mitigation;
- Secondary Impact Assessment;
- Monitoring and Mitigation; and
- Residual Effects.

9.1.2 Summary of Effects

9.1.2.1 This chapter considers the likely significant effects of the OfTI on the physical hydrodynamic environment (the tidal and wave regimes).

9.1.2.2 The effects on hydrodynamic receptors that were assessed for the OfTI are:

- Changes to the tidal regime due to the presence of the offshore export cable and offshore platforms (OSP); and
- Changes to the wave regime due to the presence of the offshore export cable and OSPs.

9.1.2.3 The receptors considered in this assessment are:

- The Smith Bank;
- Designated sites; and
- Surfing venues.

9.1.3 Proposed Mitigation Measures and Residual Effects

9.1.3.1 No mitigation measures are proposed.

9.1.3.2 Table 9.1-1 below summarises the results of the impact assessment.

Table 9.1-1 Impact Assessment Summary

Effect	Receptor	Pre-Mitigation Effect	Mitigation	Post-Mitigation Effect
Construction				
Changes to the tidal and wave regimes (Cables)	Smith Bank, designated sites and surfing venues	Negligible Significance	None	Negligible Significance
Operation				
Changes to the tidal and wave regimes (Cables)	Smith Bank, designated sites and surfing venues	Negligible Significance	None	Negligible Significance
Changes to the tidal and wave regimes (OSPs)	Smith Bank, designated sites and surfing venues	Negligible Significance	None	Negligible Significance
Decommissioning				
(Partial impacts only)	Smith Bank, designated sites and surfing venues	Negligible Significance	None	Negligible Significance

9.1.4 Introduction

9.1.4.1 The following paragraphs describe the likely significant effects of the OfTI on physical processes in the marine environment and includes effects on water levels, currents and waves. Consequential and other direct effects on sediment transport and geomorphology are considered in Chapter 9.2 (Sedimentary and Coastal Processes).

9.1.4.2 The baseline wave and tidal conditions are described in Chapter 3.4 (Hydrodymanics: Wave Climate and Tidal Regime) of this document and the supporting Technical Appendix 3.4 A (Metocean and Coastal processes ABPmer, 2011a).

9.1.4.3 More details regarding the impact assessment methods used and results obtained and reported may be found in the supporting Technical Appendix 3.4 B

(Metocean and Coastal processes ABPmer, 2011c).

9.1.5 *Rochdale Envelope Parameters Considered in the Assessment*

9.1.5.1 The range of Project parameters adopted within this physical process assessment, as detailed in the supporting technical annex, are summarised in Table 9.1-2 below. The parameters set out below define the "Rochdale Envelope" realistic worst case scenario for each likely significant effect on the physical hydrodynamic environment. These are drawn from a range of development options set out in the Project Description in Chapter 2.2.

Table 9.1-2 Rochdale Envelope Parameter Relevant to the Hydrodynamic Impact Assessment

Type of Effect	Rochdale Envelope Scenario Assessed
Construction & Decommissioning	
Changes to the tidal and wave regimes	Cables 0.15 m diameter, initially laid to the seabed, then buried or otherwise protected for their operational lifetime.
Operation	
Changes to the tidal and wave regimes	Cables 0.15 m diameter, buried or otherwise protected for their operational lifetime.
	Two Offshore Substation Platforms (OSPs) in each of the three proposed wind farm sites and two additional OSPs on the export cable route (but within 2 km of the proposed wind farm sites) (i.e. eight in total), dispersed evenly throughout the total area. Foundations may be either GBS, jacket or semi-submersible types.

9.1.6 *EIA Methodology*

9.1.6.1 The methodology and terminology for the assessment of significance of any impacts is the same as that described in Chapter 6.1 (Hydrodynamics: Wave Climate and Tidal Regime) in relation to the wind farm infrastructure.

9.1.7 *Impact Assessment: Offshore Transmission Infrastructure*

9.1.7.1 This assessment considers the likely significant effects of the OfTI on physical process receptors identified within the study area. Physical process receptors that are potentially sensitive to changes in the physical baseline environment include:

- Smith Bank - A submerged bathymetric high in the Outer Moray Firth with a core of stable glacial tills covered by a veneer of sands and gravels of variable thickness and proportion. The form and function of the bank is relatively insensitive to changes in physical processes but is considered due to its proximity to the source of effects from the OfTI and wind farm infrastructure;
- Designated sites - SPA, SAC, SSSI and Ramsar sites within the Moray Firth. A full list of the sites considered and a summary of their morphological type may be found in Technical Appendix 3.4 A. These receptors are potentially sensitive to local changes in tidal range, wave climate and sediment supply; and
- Recreational surfing venues - A full list of the sites considered and a summary of their baseline wave characteristics may be found in Technical Appendices 3.4 A and 3.4 B. These receptors are variably sensitive to local changes in tidal range and wave climate.

9.1.7.2 A change in tidal or wave regimes alone does not necessarily imply an effect, if there are no receptors present that are sensitive to the change. Consequential (indirect) effects on sediment transport patterns and morphology are considered in Chapter 9.2 (Sedimentary and Coastal Processes).

9.1.7.3 Effects on these receptors are considered in relation to the construction, operation and decommissioning phases of the development in the following paragraphs.

Construction

9.1.7.4 The effect of the installed OSPs is considered in paragraphs 9.1.7.10 to 9.1.7.17 (see 'Operation'). The effect of less than the total amount of infrastructure at an intermediate stage in the construction process is (proportionally) less than that reported for the operational phase of the development.

9.1.7.5 Therefore, these impacts are not considered explicitly during the construction phase.

Changes to the Tidal and Wave Regimes (Transmission Cables)

9.1.7.6 Cables will be laid to the seabed through the water column. It is intended to then bury the cables along most of their length, either immediately or as a secondary operation, either beneath the seabed or, where this is not possible, under cable protection measures (rock placement or mattressing). Introducing these materials and machines to the baseline environment will present some small blockage to water movements locally.

Sensitive Receptor: Smith Bank, Designated Sites and Recreational Surfing Venues

9.1.7.7 The diameter of the transmission cables (order of 0.15 m) is too small to modify the ambient currents other than locally to a distance more than the order of millimetres from the cable, and only then when and where it is both submerged in the water and exposed above the seabed (as may happen during the construction period). As such, if the cable is laid and buried in one continuous operation, these effects will last for the order of seconds or minutes locally and would be small in comparison to the (also relatively small) disturbance associated with the presence and passage of the cable burial machine. If the cable is laid initially onto the seabed surface and buried more than a few hours later, more persistent but still low magnitude change to local currents may lead to local scour (described in Chapter 9.2: Sedimentary and Coastal Processes).

9.1.7.8 The diameter of the transmission cables is also too small to modify the ambient wave regime (height, period, direction). The cable may however interact locally with the oscillatory water motion under individual waves as described in the previous paragraph in relation to tidal currents, if the waves present are sufficiently large to cause movement of water at the seabed.

9.1.7.9 A negligible magnitude of change within the range of natural variability is therefore assessed to arise in areas of low sensitivity. This effect is therefore of **negligible significance** and therefore not significant in terms of the EIA Regulations.

Operation

Changes to the Tidal and Wave Regimes (Transmission Cables)

9.1.7.10 Cables will be buried beneath the seabed or under cable protection measures. Introducing materials to the baseline environment that are proud of the seabed will present some small blockage to water movements locally.

Sensitive Receptor: Smith Bank, Designated Sites and Recreational Surfing Venues

9.1.7.11 It is anticipated that during operation, the offshore export cables will be buried either in a trench, or under other protective materials. Buried cables present no obstacle to flows and so will not interact with the tidal and wave regimes. The dimensions of cable protection materials (maximum approximately 1 m high and in the order of metres wide with a sloped profile) are small both in an absolute sense and relative to the water depth. As such, cable protection measures have very little potential to interact with, or therefore to affect the ambient wave and tidal regimes.

9.1.7.12 Sections of cable and / or cable protection measures that are (or become) exposed on the seabed have the potential to interact locally with tidal and wave flows, but are of too small a physical scale to modify the regimes. The extent of any effect is similar to that described in relation to local scour (described in Chapter 9.2: Sedimentary and Coastal Processes).

9.1.7.13 A low magnitude of change within the range of natural variability is therefore assessed to arise in areas of low sensitivity. This effect is therefore of **negligible significance** and therefore not significant in terms of the EIA Regulations.

Changes to the Tidal and Wave Regimes (OSPs)

9.1.7.14 Changes to the tidal and wave regimes (water levels and currents and the joint statistics of wave height, period and direction) may arise from interaction of tidal currents and individual waves with obstacles in the water column (in this case the OSP foundations). The effect of individual foundations is principally controlled by the foundation shape and dimensions. The effect of multiple foundations is additionally controlled by the total number of foundations and their spacing and layout relative to tidal currents or wave direction. A change in tides or waves (instantaneous magnitude and direction within the range of natural variability) alone is not considered to constitute an effect as there are no physical process receptors that are directly sensitive to such changes. Consequential (indirect) effects on the sedimentary environment are considered in Chapter 9.2 (Sedimentary and Coastal Processes). Other consequential (indirect) effects are also considered, where relevant in other chapters: Chapter 10.1 (Benthic Ecology); Chapter 10.2 (Fish and Shellfish Ecology); and Chapter 11.5 (Archaeology).

Sensitive Receptor: Smith Bank, Designated Sites and Recreational Surfing Venues

9.1.7.15 An assessment of the effect on tidal and wave regimes of up to 339 turbine foundations in the three proposed wind farm sites was provided in Chapter 6.1 (Hydrodynamics: Wave Climate and Tidal Regime). The effect of the three sites together was shown to be not significant.

9.1.7.16 A single OSP foundation has dimensions and general blockage equivalent to two or less of the individual foundations previously tested. The additional effect of two

OSPs in a site or eight OSPs distributed within or immediately adjacent to the array is therefore much smaller than the array scale effect of all turbine foundations, as already assessed.

9.1.7.17 A low magnitude of change within the range of natural variability is therefore assessed to arise in areas of low sensitivity. This effect is therefore of **negligible significance** and therefore not significant in terms of the EIA Regulations.

Decommissioning

9.1.7.18 Where and when wind farm infrastructure is no longer present, there is no potential for any modification to the baseline wave and tidal regimes. The worst case scenario, of the infrastructure associated with three wind farms being present, is considered in the preceding paragraphs. The effect of less than the proposed total amount of infrastructure present at an intermediate stage in the decommissioning process will be less than that reported (as not significant) for the operational phase of the development (i.e. of a low magnitude and within the range of natural variability).

9.1.8 Proposed Monitoring and Mitigation

Construction

9.1.8.1 No mitigation measures are proposed.

Operation

9.1.8.2 No mitigation measures are proposed

Decommissioning

9.1.8.3 No mitigation measures are proposed.

9.1.9 Residual Impacts

9.1.9.1 No residual effects are predicted.

9.1.10 Habitats Regulations Appraisal

9.1.10.1 Likely effects from the construction, operation and decommissioning of the OfTI on the wave and tidal regime are of **negligible significance** and, therefore, do not give rise to Habitats Regulations Appraisal concerns. The effects on the physical marine environment considered are also considered with respect to the requirements for Habitats Regulation Assessment in other chapters: Chapter 10.1 (Benthic Ecology); Chapter 10.2 (Fish and Shellfish Ecology); Chapter 10.4 (Ornithology); and Chapter 12.2 (Habitat Regulations Appraisal Summary).

9.1.11 References

ABPmer, 2011a. Moray Firth Round 3 Zone: Physical Processes Baseline Assessment. ABPmer Report R1869.

ABPmer, 2011c. Moray Firth Round 3 Zone: Physical Processes Scheme Impact Assessment. ABPmer Report R1894.

9.2 Sedimentary and Coastal Processes

9.2.1 Summary of Effects and Mitigation

9.2.1.1 This chapter considers the likely significant effects of the offshore transmission infrastructure (OfTI) on the physical sedimentary environment (patterns of sediment transport and geomorphological evolution). A more detailed description may be found in the supporting technical appendix: Metocean and Coastal Processes (Technical Appendix 3.4 A, ABPmer, 2011a).

9.2.1.2 This assessment is informed by the following baseline chapters:

- Chapter 3.1 (Bathymetry);
- Chapter 3.2 (Geology);
- Chapter 3.3 (Wind Climate);
- Chapter 3.4 (Hydrodynamics: Wave Climate and Tidal Regime); and
- Chapter 3.5 (Sedimentary and Coastal Processes).

9.2.1.3 This impact assessment is also used to inform the following assessments:

- Chapters 6.1, 9.1 and 13.1 (Hydrodynamics: Wave Climate and Tidal Regime);
- Chapters 6.2 and 13.2 (Sedimentary and Coastal Processes);
- Chapters 7.1, 10.1 and 14.1 (Benthic Ecology);
- Chapters 7.2, 10.2 and 14.2 (Fish and Shellfish Ecology); and
- Chapters 8.5, 11.5 and 15.5 (Archaeology and Visual Receptors).

9.2.1.4 This chapter comprises the following:

- EIA Methodology;
- Primary Impact Assessment;
- Monitoring and Mitigation;
- Secondary Impact Assessment;
- Monitoring and Mitigation; and
- Residual Effects.

Summary of Effects

9.2.1.5 This chapter considers the likely significant effects of the offshore transmission infrastructure on the physical sedimentary environment (patterns of sediment transport and geomorphological evolution). The effects on sedimentary and coastal processes that were assessed are:

- Increase in suspended sediment concentrations as a result of OSP installation activities and the presence of the OSP foundations;
- Increase in suspended sediment concentrations as a result of export cable installation activities;
- Disturbance of coastal morphology at the landfall site; and
- Scour effects due to the presence of the OSP foundations, export cables and cable protection measures.

9.2.1.6 Receptors considered in this assessment are:

- Smith Bank;
- Seabed along the offshore export cable route;
- Designated Coastal Habitats; and
- Coastal morphology at the export cable landfall.

Proposed Mitigation Measures and Residual Effects

9.2.1.7 Scour protection may be applied to sections of cable that would otherwise be exposed at the seabed surface. The protection has dual purposes in both preventing scour and protecting the cable from external damage. The width of seabed about the cable route potentially affected by either scour or protection materials is similar. The significance of residual effects is therefore the same in either case.

9.2.1.8 Table 9.2-1 below summarises the results of the impact assessment.

Table 9.2-1 Impact Assessment Summary

Effect	Receptor	Pre-Mitigation Effect	Mitigation	Post-Mitigation Effect
Construction				
Increase in suspended sediment concentrations as a result of OSP installation activities	Smith Bank	Minor Significance	None	Minor Significance
Increase in suspended sediment concentrations as a result of export cable installation activities	Smith Bank & cable corridor	Minor Significance	None	Minor Significance
Disturbance of coastal morphology at the landfall site	Fraserburgh Landfall	Negligible Significance	None	Negligible Significance
Operation				
Changes to the sediment transport regime due to the presence of the OSP foundations	Smith Bank	Negligible Significance	None	Negligible Significance
	Designated Coastal Habitats	Negligible Significance	None	Negligible Significance
Scour effects due to the presence of the OSP foundations	Smith Bank	Negligible Significance	Scour protection	Negligible Significance
Scour effects due to the exposure of export cables	Smith Bank & cable corridor	Negligible Significance	Scour protection	Negligible Significance
Scour effects due to cable protection measures	Smith Bank & cable corridor	Negligible Significance	None	Negligible Significance
Decommissioning				
(Partial impacts only)	As 'Construction'	Negligible or Minor Significance	None	Negligible or Minor Significance

9.2.2 Introduction

9.2.2.1 The following paragraphs describe the likely significant effects of the OfTI on physical processes in the marine environment and includes effects on sediment transport and geomorphology. Some effects arise as an indirect result of effects on water levels, currents and waves, considered in Chapter 9.1 (Hydrodynamics: Wave Climate and Tidal Regime).

9.2.2.2 The baseline sedimentary and geomorphological conditions are described in Chapter 3.5 (Sedimentary and Coastal Processes) of this document and the supporting technical appendix: Metocean and Coastal Processes (Technical Appendix 3.4 A, ABPmer, 2011a).

9.2.2.3 More details regarding the impact assessment methods used and results obtained and reported may be found in the supporting technical appendix: Metocean and Coastal Processes (Technical Appendix 3.4 C ABPmer, 2011b).

9.2.3 Rochdale Envelope Parameters Considered in the Assessment

9.2.3.1 The range of Project parameters relevant to this physical process assessment, as detailed in the supporting technical appendix, are summarised in Table 9.2-2 below. The parameters set out below define the "Rochdale Envelope" realistic worst case scenario for each likely significant effect on the physical hydrodynamic environment. These are drawn from a range of development options set out in the Project Description in Chapter 2.2.

Table 9.2-2 Rochdale Envelope Parameter Relevant to the Physical Processes Impact Assessment

Potential Effect	Rochdale Envelope Scenario Assessed
Construction & Decommissioning	
Increase in suspended sediment concentrations as a result of transmission cable installation activities	Trenching by energetic means (e.g. jetting). Single trench (i.e. multiple export cable trenches not simultaneously installed) with cross-section of disturbance 1 m wide by 3 m deep in 'U' shaped profile. 100 % of material resuspended.
Increase in suspended sediment concentrations as a result of OSP foundation installation activities	Two Offshore Substation Platforms (OSPs) in each of the three proposed wind farm sites and two additional OSPs on the offshore export cable route (but within 2 km of the proposed wind farm sites) (i.e. eight in total), dispersed evenly throughout the total area. Foundations may be either GBS, jacket or semi-submersible types.
Disturbance of coastal morphology at the landfall site	Open trenching or horizontal directional drilling (HDD) at the Fraserburgh landfall site.
Operation	
Changes to the Sediment Transport Regime Due to the Presence of the OSP Foundations	Two Offshore Substation Platforms (OSPs) in each of the three proposed wind farm sites and two additional OSPs on the offshore export cable route (i.e. eight in total), dispersed evenly throughout the total area. Foundations may be either GBS, jacket or semi-submersible types.
Introduction of Scour Effects Due to the Presence of the OSP Foundations	
Scour effects due to the exposure of transmission cables	Transmission cables and cable protection measures.
Scour effects due to cable protection measures	

9.2.4 EIA Methodology

9.2.4.1 The methodology and terminology for the assessment of significance of any effects is the same as that described in Chapter 6.1 (Hydrodynamics: Wave Climate and Tidal Regime) in relation to the wind farm infrastructure.

9.2.5 Impact Assessment: Offshore Transmission Infrastructure

9.2.5.1 This assessment considers the effects of the OfTI on physical process receptors identified within the study area (shown in Figure 3.1-1, Volume 6 a). Physical process receptors that are potentially sensitive to changes in the physical baseline environment include:

- Smith Bank: A submerged bathymetric high in the Outer Moray Firth with a core of stable glacial tills covered by a veneer of sands and gravels of variable thickness and proportion. The form and function of the bank is relatively insensitive to changes in physical processes but is considered due to its proximity to the source of all effects from the wind farms.
- Designated coastal habitats: SPA, SAC, SSSI and Ramsar sites within the Moray Firth. A full list of the sites considered and a summary of their morphological type may be found in Technical Appendix 3.4 A. These receptors are variably potentially sensitive to changes in local tidal range, wave climate and sediment supply.
- Fraserburgh landfall site: A sandy beach within an embayment bounded by rocky headlands. The beach at the landfall is backed by managed and vegetated sand dunes.
- Seabed along the export cable route: A range of sediment types including sandy, gravelly sands and muds in varying proportion. The seabed along the route is not subject to any designations.

9.2.5.2 This chapter considers both direct and consequential (indirect) effects on sediment mobility, transport patterns and morphology.

9.2.5.3 Effects on these receptors are considered in relation to the construction, operation and decommissioning phases of the development in the following paragraphs.

Construction

9.2.5.4 The following paragraphs consider the effects of the OfTI on the sedimentary regime and morphological features during the construction phase. More details of this assessment may be found in Technical Appendix 3.4 C.

Increase in Suspended Sediment Concentrations (SSC) as a Result of Transmission Cable Installation Activities

9.2.5.5 An increase in SSC will arise where sediments are disturbed during energetic operations at or below the seabed. The magnitude of the effect locally will depend upon the sediment release rate. The nature of the effect and its extent and magnitude in the far field will depend upon the characteristics of the sediments being released (controlling the duration of time spent in suspension), the water depth (affecting the volume of water for dispersion and dilution) and the current speed and direction, both at the time of release and the residual current over longer periods of time (affecting rates and direction of advection). A change in levels of SSC locally does not necessarily imply an effect, if there are no receptors present that are sensitive to the change. Other consequential (indirect) effects are also considered, where relevant, in other chapters: Chapter 10.1 (Benthic Ecology); Chapter 10.2 (Fish and Shellfish Ecology); and Chapter 11.5 (Archaeology).

Sensitive Receptor: Smith Bank

9.2.5.6 On the basis of the evidence base (Royal Haskoning and BOMEL, 2008), cable installation by burial into the seabed along the cable route will have a relatively large magnitude effect on SSC (elevated to order 100s to 10,000s mg / l). However, the effect will be short-term (order of seconds to minutes, depending on the sediment grain size and degree of aggregation) and will be largely localised to the cable installation location (main effect within 10s of metres).

9.2.5.7 The thickness of sediment accumulation will be limited by the volume of sediment being disturbed and should not exceed a few millimetres other than immediately adjacent to the cable. Once redeposited to the bed, the displaced material will join the natural sedimentary environment and ceases to present any further effect.

9.2.5.8 The effects of cable burial on SSC are of a magnitude potentially in excess of the natural range of variability depending upon the height in the water column being considered. However, the effect will be localised and temporary.

9.2.5.9 A low to medium magnitude of change locally and temporarily exceeding the range of natural variability is therefore assessed to arise in an area of low sensitivity, resulting in a temporary negative effect of **minor significance** and therefore not significant in terms of the EIA Regulations.

Increase in Suspended Sediment Concentrations as a Result of OSP Foundation Installation Activities

9.2.5.10 An increase in SSC will arise where sediments are disturbed from the seabed whilst preparing the seabed for GBS foundations for the OSPs. The magnitude of the effect locally will depend upon the sediment release rate. The nature of the effect and its extent and magnitude in the far field will depend upon the characteristics of the sediments being released (controlling the duration of time spent in suspension), the water depth (affecting the volume of water for dispersion and dilution) and the current speed and direction, both at the time of release and the residual current over longer periods of time (affecting rates and direction of advection). A change in levels of SSC locally does not necessarily imply an effect, if there are no receptors present that are sensitive to the change. Other consequential (indirect) effects are also considered, where relevant, in other chapters: Chapter 10.1 (Benthic Ecology); Chapter 10.2 (Fish and Shellfish Ecology); and Chapter 11.5 (Archaeology).

Sensitive Receptor: Smith Bank

9.2.5.11 The release of sediment into the upper water column during dredging works will initially lead to a local increase in suspended sediment concentration. The resulting sediment plume will be advected with ambient tidal currents and will be subject to general processes of dispersion, deposition and re-suspension over time.

9.2.5.12 To quantify the likely magnitude and extent of the increase in SSC, currents from the numerical tidal model were used in conjunction with a plume dispersion model. Realistic sediment release types and rates were estimated based upon the available geotechnical data and typical dredging operation methodologies.

9.2.5.13 SSC is an additive quantity and so the calculated effect of the works indicates the predicted increase above ambient values.

9.2.5.14 Dredging as part of bed preparation for GBS foundations will lead to:

- An increase in SSC of 30 to 35 mg / l above ambient levels depending on the tidal state and the local water depth at the time and location of the release. These maximum levels of effect are contained within 50 to 100 m of the dredger and only occurring during sediment release;
- A maximum increase in SSC of 20 mg / l or less above ambient levels within 500 to 1,000 m in a plume downstream and to 10 mg / l or less within 2,000 to 3,000 m downstream;
- Both of the above levels of effect are only present during dredging and no more than 1 hour after cessation of dredging; and
- A more widely dispersed residual increase in SSC of 1 to 4 mg / l above ambient levels.

9.2.5.15 Effects are generally of a magnitude consistent with the natural range of variability (< 5 mg / l during calm periods to 100s to 1,000s mg / l near to the seabed during storm events). Local effects around the dredger may however be potentially in excess of the natural range of variability in the upper water column but will be localised and temporary.

9.2.5.16 Marine aggregate dredging is a relatively standard and established practice and so will be subject to a number of embedded mitigation measures in the design of the machinery and methodologies normally employed. This will likely limit levels of SSC resulting from the normal operation of such machines to levels that are generally acceptable according to a broad range of standards and in a variety of environment types.

9.2.5.17 A low magnitude of change that may locally and temporarily exceed the range of natural variability is therefore assessed to arise in an area of low sensitivity, resulting in a negative effect of **minor significance** and therefore not significant in terms of the EIA Regulations.

Disturbance of Coastal Morphology at the Landfall Site

9.2.5.18 The offshore export cable will be buried where it transits from the offshore to onshore environments, through the nearshore, intertidal, beach and hinterland areas of the export cable landfall. The disturbance caused by this operation may potentially lead to resuspension of sediments and a disruption to coastal processes.

Sensitive Receptor: Export Cable Landfall & Export Cable Route

9.2.5.19 Open trenching techniques involve mechanically excavating a trench through the beach and hinterland to the jointing bay. The cable is placed in the trench, which is then backfilled. Open cut trenching can be a fast, economical means of installing cables but the technique poses some engineering challenges in a tidal environment to keep the trench open during tidal inundation.

9.2.5.20 Excavating a trench across the nearshore and intertidal zone has the potential to affect local morphology and sedimentary processes, including the relative bed level, seabed mobility and local longshore sediment transport. Trench excavation would be completed (potentially requiring ongoing excavations to maintain the trench opening and depth during subsequent tidal cycles) before the cable is installed and the trench backfilled. It is possible that the excavation will include both the temporary removal of sand and cutting of rock in places to locate the cable below the minimum expected bed level. A temporary jointing pit may be used during installation, which will be located within or above (on land) the intertidal zone. Given that the main operations will likely be undertaken during relatively calm conditions (when longshore transport rates are minimal) and only lasting a short period of time (expected to be no more than a few days), the only expected effect on coastal processes is likely to be a temporary and localised increase in SSC and the temporary presence of either a trenched depression or furrow in the beach. With or without backfilling, a trench in sand will be quickly incorporated back into the natural environment within at most a few tidal inundations. No more extensive or longer term effect is expected.

9.2.5.21 To justify the assumption of no potential for long term interaction between open trenched cables and the coastal zone, the export cable burial design will meet the following conditions during the expected lifetime of the installation:

- The cable will be suitably deeply buried from onshore to the depth of closure (the area of seabed normally exchanging sediment with the beach on seasonal and inter-annual time scales) to prevent export cable exposure. This depth will be determined as part of the detailed engineering plan for the landfall operation; and
- Any fixed onshore infrastructure (with the exception of the temporary jointing pit) will be located onshore of the high-water mark, which may move landward due to coastal retreat.

9.2.5.22 Alternatively, once the cable reaches landfall, HDD works can be used to create an underground conduit for the cable between the offshore and onshore parts of the route. This method has historically been shown to cause minimal direct disturbance to the existing coastline and will also not leave any infrastructure exposed in the active parts of the beach (onshore or offshore) and so will not affect littoral processes.

9.2.5.23 To justify the assumption of no potential for interaction between the cables and the coastal zone, the HDD route design would meet the following conditions during the expected lifetime of the installation:

- The seaward exit point of the HDD will be located as far offshore as practicable towards the depth of closure;
- The cable will also be suitably buried between the seaward exit of the HDD and the depth of closure (the depth of water beyond which annually significant wave events will cease to contribute to beach sediment supply and morphological processes); and
- The landward exit point of the HDD will be located onshore of the high-water mark, which may move landward due to coastal retreat.

9.2.5.24 The majority of drill arisings will be captured at the onshore end of the HDD route and so will not cause any effects with regards to water quality during installation.

9.2.5.25 A quantitative assessment (based on the sediment types present and the typical intra-annual wave regime at the landfall location, derived from the wave models) indicates that the beach closure depth at the Fraserburgh site is in the order of 11 m. It is conservatively assumed that this depth is relative to the Lowest Astronomical Tidal water level (LAT). There can be no potential for the cable to interact with the wave, tidal or sedimentary regimes directly associated with maintaining the beach, provided that an adequate depth of burial (either through trenching or HDD, or a combination of both) is achieved between the beach and offshore of the present day 11 m depth contour. Climate change will lead to mean sea level rise and so will not affect the identified locations on the basis of present day bathymetry.

9.2.5.26 The effects of cable landfall operations are generally of a low magnitude consistent with the natural range of variation in beach morphology. The main effects during installation will be localised (order of metres). Effects of open trenching will also be temporary (order of hours to days) in most locations except where dune crests or vegetation are disturbed (order of days to months or years). During the operational phase, provided a sufficient burial depth is achieved and the landward jointing station is located sufficiently far back to account for rollback of the dunes in the lifetime of the installation, the cable landfall will have no further potential to affect the morphology of the coastline. The receptor therefore has a low sensitivity to these operations.

9.2.5.27 This effect is therefore of **negligible significance** and therefore not significant in terms of the EIA Regulations.

Operation

9.2.5.28 This section considers the effects of the OfTI on the sedimentary regime and morphological features during the operation phase. More details of this assessment may be found in the supporting technical appendix: Metocean and Coastal Processes (Technical Appendix 3.4 C, ABPmer, 2011b).

Changes to the Sediment Transport Regime Due to the Presence of the OSP Foundations

9.2.5.29 The sediment transport regime (rates, directions and the nature of sediment transport) is controlled by the interaction of surficial seabed sediments with the tidal and wave regimes locally.

Sensitive Receptor: Smith Bank

9.2.5.30 It is the combined wave and tidal regimes that ultimately control sediment transport and therefore the seabed form within the study area. It was shown in Chapter 9.1 (Hydrodynamics: Wave Climate and Tidal Regime) that the OSPs (realistically only considered in conjunction with the associated wind farm developments) cause no significant change to the speed, direction or asymmetry of tidal currents. It was also shown that GBS foundations will cause a reduction in instantaneous significant wave height within the three proposed wind farms of up to 19 % (but more typically 5 to 10 % or less across most of the site area) and only up to 5 % in the outside of the EDA, which is of the same order as inter-annual and inter-decadal variability in storm intensity. Jackets will have little or no measureable effect (< 2 %) on wave height. Neither GBS nor Jacket foundations will measurably affect wave period or direction.

9.2.5.31 Given no significant effect on the parameters controlling patterns of sediment transport, in particular the direction and asymmetry of tidal currents, there will be no corresponding difference in the potential rates and directions of sediment transport through the OfTI site (provided that the supply of sediment is available for transport).

9.2.5.32 The predicted effect of a reduction in wave height on sediment transport pathways and resulting morphology in the OfTI site is:

- The areas within the three proposed wind farms may tend to accumulate sediment at a slightly higher rate than would have otherwise occurred during the operational lifetime of the development;
- The supply of sediment to areas located further into the Moray Firth might be slightly less than would have otherwise occurred during the operational lifetime of the development;
- However, as stated above, the absolute difference in sediment transport attributable to the wind farm is less than the potential for natural variability over the same period.

9.2.5.33 There will, therefore, be no effect on the form or function of Smith Bank.

9.2.5.34 A low magnitude of change within the range of natural variability is therefore assessed to arise in areas of low sensitivity. This effect is therefore of **negligible significance** and therefore not significant in terms of the EIA Regulations.

Sensitive Receptor: Designated Coastal Habitats

9.2.5.35 It was demonstrated above that there will be no significant effect on sediment transport rates through the three proposed wind farms as a result of their presence (including the OSP foundations).

9.2.5.36 There will therefore be no effect on the form or function of designated coastal habitats located outside of the proposed wind farm sites (see Chapter 12.2: Habitat Regulations Appraisal Summary).

9.2.5.37 A low magnitude of change within the range of natural variability is therefore assessed to arise in areas of low to medium sensitivity. This effect is therefore of **negligible significance** and therefore not significant in terms of the EIA Regulations.

Introduction of Scour Effects Due to the Presence of the OSP Foundations

9.2.5.38 Scour can occur as the result of a localised increase in erosion potential, caused by the interaction between obstacles and water movements near to the seabed. As such, extensive scour is not naturally present in the marine environment and its introduction may constitute a further area of modification to the nature and level of the seabed. In addition to the slopes that may develop, the surface of the scour pit may develop a sediment texture different to that of the ambient seabed due to the difference in sediment transport potential.

Sensitive Receptor: Smith Bank

9.2.5.39 There is a potential for scour to develop where and when scour protection is not applied, possibly in the interim period between installation of the foundation and placement of the protection.

9.2.5.40 Overall, in terms of scour depth, the GBS foundation for OSPs is predicted to cause the largest effect with a maximum depth of, approximately, 9 to 12 m local to the structure. In reality, this depth is unlikely to be attained, at least in all locations around a given foundation, due to potential constraints arising from the sub-surface geology. The presence of gravel in the upper sandy layers will likely lead to bed armouring in the scour pit that will restrict the overall depth or rate of scour development. Also, the consolidated till surface at, approximately, 0.5 to 2 m below the seabed is described as layered sandy silty clays of variable density and hardness (Osiris, 2011a), and therefore is likely to be generally cohesive, consolidated and largely more resistant to erosion than non-cohesive (sandy) sediments.

9.2.5.41 The extent of scour from the edge of a foundation is calculated assuming the profile of the scour pit is an inverted cone with slopes at the angle of repose for sand (32°). It is noted that the separation between individual large items of infrastructure is in the order of hundreds of metres and the greatest extent of scour from the centroid of a foundation location is only 51 m. Therefore, scour effects are not predicted to interact or coalesce (e.g. between OSP and WTG foundations). The net additional footprint of scour from OSPs will be a proportionally small increase in the predicted area for all wind farm foundations (i.e. 2 to 3 % of 0.54 % of the total site area affected).

9.2.5.42 The time theoretically required for the majority of equilibrium scour pit development around a foundation is in the order of hours to days under flow conditions sufficient to induce scour. This makes the assumption of a mobile uniform non-cohesive sediment substrate. Approximately symmetrical scour will only develop following sufficient exposure to both flood and ebb tidal directions. Waves of a sufficient size to interact with the seabed do not typically cause rapid initial scour directly, but can increase the rate of initial scour development.

9.2.5.43 The effects of the foundations in causing scour are of a small to medium magnitude relative to the range of naturally occurring variability in seabed level but do not cause the normal range of water depths to be exceeded. The effects of scour around OSPs, especially alone but also in conjunction with the wind farm infrastructure are limited to only a small proportion of the area of each of the three proposed wind farms and an even smaller proportion of the area of Smith Bank.

9.2.5.44 A low to medium magnitude of change that does not exceed the range of natural variability is therefore assessed to arise in an area of low sensitivity. This effect is therefore of **minor significance** and therefore not significant in terms of the EIA Regulations.

Scour Effects due to the Exposure of Offshore Export Cables.

9.2.5.45 Offshore export cables will be either buried or surface laid and protected at the time of construction and will be resistant to scour whilst they remain in this condition. Should a cable become exposed at the seabed surface due to bed erosion (not anticipated in the present study) or disturbance of the overlying protection, the presence of the cable may lead to scour. Scour can occur as the result of a localised increase in erosion potential, caused by the interaction between obstacles and water movements near to the seabed. As such, extensive scour is not naturally present in the marine environment and its introduction may constitute a further area of modification to the nature and level of the seabed. In addition to the slopes that may develop, the surface of the scour pit may develop a sediment texture different to that of the ambient seabed due to the difference in sediment transport potential.

Sensitive Receptor: Smith Bank & Export Cable Route

9.2.5.46 The offshore export cable diameter is likely to be in the order of 0.15 m and up to four individual cables might be laid in one of two cable bundles. From Whitehouse (1998), a conservative estimate for all cases (current, wave or combined scour) is that the maximum depth of scour beneath a section of singularly exposed cable will be between one and three times the cable diameter (i.e. order of 0.15 to 0.45 m for single cables and 0.3 to 0.9 m for the bundle) and the maximum horizontal extent of any scour effect will be up to fifty times the cable diameter (i.e. order of 7.5 to 15 m). As such, any depression created will not necessarily be steeply sided. In predominantly sandy areas, the surface of the scour pit will be of similar character to the ambient bed. In more gravelly areas, a gravel lag veneer may initially form as finer sands are preferentially winnowed, but may then become buried by predominantly sandy material following recovery of the seabed if self burial of the cable occurs. It is further noted that cable exposure would be subject to remedial action (reburial or protection).

9.2.5.47 The effects of scour potentially resulting from the exposure of offshore export cables onto the seabed are considered to be of a low magnitude relative to the range of naturally occurring variability. Effects on morphology or sediment surface texture will be localised to the cable route.

9.2.5.48 This effect is therefore of **negligible significance** and not significant in terms of the EIA Regulations.

Scour Effects due to Cable Protection Measures

9.2.5.49 Scour can occur as the result of a localised increase in erosion potential, caused by the interaction between obstacles and water movements near to the seabed. As such, extensive scour is not naturally present in the marine environment and its introduction may constitute a further area of modification to the nature and level of the seabed. In addition to the slopes that may develop, the surface of the scour pit may develop a sediment texture different to that of the ambient seabed due to the difference in sediment transport potential.

Sensitive Receptor: Smith Bank & Offshore Export Cable Route

9.2.5.50 Protection measures that might be deployed onto surface laid or otherwise exposed sections of OfTI may take various forms, most likely a form of:.

- Rock placement; or
- Concrete mattressing.

9.2.5.51 Protection measures are used to mitigate the engineering risk posed by scour and exposure of the offshore export cable to external damage. The measures will prevent scour from developing around the cable; however, the area occupied by the scour protection might also be similarly considered as a modification to the sedimentary environment and may cause a more limited depth and area of secondary scour to develop.

9.2.5.52 There is insufficient information available to accurately quantify the effect of all possible types of protection measure, which may vary greatly in design and scale. The maximum thickness of the protection will be in the order of 1 m. The total width of the protection material will be in the order of 2 to 3 m either side of the cable itself, likely with a sloping or tapering profile.

9.2.5.53 The slope angle presented by sections of protected cable would be in the order of five to nine° which is within the natural range of bed slope angles associated with bed forms and so will not affect patterns of sediment transport following the initial period of accumulation.

9.2.5.54 Alternatively, conditions may not be favourable for sediment accumulation. Where this is due to very low transport rates (e.g. in the central part of the Outer Moray Firth), the presence or absence of an obstacle will therefore not cause any further effect. Where this is due to a tendency for the protection material to create turbulence and secondary scour, the action of the (upstream) scour will be to actively resuspend and transport sediment over the obstacle, again therefore not causing any further effect.

9.2.5.55 The effects of cable protection measures are considered to be of a low magnitude relative to the range of naturally occurring variability and will not have a measurable effect on sediment transport beyond a short to medium term period of initial adjustment. Effects on morphology or sediment surface texture will be localised to the cable route.

9.2.5.56 This effect is therefore of **negligible significance** and therefore not significant in terms of the EIA Regulations.

Decommissioning

9.2.5.57 It is considered that the methods likely to be employed during decommissioning will be of a similar general nature but overall less energetic and disturbing a smaller volume of sediment than previously assessed in relation to construction. Therefore, the types of effect from decommissioning and their significance can only be considered to be similar to or less than that already provided above (either not significant or of minor significance).

9.2.5.58 Whether removed or left in-situ, decommissioned cables have no greater potential to impact upon sediment transport and geomorphology than as described above for the construction and operational phases, respectively.

9.2.6 Proposed Monitoring and Mitigation

Construction

9.2.6.1 No mitigation measures are proposed.

Operation

9.2.6.2 The OfTI will be suitably monitored for unintended exposure if previously buried and for unwanted scour if exposed above the seabed. Scour protection may be applied to OSP foundations or to sections of cable that would otherwise be exposed at the seabed surface. Cable protection has dual purposes in both preventing scour and protecting the cable from external damage. The width of seabed about cable routes and the area around foundations potentially affected by either scour or protection materials is generally similar.

Decommissioning

9.2.6.3 No mitigation measures are proposed.

9.2.7 Residual Effects

9.2.7.1 No residual effects are predicted.

9.2.8 Habitats Regulations Appraisal

9.2.8.1 Likely effects from the construction, operation and decommissioning of the OfTI on sedimentary and coastal processes are of negligible significance and therefore do not give rise to Habitats Regulations Appraisal concerns. The effects on the physical marine environment considered are also considered with respect to the requirements for Habitats Regulation Assessment in other chapters: Chapter 10.1 (Benthic Ecology); Chapter 10.2 (Fish and Shellfish Ecology); Chapter 10.4 (Ornithology); and Chapter 12.2 (Habitat Regulations Appraisal Summary).

9.2.9 References

ABPmer, 2011a. Moray Firth Round 3 Zone: Physical Processes Baseline Assessment. ABPmer Report R1869.

ABPmer, 2011c. Moray Firth Round 3 Zone: Physical Processes Scheme Impact Assessment. ABPmer Report R1894.

Royal Haskoning and BOMEL, 2008. Review of cabling techniques and environmental effects applicable to the offshore win farm industry. For BERR. www.berr.gov.uk / files / file43527.pdf.

Whitehouse, R.J.S.,1998. Scour at marine structures: A manual for practical applications. Thomas Telford, London, 198 pp.

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9.3 Hydrology, Geology and Hydrogeology

9.3.1.1 This assessment details the evaluation of likely significant environmental effects on hydrology, geology and hydrogeology on identified receptors as a result of the proposed development and provides mitigation measures to address these effects. The baseline description is provided in Chapter 3.7 and technical research in relation to ground conditions and land contamination is provided in Technical Appendix 3.7 A.

9.3.1.2 Effects on hydrology, geology and hydrogeology may result in secondary ecological effects on habitats or species. Effects on ecological receptors, including fish, are considered in the following chapters:

- Fish and Shellfish Ecology (Chapter 10.2);
- Intertidal Ecology (Chapter 10.5); and.
- Terrestrial Ecology (Chapter 10.6).

9.3.1.3 Any likely significant hydrological, geological and hydrogeological effects during the construction and operational phase of the transmission infrastructure including substation have been analysed and effective mitigation measures have been identified. Following mitigation, all residual effects have been estimated as **insignificant** under the EIA Regulations. Likely significant effects for the decommissioning phase are yet to be defined but are considered to be no greater than those assessed for the construction phase.

9.3.1.4 This chapter contains relevant information on the OnTI to allow Scottish Ministers and Marine Scotland to make decisions on the applications for Section 36 consents and Marine Licences for the three proposed wind farm sites and the OfTI. Discussions are ongoing with landowners to determine the exact location and layout of the substation(s) on their land within the preferred onshore substation area. This will be finalised following production of a masterplan by the owner / operator of the Peterhead Power Station compound which forms part of the preferred area. Once the precise location and layout for the onshore substation(s) and export cable location has been confirmed, an application for planning permission for the OnTI will be submitted to Aberdeenshire Council and will be supported by this Environmental Statement (ES) and such further information as is required to support the planning application.

9.3.2 Summary of Effects

9.3.2.1 The likely significant effects that could occur if no mitigation measures were adopted include:

- Changes to surface runoff and drainage;
- Subsoil compaction and reduced infiltration;
- Localised overland flooding;
- Excessive erosion and sedimentation;
- Alteration of groundwater levels / patterns;
- Water quality deterioration due to construction activities;
- Loss of agricultural soils and peat;

- Sterilisation of sand and gravel / granite reserves;
- Disturbances to small watercourses at crossing locations;
- Disturbance to floodplains;
- Loss of coastal flood protection;
- Damage to geological / geomorphological sites;
- Disturbance and movement of contaminated materials;
- Pollution of water supplies;
- Human health effects from contaminated materials; and
- Damage to construction materials by contaminated ground.

9.3.3 Proposed Mitigation Measures and Residual Effects

9.3.3.1 The primary mitigation action is the careful selection of cable routing and sub-station siting to avoid, where possible, sensitive areas such as designated sites, peat bogs, private water supplies, water abstraction locations, floodplains and contaminated land.

9.3.3.2 Additional mitigation includes best practice construction site management that focuses on water pollution prevention, effective drainage and erosion prevention. Appropriate construction methods will be used for locations that cross watercourses.

9.3.3.3 A sustainable drainage system will be incorporated into the proposed substation compound to reduce effect on runoff, flooding and water quality.

9.3.3.4 A hydrology, geology, hydrogeology effect summary, detailing residual effects pre and post mitigation, is outlined in Table 9.3-1 below.

Table 9.3-1 Residual Effect Summary

Effect	Receptor	Pre-Mitigation Effect Significance	Mitigation	Post-Mitigation Effect Significance
Construction				
Changes to surface runoff and drainage	Kessock Burn catchment	Insignificant (areas with low gradient topography) Significant (areas with moderate or high gradient topography)	Sustainable drainage system and sediment control	Insignificant (areas with low gradient topography) Minor significance (areas with moderate or high gradient topography)
	Water of Philorth Catchment			
	Burn of Savoch catchments (Ellie Burn, Green Burn and Burn of Logie)			
	North Ugie Water catchment			
	South Ugie Water catchment			
	Burn of Faichfield catchment			

Effect	Receptor	Pre-Mitigation Effect Significance	Mitigation	Post-Mitigation Effect Significance
Changes to surface runoff and drainage	Remaining River Ugie catchments		Sustainable drainage system and sediment control	
	Unnamed catchment south of Peterhead			
	Unnamed catchment at Peterhead Power Station			
	Soils	Insignificant		Insignificant
Subsoil compaction and reduced infiltration	Kessock Burn catchment	Minor significance	Sustainable drainage system and sediment control	Insignificant
	Water of Philorth Catchment			
	Burn of Savoch catchments (Ellie Burn, Green Burn and Burn of Logie)			
	North Ugie Water catchment			
	South Ugie Water catchment			
	Burn of Faichfield catchment			
	Remaining River Ugie catchments			
	Unnamed catchment south of Peterhead			
	Unnamed catchment at Peterhead Power Station			
	Soils			

Effect	Receptor	Pre-Mitigation Effect Significance	Mitigation	Post-Mitigation Effect Significance
Localised overland flooding	Kessock Burn catchment	Significant	Sustainable drainage system and sediment control	Minor significance
	Water of Philorth Catchment			
	Burn of Savoch catchments (Ellie Burn, Green Burn and Burn of Logie)			
	North Ugie Water catchment			
	South Ugie Water catchment			
	Burn of Faichfield catchment			
	Remaining River Ugie catchments			
	Unnamed catchment south of Peterhead			
	Unnamed catchment at Peterhead Power Station	Significant	Sustainable drainage system and sediment control	Minor significance
Excessive erosion and sedimentation	Kessock Burn	Significant	Sustainable drainage system and sediment control, environmental monitoring	Minor significance
	Water of Philorth			
	Burn of Savoch tributaries (Ellie Burn, Green Burn and Burn of Logie)			
	North Ugie Water			
	South Ugie Water			
	Burn of Faichfield			
	River Ugie			
	Unnamed watercourse south of Peterhead			
	Unnamed watercourse at Peterhead Power Station			

Effect	Receptor	Pre-Mitigation Effect Significance	Mitigation	Post-Mitigation Effect Significance
Excessive erosion and sedimentation (continued)	Minor watercourses throughout study area			
	Loch of Strathbeg	Highly Significant		Minor significance
	Soils	Significant		Minor significance
	(surface) Water Supplies/ abstraction	Highly Significant		Minor significance
Alteration of groundwater levels / patterns (groundwater and dependent water supplies)	Groundwater (Class 2)	Significant	Site investigation, Sustainable drainage system and sediment control, environmental monitoring	Minor significance
	Groundwater (Class 3)	Significant		Minor significance
	Groundwater (Class 4b, 4c and 4d)	Highly Significant		Minor significance
	(Ground) water supplies/ abstractions	Highly Significant		Minor significance
water quality deterioration due to construction activities	Kessock Burn	Significant	Cable route detailed alignment development, Construction environmental management; sustainable drainage system and sediment control, site investigation, environmental monitoring	Minor significance
	Water of Philorth			
	Burn of Savoch tributaries (Ellie Burn, Green Burn and Burn of Logie)			
	North Ugie Water			
	South Ugie Water			
	Burn of Faichfield			
	River Ugie			
	Unnamed watercourse south of Peterhead			
	Unnamed watercourse at Peterhead Power Station			
	Minor watercourses throughout study area			
	Loch of Strathbeg	Highly Significant		Minor significance
	Water Supplies	Highly Significant		Minor significance

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Effect	Receptor	Pre-Mitigation Effect Significance	Mitigation	Post-Mitigation Effect Significance
Water quality deterioration due to construction activities (continued)	Groundwater (Class 2)	Significant		Minor significance
	Groundwater (Class 3)	Significant		Minor significance
	Groundwater (Class 4b, 4c and 4d)	Highly Significant		Minor significance
Loss of agricultural soils and peat	Soils	Minor significance	Route alignment development / avoiding certain areas, construction environmental management plan	Insignificant
	Peat	Minor significance		Insignificant
Sterilisation of Mineral Reserves	Mineral Reserves	Minor significance	Consultation with landowners and avoidance of areas	Insignificant
Disturbances to small watercourses at crossing locations (small rivers)	Kessock Burn	Minor significance to significant	Cable route alignment development, Construction environmental management; reinstatement method, watercourse crossing design	Insignificant to Minor significance
	Burn of Savoch tributaries (Ellie Burn, Green Burn and Burn of Logie)			
	Unnamed watercourse south of Peterhead			
	Unnamed watercourse at Peterhead Power Station			
	Unnamed watercourse at Peterhead Power Station			
	Minor watercourses throughout study area	Minor significance		Insignificant
Disturbance to medium and large rivers and floodplains (medium to large rivers and floodplains)	Water of Philorth	Significant	Cable route alignment development, Construction environmental management; reinstatement method, watercourse crossing design	Minor significance
	North Ugie Water			
	South Ugie Water			
	Burn of Faichfield	Minor significance to significant		Insignificant to Minor significance
	River Ugie	Significant		Minor significance

Effect	Receptor	Pre-Mitigation Effect Significance	Mitigation	Post-Mitigation Effect Significance
Loss of coastal flood protection	Dunes	Significant	Route alignment development / avoiding certain areas; construction method	Insignificant
Damage to geological / geomorphological sites	Kirkhill and Philorth Valley SSSI	Highly significant	Route alignment development / avoiding certain areas	Minor significance
	Sinclair Hills SESA	Significant		Minor significance
Disturbance and movement of contaminated materials	Soils	Significant	Construction environmental management; site investigation; route alignment development / avoiding certain areas	Minor significance
	Peat	Significant		Minor significance
	Superficial Geology	Minor significance		Insignificant
	Kessock Burn	Significant		Minor significance
	Water of Philorth			
	Burn of Savoch tributaries (Ellie Burn, Green Burn and Burn of Logie)			
	North Ugie Water	Significant	Construction environmental management; site investigation; route alignment development / avoiding certain areas	Minor significance
	South Ugie Water			
	Burn of Faichfield			
	River Ugie			
	Unnamed watercourse south of Peterhead			
	Unnamed watercourse at Peterhead Power Station			
	Minor watercourses throughout study area			
	Water Supplies	Highly significant		Minor significance
	Groundwater (Class 2)	Significant		Minor significance
	Groundwater (Class 3)	Significant		Minor significance
	Groundwater (Class 4b, 4c and 4d)	Highly significant		Minor significance

Effect	Receptor	Pre-Mitigation Effect Significance	Mitigation	Post-Mitigation Effect Significance
Pollution of water supplies	Water supplies	Highly significant	Cable route alignment development, environmental monitoring, sustainable drainage system and sediment control	Minor significance
Human health effects from contaminated materials	Human Health	Highly significant	Site investigation, Construction environmental management, cable route alignment and development	Minor significance
Damage to construction materials by contaminated ground (construction materials)		Minor significance	Site investigation, cable route alignment and development, Construction environmental management	Insignificant
Operation				
Alteration of groundwater levels/patterns	Groundwater	Minor significance	Site investigation, sustainable drainage system and sediment control	Minor significance
Human health effects from contaminated materials	Human Health	Highly significant	Site investigation, Construction environmental management, cable route alignment development	Minor significance
Changes to runoff and drainage patterns at the proposed substation	Coastal catchments / drainage areas near Peterhead Power Station	Significant	Sustainable drainage system	Insignificant
Decommissioning				
Potentially as defined for construction phase	Potentially as defined for construction phase	Potentially as defined for construction phase	Potentially as defined for construction phase	Potentially as defined for construction phase

9.3.4 *Rochdale Envelope Parameters Considered in the Assessment*

9.3.4.1 The Rochdale Envelope parameters for the impact assessment, based on details within the Project Description in Chapter 2.2, are summarised in Table 9.3-2 below.

Table 9.3-2 Rochdale Envelope Parameters Relevant to the Hydrology, Geology and Hydrogeology Impact Assessment

<table>
<tr><th>Potential Effect</th><th>Rochdale Envelope Scenario Assessed</th></tr>
<tr><td colspan="2">Construction & Decommissioning</td></tr>
<tr><td>Effects on hydrological regime</td><td rowspan="4">Cable burial:
• Construction corridor of maximum 20 m;
• Maximum trench width of 5 m (some sections, for example: near landfall points, may require two separate trenches, each 3 m wide);
• Target trench depth 1 m (1.2 m to 1.5 m may be required to achieve sufficient cover depth); and
• Mechanical excavation or cable plough on land.</td></tr>
<tr><td>Effects on hydrogeological regime</td></tr>
<tr><td>Effects on water quality</td></tr>
<tr><td>Loss of agricultural soils and peat</td></tr>
<tr><td>Sterilisation of sand and gravel / granite reserves</td><td rowspan="3">• Directional drilling for sensitive or large watercourses; and
• Dam and overpump to facilitate mechanical excavation in minor water courses.
Substation:
• Compound size 200 m x 170 m; and
• Temporary laydown area: 100 m x 100 m.</td></tr>
<tr><td>Effects from land contamination</td></tr>
<tr><td>Effects on geological / geomorphological SSSI</td></tr>
<tr><td colspan="2">Operation</td></tr>
<tr><td>Alteration of groundwater flow patterns</td><td rowspan="3">Restored cable trench:
• Maximum trench width of 5 m (some sections, for example: near landfall points, may require two separate trenches, each 3 m wide); and
• Target trench depth 1 m (1.2 m to 1.5 m may be required to achieve sufficient cover depth).
Substation:
• Compound size 200 m x 170 m.</td></tr>
<tr><td>Effects from land contamination</td></tr>
<tr><td>Changes to runoff / drainage in substation area</td></tr>
</table>

9.3.4.2 The cable may be constructed during a single operation or as two separate operations. In the latter case the first bundle of two cables would be installed followed by the second bundle of two cables at a later time to coincide with the phased construction of the individual wind farm sites.

9.3.4.3 Whether the cables will be installed during a single or two separate operations, has no effect on magnitude or the significance of the assessed effects. However, as most effects are likely to occur during the construction phase, the likelihood of an effect occurring is increased when two construction phases are used. In any case the proposed mitigation measures are effective in reducing the likely significant environmental effect for each operation to insignificant or minor significance levels as demonstrated above.

9.3.5 Methodology

9.3.5.1 The significance of the likely effects of the proposed development has been defined by taking into account the sensitivity of the receiving environment together with the potential magnitude and probability of the effect. The assessment methodology is based on SNH guidance (2009) and the Highways Agency's Design Manual for Roads and Bridges, Volume 11 (2009) and has been developed by RPS based on its experience of carrying out assessments for a range of developments.

9.3.5.2 During the first stages of the assessment, detailed baseline desk studies were undertaken followed by site surveys. These assessments included a review of relevant baseline data such as water quality data, historic land use, location of watercourses, site topography, designated areas, private water supplies, superficial and solid geology maps, groundwater maps, etc. Initial findings were verified during the surveys when possible and any additional relevant information was recorded.

9.3.5.3 All baseline and survey data was captured within a Geographic Information System (GIS) to allow overlaying and buffering of receptors (such as sensitive areas and private water supplies), together with the onshore cable route. This information then informed the assessment of likely significant effects on various receptors within and beyond the study area. Based on experience of similar developments, appropriate mitigation measures were developed.

Sensitivity of Receptors

9.3.5.4 The sensitivity of the receiving environment, i.e. its ability to absorb the effect without perceptible change, is defined as ranging from Very High to Low, as shown in Table 9.3-3 below.

Table 9.3-3 Definition of Sensitivity of the Receiving Environment

Sensitivity	Definition Examples
Very High	High quality and rarity, regional or national scale and limited potential for substitution / replacement. This includes the following: • Site of Special Scientific Interest (SSSI) or Special Area of Conservation (SAC); • SEPA Water Quality defined as High; • Surface Water – large scale industrial abstractions > 1,000 m^3 / day within 2 km downstream; • Abstractions for public drinking water supply; • Private Water Supplies – Surface water abstractions within 0 to 200 m and groundwater spring abstractions from 0-100 m from construction activities; • Designated salmonid fishery and / or salmonid spawning grounds present; • Watercourse widely used for recreation, directly related to watercourse quality (e.g. salmon fishery) within 2 km downstream; • Conveyance of flow and material, main river > 20 m wide; • Active floodplain area with known risks of widespread flooding (e.g. in relation to a flood prevention scheme); • Groundwater abstractions > 1,000 m^3 / day (within zone of influence from development); • Groundwater – public drinking water supply; • Groundwater aquifer vulnerability classed between 4d, 4c, 4b, 4a and 5 in the SEPA vulnerability classification scheme; and • Geology rare or of national importance as defined by SSSI or Regional Important Geological Site (RIGS).

Sensitivity	Definition Examples
High	Receptor with a high quality and rarity, local scale and limited potential for substitution / replacement or receptor with a medium quality and rarity, regional or national scale and limited potential for substitution/replacement. This includes the following: • SEPA Water Quality defined as Good; • Large scale industrial agricultural abstractions 500 to 1,000 m^3 / day within 2 km downstream; • Surface water abstractions for private water supply for more than 15 people; • Private Water Supplies – Surface water abstractions within 200 to 600 m, groundwater spring abstractions from 100 to 400 m, and groundwater borehole abstractions from 0 to 200 m from construction activities; • Designated salmonid fishery and/or cyprinid fishery (Coarse Fish, including roach, carp, chubb, bream etc); • Watercourse used for recreation, directly related to watercourse quality (e.g. swimming, salmon fishery etc); • Conveyance of flow and material, main river 10 to 20 m wide; • Active floodplain area (Important in relation to flood defence); • Groundwater abstractions 500 to 1,000 m^3/day (within zone of influence from development); • Groundwater abstraction for private water supply > 10 m^3/day or serves > 50 people; and • Groundwater aquifer vulnerability classed as 3 in the SEPA vulnerability classification scheme.
Medium	Receptor with a medium quality and rarity, local scale and limited potential for substitution / replacement or receptor with a low quality and rarity, regional or national scale and limited potential for substitution / replacement. This includes the following: • SEPA Water Quality defined as Moderate; • Industrial / agricultural abstractions 50 to 499 m^3/day within 2 km downstream; • Occasional or local recreation (e.g. local angling clubs); • Conveyance of flow and material, main river < 10 m wide or ordinary watercourse > 5 m wide; • Existing flood defences; • Groundwater abstractions 50 to 499 m^3 / day; • Private Water Supplies – Surface water abstractions from 600 to > 800 m, groundwater spring abstractions from 400 to 800 m and groundwater borehole abstractions from 200 to 600 m from construction activities; • May be subject to improvement plans by SEPA; • Designated cyprinid fishery, salmonid species may be present and catchment locally important for fisheries; • Watercourse not widely used for recreation, or recreation use not directly related to watercourse quality; and • Groundwater aquifer vulnerability classed as 2 in the SEPA vulnerability classification scheme.

Sensitivity	Definition Examples
Low	Receptor with a low quality and rarity, local scale and limited potential for substitution/replacement. Environmental equilibrium is stable and is resilient to changes that are greater than natural fluctuations, without detriment to its present character. This includes the following: • SEPA water quality defined as Poor or Bad; • Industrial/agricultural abstractions < 50 m^3 / day within 2 km downstream; • Fish sporadically present or restricted, no designated features; • Receptors not used for recreation (e.g. no clubs or access route associated with watercourse); • Watercourse < 5 m wide – flow conveyance capacity of watercourse low – very limited floodplain as defined by topography, historical information and SEPA flood map; • Groundwater abstractions < 50 m^3/day; • Private Water Supplies – groundwater spring abstraction > 800 m and groundwater borehole abstractions from 600 to > 800 m from construction activities; • No public drinking water supplies; • Groundwater aquifer vulnerability classed as 1 in the SEPA vulnerability classification scheme; • Receptor heavily engineered or artificially modified and may dry up during summer months; and • Geology not designated under a SSSI or RIGS or protected by specific guidance.

Magnitude of Effects

9.3.5.5 The magnitude of effect includes the timing, scale, size and duration of the effect and is categorised from Major to Negligible as shown in Table 9.3-4 below.

Table 9.3-4 Magnitude of Effect

Magnitude	Criteria	Description and Example
Major	Results in loss of attribute	• Fundamental (long term or permanent) changes to geology, hydrology, water quality and hydrogeology; • Loss of designated Salmonid Fishery; • Loss of national level designated species / habitats; • Changes in WFD water quality status of river reach; • Loss flood storage / increased flood risk; and • Pollution of potable source of abstraction compared to pre-development conditions.
Moderate	Results in effect on integrity of attribute or loss of part of attribute	• Material but non-fundamental and short to medium term changes to the geology, hydrology, water quality and hydrogeology; • Loss in productivity of a fishery; • Contribution of a significant proportion of the discharges in the receiving water, but insignificant enough to change its water quality status; and • No increase in flood risk.

Magnitude	Criteria	Description and Example
Minor	Results in minor effect on attribute	• Detectable but non-material and transitory changes to the geology, hydrology, water quality and hydrogeology; • Changes are of limited size and / or proportion; and • No increase in flood risk.
Negligible	Results in an effect on attribute but of insufficient magnitude to affect the use / integrity	• No perceptible changes to the geology, hydrology, water quality and hydrogeology; • Discharges to watercourse but no loss in quality, fishery productivity or biodiversity; • No significant effect on the economic value of the receptor; and • No increase in flood risk.

Significance of Effect

9.3.5.6 The sensitivity of the receiving environment together with the magnitude of the effect defines the significance of the effect prior to application of mitigation measures as outlined in Table 9.3-5 below.

Table 9.3-5 Significance Criteria

Magnitude of Potential Effect	Sensitivity of Receptor			
	Very High	**High**	**Medium**	**Low**
Major	Highly Significant	Highly Significant	Significant	Minor significance
Moderate	Highly Significant	Significant	Significant	Minor significance
Minor	Minor significance	Minor significance	Minor significance	Insignificant
Negligible	Minor significance	Insignificant	Insignificant	Insignificant

9.3.5.7 Likely effects are therefore concluded to be insignificant, minor significance, significant and highly significant. Significant and highly significant represent effects considered to be 'significant' in terms of the EIA regulations (SSI 2011 No. 139).

9.3.6 *Assessment of Sensitivity of Receptors*

9.3.6.1 On the basis of the baseline assessment and available information, Table 9.3-6 below identifies the sensitivity of receptors, with justification for their categorization: MORL will strive to avoid all possible effects where possible. Further details of the individual receptors are presented in Chapter 3.7 (Hydrology, Geology and Hydrogeology).

Table 9.3-6 Sensitivity of Receptors

Receptor	Sensitivity	Justification and Comments
Kessock Burn Catchment	Medium	Predominantly rural with extensive drainage improvements (ditches, field drains, etc.)
Water Of Philorth Catchment		
Burn of Savoch Catchments (Ellie Burn, Green Burn and Burn of Logie)		
North Ugie Water Catchment		
South Ugie Water Catchment		
Burn of Faichfield Catchment		
Remaining River Ugie Catchments		
Unnamed Catchment South of Peterhead		
Unnamed Catchment at Peterhead Power Station		
Kessock Burn	Morphology: low to medium Water quality: medium	Rivers affected by agriculture, in terms of both morphology and water quality. River channels do not exceed 5 m width. There are no abstractions for public water supplies within or downstream of the rivers (see Figure 8: Abstractions and water supplies in Technical Appendix 3.7 A).
Water of Philorth	Morphology: medium Water quality: medium	Rivers affected by agriculture, in terms of both morphology and water quality. River channels do not exceed 10 m width. Wide floodplains along some river reaches. There are no abstractions for public water supplies within or downstream of the rivers (see Figure 8: Abstractions and water supplies in Technical Appendix 3.7 A).
Burn of Savoch Tributaries (Ellie Burn, Green Burn and Burn of Logie)	Morphology: low to medium Water quality: medium	Rivers affected by agriculture, in terms of both morphology and water quality. River channels do not exceed 5 m width. There are no abstractions for public water supplies within or downstream of the rivers (see Figure 8: Abstractions and water supplies in Technical Appendix 3.7 A).
North Ugie Water	Morphology:	Rivers affected by agriculture, in terms of both morphology and

Receptor	Sensitivity	Justification and Comments
South Ugie Water	medium to high Water quality: medium	water quality. River channels do not exceed 10 m width. Extensive floodplains along the rivers within and downstream of the study area. There are no abstractions for public water supplies within or downstream of the rivers (see Figure 8: Abstractions and water supplies in Technical Appendix 3.7 A).
Burn of Faichfield	Morphology: low to medium Water quality: medium	Rivers affected by agriculture, in terms of both morphology and water quality. River channels do not exceed 10 m width. There are no abstractions for public water supplies within or downstream of the rivers (see Figure 8: Abstractions and water supplies in Technical Appendix 3.7 A).
River Ugie	Morphology: medium to high Water quality: medium	Rivers affected by agriculture, in terms of both morphology and water quality. River channel approximately 10 m wide. Extensive floodplains along the rivers within and downstream of the study area. There are no abstractions for public water supplies within or downstream of the rivers (see Figure 8: Abstractions and water supplies in Technical Appendix 3.7 A).
Unnamed Watercourse South of Peterhead **Unnamed Watercourse at Peterhead Power Station**	Morphology: low to medium Water quality: medium	Rivers affected by agriculture, in terms of both morphology and water quality. River channels do not exceed 5 m width. There are no abstractions for public water supplies within or downstream of the rivers (see Figure 8: Abstractions and water supplies in Technical Appendix 3.7 A).
Minor Watercourses Throughout Study Area	Morphology: low Water quality: medium	Rivers affected by agriculture, in terms of both morphology and water quality. River channels do not exceed 5 m width. There are no abstractions for public water supplies within or downstream of the rivers (see Figure 8: Abstractions and water supplies in Technical Appendix 3.7 A).
Loch of Strathbeg	Very high	Loch of Strathbeg is a designated area (SSSI, SPA). Although outside the study area, the loch is potentially affected (water quality, sedimentation, etc) as it is located downstream of the cable route within the Burn of Savoch catchment.
Groundwater: **Class 2** **Class 3** **Class 4b** **Class 4c** **Class 4d**	Medium (Class 2) High (Class 3) Very High (Class 4b, 4c and 4d)	SEPA's Groundwater Vulnerability Map details that the site is underlain by Vulnerability Class 2, 3 and 4bto 4d. Figure 3.7-3, Volume 6 a details the sensitivity classification for groundwater based on the groundwater vulnerability. These receptors have been grouped together as they are susceptible to the same magnitude of likely effects.
Soils	Medium	Agricultural soils are present throughout the study area that are considered to be of medium quality.

Receptor	Sensitivity	Justification and Comments
Philorth Valley and Kirkhill SSSI	Very High	The geomorphological designated SSSIs at Philorth Valley and Kirkhill are considered to be of very high sensitivity given their statutory designation. Figure 3.7-4, Volume 6 a summarises the sensitivity classifications for the superficial geology.
Sinclair Hills SESA	High	The Sinclair Hills SESA is considered to be of high sensitivity given the local designation due to its geomorphological interest. Figure 3.7-4, Volume 6 a summarises the sensitivity classifications for the superficial geology.
Peat	Medium	The areas of peat located in the onshore cable route are considered to be of medium sensitivity. Figure 3.7-4, Volume 6 a summarises the sensitivity classifications for the superficial geology.
Superficial Geology (excluding peat)	Low	The superficial geology (excluding peat) within the study area is considered to be of low sensitivity as it has no statutory designation or RIGS registration. Figure 3.7-4, Volume 6 a summarises the sensitivity classifications for the superficial geology.
Mineral Reserves (including sand, gravel and hard rock)	Medium	It is considered probable given the geology (both superficial and solid) and the history of hard rock quarries/sand and gravel pits within the study area that potentially economical mineral reserves may exist. These receptors have been grouped together as they have the same sensitivity and are susceptible to the same magnitude of likely effects.
Dunes	Medium and high	The very eastern edge of the landfall route is part of the Waters of Philorth Local Nature Reserve (high sensitivity). The remainder of the landfall route (except for the urban areas in Fraserburgh) is also occupied by sand dunes but these do not hold any protection by specific guidance/designation (medium sensitivity).
Solid Geology	Low	The solid geology comprises felsic igneous rocks and psammites, semipellite / pelite and quartzite of the Argyl Group. These have no statutory protection within the study area.
Water Supplies	Low and very high	Low sensitivity away from water supplies and buffer zones shown in Figure 8 in Technical Appendix 3.7 A. Very high sensitivity if located within the buffer zones
Human Health	Very high	Human health of users land within the study area, construction workers and future users associated with the development could be impacted by contact with contaminated materials / soil gases / vapours in areas of potential land contamination.
Construction Materials	Medium	The construction materials used in the development could be effected / deleteriously effected by aggressive ground conditions in areas of potential land contamination.

9.3.6.2 Table 9.3-6 above includes human health (e.g. construction workers and site users) and construction materials (e.g. inground concrete and cable materials) as these are additional receptors for potential effects resulting from historical land contamination.

9.3.7 Details of Impact Assessment: Construction

9.3.7.1 The assessment of likely significant effects has been carried out for both the proposals without any mitigation measures in place as well as considering a range of mitigation measures. In each case the likely magnitude is assessed.

Changes to Surface Runoff and Drainage Patterns

9.3.7.2 The construction of cable trenches, temporary construction areas and access tracks could lead to a change in surface water runoff and drainage patterns. Surface water runoff could be diverted away from natural drainage routes and rainfall could collect within trenches and other excavations.

9.3.7.3 Trenches along slopes have the potential for collecting and diverting surface runoff over considerable distance if no adequate drainage systems are provided.

9.3.7.4 The greatest potential for changes to runoff and drainage exists in areas with a moderate to high gradient. Generally the onshore cable route consists of low gradient topography and excavating a cable trench in these areas is thought to have a limited effect on surface runoff (see Figure 3.7-1, Volume 6 a).

9.3.7.5 Areas of higher gradient exist throughout the study area, including the valley sides of small and large watercourses. Depending on the alignment of the cable route, relative to the elevation contours, there could be a potential disturbance of the existing runoff regime.

9.3.7.6 Table 9.3-7 below summarises the impact assessment for this effect.

Table 9.3-7 Changes to Surface Runoff and Drainage Patterns Effect

<table>
<tr><th>Receptor</th><th>Sensitivity</th><th>Pre-Mitigation Magnitude</th><th>Pre-Mitigation Significance</th></tr>
<tr><td>Kessock Burn Catchment</td><td rowspan="9">Medium</td><td rowspan="9">Negligible (areas with low gradient topography)

Moderate (areas with moderate or high gradient topography)</td><td rowspan="9">Insignificant (areas with low gradient topography)

Significant (areas with moderate or high gradient topography)</td></tr>
<tr><td>Water of Philorth Catchment</td></tr>
<tr><td>Burn of Savoch Catchments (Ellie Burn, Green Burn and Burn of Logie)</td></tr>
<tr><td>North Ugie Water Catchment</td></tr>
<tr><td>South Ugie Water Catchment</td></tr>
<tr><td>Burn of Faichfield Catchment</td></tr>
<tr><td>Remaining River Ugie Catchments</td></tr>
<tr><td>Unnamed Catchment South of Peterhead</td></tr>
<tr><td>Unnamed Catchment at Peterhead Power Station</td></tr>
<tr><td>Soils</td><td>Medium</td><td>Negligible</td><td>Insignificant</td></tr>
</table>

Subsoil Compaction and Reduced Groundwater Infiltration

9.3.7.7 For example: during the construction phase, subsoils may be compacted due to the construction of access tracks, movement of vehicles and machinery etc. Reduced soil permeability could lead to a reduction in infiltration of rainfall and surface water to the subsoil and groundwater.

9.3.7.8 Infiltration is an important component of the hydrological cycle and any changes could affect the proportion of rainfall directly contributing to river flows through overland flow. On a river catchment scale the effect of onshore cable route on infiltration is likely to be limited due to the small percentage of catchment area disturbed.

9.3.7.9 For the proposed sub-station site, an area of approximately 200 m by 170 m is cleared. Here, infiltration rates may be affected on a field scale if no suitable mitigation measures are adopted.

9.3.7.10 Table 9.3-8 below summarises the impact assessment for this effect.

Table 9.3-8 Subsoil Compaction and Reduced Groundwater Infiltration

<table>
<tr><th>Receptor</th><th>Sensitivity</th><th>Pre-Mitigation Magnitude</th><th>Pre-Mitigation Significance</th></tr>
<tr><td>Kessock Burn Catchment</td><td rowspan="9">Medium</td><td rowspan="9">Minor</td><td rowspan="9">Minor significance</td></tr>
<tr><td>Water of Philorth Catchment</td></tr>
<tr><td>Burn of Savoch Catchments (Ellie Burn, Green Burn and Burn of Logie)</td></tr>
<tr><td>North Ugie Water Catchment</td></tr>
<tr><td>South Ugie Water Catchment</td></tr>
<tr><td>Burn of Faichfield Catchment</td></tr>
<tr><td>Remaining River Ugie Catchments</td></tr>
<tr><td>Unnamed Catchment South of Peterhead</td></tr>
<tr><td>Unnamed Catchment at Peterhead Power Station</td></tr>
<tr><td>Soils</td><td>Medium</td><td>Minor</td><td>Minor significance</td></tr>
</table>

Localised Overland Flooding

9.3.7.11 The various construction activities, including temporary access track construction, modifications to existing drainage ditches, etc, could potentially create a risk of overland or pluvial flooding in places. This effect would be very localised and dependent on the topography, existing drainage infrastructure, natural streams, road drainage, etc. During heavy rainfall, surface water may be channelled towards areas currently not associated with poor drainage or overland flooding.

9.3.7.12 The risk of overland flooding is most likely to be present where the proposed cable would interact with existing roads, farm access tracks and built-up areas.

9.3.7.13 Table 9.3-9 below summarises the impact assessment for this effect.

Table 9.3-9 Localised Overland Flooding Effect

Receptor	Sensitivity	Pre-Mitigation Magnitude	Pre-Mitigation Significance
Kessock Burn Catchment	Medium	Moderate	Significant
Water of Philorth Catchment			
Burn of Savoch Catchments (Ellie Burn, Green Burn and Burn of Logie)			
North Ugie Water Catchment			
South Ugie Water Catchment			
Burn of Faichfield Catchment			
Remaining River Ugie Catchments			
Unnamed Catchment South of Peterhead			
Unnamed Catchment at Peterhead Power Station			

Excessive Erosion and Sedimentation

9.3.7.14 The required earthworks, including excavations, sidecasting and stockpiling and other construction activities, may lead to excessive erosion, movement and deposition of sediments.

9.3.7.15 Sediment laden runoff could have a detrimental effect on surface water quality, fish and other aquatic species.

9.3.7.16 In rivers, a sediment load greater than under natural conditions could affect the morphology through, for example, deposition of material in slow flowing river reaches. This could have an effect on the stability of river beds and banks as well as flood levels.

9.3.7.17 This effect applies throughout the study area as there is an extensive network of small streams as well as a number of larger rivers. Sediment could also affect the Loch of Strathbeg as a designated area and important habitat. Here sedimentation would naturally occur due to reduced flow velocities. The long-term equilibrium of sediment supply to the loch is not affected as any effect during the construction of the cable route is temporary only.

9.3.7.18 Table 9.3-10 below summarises the impact assessment for this effect.

Table 9.3-10 Excessive Erosion and Sedimentation

Receptor	Sensitivity	Pre-Mitigation Magnitude	Pre-Mitigation Significance
Kessock Burn	Medium (water quality)	Moderate	Significant
Water of Philorth			
Burn of Savoch Tributaries (Ellie Burn, Green Burn and Burn of Logie)			
North Ugie Water			
South Ugie Water			
Burn of Faichfield			
River Ugie			
Unnamed Watercourse South of Peterhead			
Unnamed Watercourse at Peterhead Power Station			
Minor Watercourses Throughout Study Area			
Loch of Strathbeg	Very High	Moderate	Highly Significant
Soils	Medium	Moderate	Significant
(Surface) Water Supplies/Abstractions	Very High	Moderate	Highly Significant

Alteration of Groundwater Levels and Flow Patterns

9.3.7.19 The depth to groundwater is at present unconfirmed but a review of BGS borehole records indicates that in areas of glacial till, shallow excavations could be dry. In areas of alluvium and sand / gravel strata groundwater levels were noted on historical borehole records to be between 2 to 4 m below ground level however one location was noted to be as shallow as 1.5 m. One location also noted slight artesian conditions resulting in water levels being coincident with ground level.

9.3.7.20 The trench / foundation excavations for the majority of the route are understood to have a target depth of 1 m, but may increase to 2 m in some areas. Therefore the majority would be dry. However there is the potential that in some areas these activities could intercept the groundwater table by a small margin. This may require localised dewatering of excavations to enable work to be undertaken. It is considered that any effect of the groundwater levels from such activities would be temporary and very localised.

9.3.7.21 Deeper excavations (for example: directional drilling thrust and reception pits) are likely to be needed where crossing sensitive watercourses. The depth of these is not known at this stage as this requires detailed design; however, they could be larger/deeper than the main cable trenches. Such excavations are very likely to intercept the ground water table and would be likely to need dewatering to enable works to be undertaken. Again such activities are considered to be short term and localised but could result in a change in flow patterns in the direct vicinity of the area which may temporarily reduce groundwater levels in water supplies within the zone of influence.

9.3.7.22 Table 9.3-11 below summarises the impact assessment for this effect.

Table 9.3-11 Alteration of Groundwater Levels and Flow Patterns

Receptor	Sensitivity	Pre-Mitigation Magnitude	Pre-Mitigation Significance
Groundwater (Class 2)	Medium	Moderate	Significant
Groundwater (Class 3)	High	Moderate	Significant
Groundwater (Class 4b, 4c and 4d)	Very High	Moderate	Highly Significant
(Ground) Water Supplies/Abstractions	Very High	Moderate	Highly Significant

Water Quality Deterioration Due to Concrete, Bentonite, Oil, Other Chemicals, etc.

9.3.7.23 A number of chemicals will likely be stored and used on-site during the construction phase. These may include unset concrete, concrete additives, bentonite, fuel and oil. These pollutants may adversely affect the water quality of surface water and groundwater environment should entry occur.

9.3.7.24 Spillages of concrete may occur within the onshore export cable route and substation construction during concrete pumping operations into foundations, which may runoff into surface watercourses. Concrete is highly corrosive and can cause pH changes in watercourses. This can have severe or fatal consequences on freshwater ecology.

9.3.7.25 There is the potential for breakout of bentonite to surface water courses during directional drilling activities. Like concrete, bentonite is alkaline and corrosive and can have a severe effect on freshwater ecology.

9.3.7.26 Contamination of surface water/groundwater and dependent water supplies may also occur as a result of spillages from routine plant maintenance, improper storage and accidental spillages.

9.3.7.27 Should an unmitigated pollution incident occur, there is a potential for periods of heavy rain to increase the volume of surface water runoff with pollutant loads such as oils and fuels from hardstandings and unset concrete.

9.3.7.28 It should be noted that these chemicals will not be present in large quantities and become inert after use.

9.3.7.29 Table 9.3-12 below summarises the impact assessment for this effect.

Table 9.3-12 Water Quality Deterioration

Receptor	Sensitivity	Pre-Mitigation Magnitude	Pre-Mitigation Significance
Kessock Burn	Medium (water quality)	Moderate	Significant
Water of Philorth			
Burn of Savoch Tributaries (Ellie Burn, Green Burn and Burn of Logie)			
North Ugie Water			
South Ugie Water			
Burn of Faichfield			
River Ugie			
Unnamed Watercourse South of Peterhead			
Unnamed Watercourse at Peterhead Power Station			
Minor Watercourses Throughout Study Area			
Loch of Strathbeg	Very High	Moderate	Highly Significant
Water Supplies	Very High	Moderate	Highly Significant
Groundwater (Class 2)	Medium	Moderate	Significant
Groundwater (Class 3)	High	Moderate	Significant
Groundwater (Class 4b, 4c and 4d)	Very High	Moderate	Highly Significant

Loss of Agricultural Soils and Peat

9.3.7.30 Construction activities could result in excavations which remove agricultural soils and peat which is present in specific sections of the onshore cable route. These soils could be lost which could reduce the overall availability of agricultural soils as a resource and loss of carbon storage.

9.3.7.31 Chapter 2.2 (Project Description) details that construction activities are to be undertaken on a corridor of 20 m wide but that excavations would likely be either two trenches 3 m wide or one trench 5 m wide. Therefore the area affected is considered small despite the long linear length of the cable route.

- **Receptor (Sensitivity):** soils (medium) and peat (medium);
- **Pre-mitigation magnitude:** minor; and.
- **Pre-mitigation significance:** Minor significance.

Sterilisation of Mineral Reserves

9.3.7.32 The construction of a cable route and associated substation could mean that future exploitation of economically viable mineral reserves is compromised within the footprint of the proposed development. No assessment of the location of economically viable reserves has been made throughout the onshore cable route; however the presence of such geology and a history of mineral extraction in the study area indicate that such reserves could exist.

9.3.7.33 Chapter 2.2 (Project Description) details that construction activities are to be undertaken on a corridor of 20 m wide but that excavations would likely be either two trenches 3 m wide or one trench 5 m wide. Therefore the area affected is considered small despite the long linear length of the cable route.

- **Receptor (Sensitivity):** mineral reserves (Medium);
- **Pre-mitigation magnitude:** minor; and
- **Pre-mitigation significance:** Minor significance.

Disturbance to (Small) Watercourses

9.3.7.34 At various locations, works will be required to construct crossings with small streams and larger rivers.

9.3.7.35 At minor streams and ditches, the watercourse would be temporarily dammed at either side of the crossing point. Subsequently, the trench would be excavated across the watercourse. If flow rates in the watercourse are substantial, or if the works at the crossing require longer than 1 day, water would be over pumped to prevent upstream flooding.

9.3.7.36 Temporary obstruction of river flows, trench excavation and subsequent re-instatement could affect the stability of the river bed and banks and could cause local erosion or scour with consequently effect on downstream water quality.

9.3.7.37 The obstruction to flows in these watercourses is not likely to have an effect on fish as this construction method would only be used for minor watercourses and drainage ditches. For a full discussion of the effect on fish, see Fish and Shellfish Ecology (Chapter 10.2), Intertidal Ecology (Chapter 10.5) and Terrestrial Ecology (Chapter 10.6).

9.3.7.38 Table 9.3-13 below summarises the impact assessment for this effect.

Table 9.3-13 Disturbance to (Small) Watercourses Effect

Receptor	Sensitivity	Pre-Mitigation Magnitude	Pre-Mitigation Significance
Kessock Burn	Low to medium (morphology)	Moderate	Minor significance to significant
Burn of Savoch Tributaries (Ellie Burn, Green Burn and Burn of Logie)			
Unnamed Watercourse South of Peterhead			

Receptor	Sensitivity	Pre-Mitigation Magnitude	Pre-Mitigation Significance
Unnamed Watercourse at Peterhead Power Station			
Unnamed Watercourse at Peterhead Power Station			
Minor Watercourses Throughout Study Area	Low (morphology)	Moderate	Minor significance

Disturbance to Medium to Large Rivers and Floodplains.

9.3.7.39 For large rivers, the cable crossing would be constructed using directional drilling techniques. This means that there would be no effect on river channels, banks and water quality.

9.3.7.40 If the cable route would cross river reaches with extensive floodplains, drilling would be undertaken from within the floodplain (although away from river banks). During high river flows, trenches within the floodplain and working areas may flood. This could lead to pollution of surface waters (oils and chemicals), widespread erosion across the floodplain, changes to floodplain flow patterns, increase in flood levels and machinery being washed away with flood flows.

9.3.7.41 Table 9.3-14 below summarises the impact assessment for this effect.

Table 9.3-14 Disturbance to Medium to Larger Rivers and Floodplains Effect

Receptor	Sensitivity	Pre-Mitigation Magnitude	Pre-Mitigation Significance
Water of Philorth	Medium (morphology)	Moderate	Significant
North Ugie Water	Medium to high (morphology)	Moderate	Significant
South Ugie Water			
Burn of Faichfield	Low to medium (morphology)	Moderate	Minor significance to significant
River Ugie	Medium to high (morphology)	Moderate	Significant

Increase of Coastal Flood Risk

9.3.7.42 At the proposed landfall point, the cable route could affect coastal flood protection systems. South of Fraserburgh a natural dune system protects the land from flooding. If a cable trench is constructed through the dune system, the land behind the dunes may become at risk of flooding from the North Sea.

9.3.7.43 In some locations, low points exist within the dunes and at these locations sea water may cause flooding within the dunes or land directly behind it. Here, land further away from the coastline and flood prone areas is protected from flooding by rising ground levels. The construction of the cable route through these areas is unlikely to affect the integrity of coastal flood protection systems.

9.3.7.44 Note that in some areas along the coastline, ground levels rise steeply. In these areas the risk of coastal flooding is very low and would not be affected by the cable route.

- **Receptor (Sensitivity):** dunes (medium and high);
- **Pre-mitigation magnitude:** moderate; and
- **Pre-mitigation significance:** significant.

Damage to Geological or Geomorphological Designated Sites

9.3.7.45 In the onshore cable route there is the Kirkhill geological SSSI, the Philorth Valley geological SSSI and Sinclair Hills SESA. These sites are all designated as a result of the value of the superficial deposits to quaternary studies including sea level changes and glaciation.

9.3.7.46 Should the cable route intercept these designated sites, there would be disturbance and loss of the soil structure in the direct area of construction activities which is the basis of the designation. The proposed construction activities are to be undertaken on a corridor of 20 m wide but excavations would likely be either two trenches 3 m wide or one trench 5 m wide. Therefore the area affected is considered small in relation to the size of the overall designated sites. The construction activities could also provide a positive effect in temporarily exposing subsurface soils to allow inspection by academic bodies with an interest in glacial studies and/or sea level changes.

9.3.7.47 Table 9.3-15 below summarises the impact assessment for this effect.

Table 9.3-15 Damage to Geological or Geomorphological Designated Sites

Receptor	Sensitivity	Pre-Mitigation Magnitude	Pre-Mitigation Significance
Kirkhill SSSI	Very High	Moderate	Highly Significant
Philorth Valley SSSI	Very High	Moderate	Highly Significant
Sinclair Hills SESA	High	Moderate	Significant

Disturbance and Movement of Contaminated Materials

9.3.7.48 There are a number of sites identified within the study area which have potential for existing contaminated soils / groundwater to be present. As the specific cable route is not yet defined within the study area the sites with potential for land contamination which may be intercepted by the construction activities are not yet known. However, given the length of the cable route there is the potential that numerous individual sites with contamination potential could be encountered.

9.3.7.49 Excavations within contaminated land could generate contaminated run off, create lateral pollution migration pathways allowing pollution to migrate beyond the land already considered to be contaminated and disturbance of confined contaminated materials (e.g. below ground tanks/pipes or buried drums containing contaminated liquids) thereby releasing it to surroundings soils / groundwater and dependent water supplies and baseflow to rivers.

9.3.7.50 Construction activities in contaminated soils could also result in the generation of waste requiring special handling/treatment/disposal.

9.3.7.51 Table 9.3-16 below summarises the impact assessment for this effect.

Table 9.3-16 Disturbance and Movement of Contaminated Materials

Receptor	Sensitivity	Pre-Mitigation Magnitude	Pre-Mitigation Significance
Soils	Medium	Moderate	Significant
Peat	Medium	Moderate	Significant
Superficial Geology	Low	Moderate	Minor Significance
Kessock Burn	Medium (water quality)	Moderate	Significant
Water of Philorth			
Burn of Savoch Tributaries (Ellie Burn, Green Burn and Burn of Logie)			
North Ugie Water			
South Ugie Water			
Burn of Faichfield			
River Ugie			
Unnamed Watercourse South of Peterhead			
Unnamed Watercourse at Peterhead Power Station			
Minor Watercourses Throughout Study Area			
Water Supplies	Very High	Moderate	Highly Significant
Groundwater (Class 2)	Medium	Moderate	Significant
Groundwater (Class 3)	High	Moderate	Significant
Groundwater (Class 4b, 4c and 4d)	Very High	Moderate	Highly Significant

Pollution of Water Supplies

9.3.7.52 Private water supplies and abstractions are present throughout the study area.

9.3.7.53 Water supplies could be affected through pollution incidents within the construction area as discussed above.

9.3.7.54 Figure 8 in Technical Appendix 3.7 A shows the locations of all identified abstraction locations (groundwater or surface water). A buffer zone is also shown indicating areas that may affect the supplies or abstractions if the cable route is constructed within these areas. Here a distance of 250 m is assumed for private water supplies smaller than 10 m³ per day and abstractions for non-domestic purposes. This distance is typically required by SEPA in relation to private water supplies. A 500 m buffer is assumed for water supplies greater than 10 m³ per day. Here a greater buffer zone is appropriate due to the greater abstraction volumes and the potential for a significant disruption.

9.3.7.55 There are no abstractions for public water supply purposes near or downstream of the onshore cable route.

- **Receptor (Sensitivity):** water supplies (very high within the buffer zone and low outside the buffer zone);
- **Pre-mitigation magnitude:** major (within the buffer zone) and negligible (outside buffer zone); and
- **Pre-mitigation significance:** highly significant (within buffer zone only) and insignificant (outside buffer zone).

Human Health Effects from Contaminated Materials

9.3.7.56 There are numerous sites identified within the study area which may contain contaminated soils / groundwater and could be a source of hazardous soil gases / vapours. Construction workers could be exposed to contaminated soils/groundwater by direct contact with these materials during excavations or by inhalation of soil gases and vapours in confined spaces during construction activities. There is also an explosive risk from hazardous gases during construction activities. Construction activities in contaminated ground may generate dusts which could mobilise contaminants into the atmosphere and subsequently be inhaled by construction workers and nearby land users.

- **Receptor (Sensitivity):** human health (very high);
- **Pre-mitigation magnitude:** moderate / major; and
- **Pre-mitigation significance:** highly significant.

Damage to Construction Materials by Contaminated Ground

9.3.7.57 Inground concrete, cable ducting and cable materials if placed in contaminated soils (e.g. hydrocarbon contamination) or aggressive ground (e.g. acidic conditions) could be liable to attack and deterioration over time.

- **Receptor (Sensitivity):** construction materials (medium);
- **Pre-mitigation magnitude:** minor; and
- **Pre-mitigation significance:** minor significance.

9.3.8 Details of Primary Impact Assessment: Operation

9.3.8.1 During the operational lifetime of the proposed cable route, the effects on the hydrology, geology and hydrogeology are negligible. The following potential effects have however been identified:

Alteration of Groundwater Flow Patterns

9.3.8.2 As previously discussed, the depth to groundwater is at present unconfirmed. The assessment of baseline data indicates that much of the onshore cable route post construction would be located above the groundwater table and therefore would have no effect on groundwater flow patterns.

9.3.8.3 There may, however, be sections of the route where the backfilled cable trenches, manhole foundations and substation foundations could be located within the influence of the water table thereby providing preferential flow/obstruction to groundwater flow. These areas are considered likely to be rare and that the preference during construction would be to complete operations above the water table.

- **Receptor (Sensitivity)**: groundwater (medium to very high);
- **Pre-mitigation magnitude:** minor; and
- **Pre-mitigation significance:** minor significance.

Human Health Effects from Contaminated Materials

9.3.8.4 There is likely to be a need for occasional maintenance / repairs to be undertaken on below ground cabling during the operational phase. In areas of the onshore cable route which intercept sites with a potential for land contamination / hazardous soil gases, such maintenance work may expose workers to contaminated soils / groundwater by direct contact or by inhalation of soil gases / vapours in confined spaces (e.g. excavations). There is also a risk to future workers on the substation site from migration of soil gases / vapours to indoor air space should the location of the substation be on / close to a site which has the potential to generate such gases.

- **Receptor (Sensitivity):** human health (very high);
- **Pre-mitigation magnitude:** moderate / major; and
- **Pre-mitigation significance:** highly significant.

Changes to Runoff and Drainage Patterns at the Proposed Sub-Station

9.3.8.5 The proposed substation is the only area where the runoff and drainage regime may be altered during the lifetime of the cable route. The principal mechanism is the potential for reduced infiltration due to impermeable surface areas and buildings.

9.3.8.6 If no mitigation measures are adopted, the increase in impermeable surface could potentially lead to increased runoff rates and a reduction in water quality.

- **Receptor (Sensitivity):** coastal catchments / drainage areas near Peterhead Power Station (medium);
- **Pre-mitigation magnitude:** moderate; and
- **Pre-mitigation significance:** significant.

9.3.9 Details of Primary Impact Assessment: Decommissioning

9.3.9.1 At present there are no details regarding the scope of decommissioning activities and as such a detailed impact assessment is not possible at this stage. However they may include removal of buried cables and demolition of the substation compound. As such, possible effects in this scenario are considered as being similar in nature to those identified for the construction phase.

9.3.10 Proposed Monitoring and Mitigation: Construction

Cable Route Detailed Alignment Development

9.3.10.1 Many of the potential construction effects will be fully or partially mitigated by careful design of the proposed cable route and its alignment.

9.3.10.2 Based on findings from the environmental baseline assessment presented in Chapter 3.7 (Hydrology, Geology and Hydrogeology), the following areas will be avoided for the final cable route where possible:

- Designated areas including geological and geomorphological SSSIs as shown in Figure 10 in Technical Appendix 3.7 A. If these areas cannot be avoided a cable alignment may be developed using corridors of already disturbed subsoils. For example: a disused railway which passes through the Philorth Valley SSSI may be utilised subject to consultation with SNH;
- Deep peat bogs. Peat is known to exist within the study area as detailed on geological maps (Figure 2 and 3 in Technical Appendix 3.7 A). Where peat cannot be avoided, detailed peat depths surveys will be undertaken and the cable route will be designed such that the effect on the peat hydrology and carbon losses are minimised. The width of the cable trench will be minimised and peat will be extracted in such a manner to enable re-use for peat restoration;
- Near private water supplies and abstractions as shown in Figure 8 in Technical Appendix 3.7 A. It may not be feasible to avoid all of these along the entire route, in particular in areas with many private water supplies clustered together. In such cases, a more detailed investigation and risk assessment will be carried out to identify the exact location and potential zone of influence. Larger (mining / agricultural) abstractions may be seasonal or their location may not be fixed and consultation with the abstraction owner may be beneficial to minimise effect;
- Floodplains as shown in the Indicative River & Coastal Flood Map (Scottish Environment Protection Agency 2010). Although avoidance of watercourses and floodplains is not entirely possible, the cable route will not run close to the river banks or over great distances parallel to rivers within the floodplain. Floodplain crossings will be over the shortest distance possible (see Paragraph 9.3.10.12 below on watercourse crossings); and
- Contaminated land as identified following detailed site investigations (see Paragraph 9.3.10.7 below).

9.3.10.3 In general, the cable trenches will not be wider than strictly necessary and construction methods will be adopted to minimise additional (temporary) land take.

9.3.10.4 **Effects mitigated:** water quality deterioration, loss of agricultural soils and peat, disturbance to (small) watercourses, disturbance to floodplains, damage to geological or geomorphological (SSSI) sites, disturbance and movement of contaminated materials, pollution of water supplies, human health effect from contaminated materials, damage to construction materials by contaminated ground.

Environmental/Construction Management Plan

9.3.10.5 A detailed Environmental Management Plan (EMP), including pollution prevention measures and construction method statements, will be put in place during construction, operation and decommissioning. The EMP will outline mitigation measures to be put in place and measures and a Draft EMP is attached in Technical Appendix 1.3 A. This should be developed in conjunction with the contractor undertaking the engineering activities and with reference to relevant best practice guidance including:

- Murnane, E., Heap, A. & Swain, A. (2006). Control of water pollution from linear construction projects : site guide, London: CIRIA;
- Audus, I., Charles, P. & Evans, S. (2005). Environmental Good Practice on Site, London: CIRIA;
- Environment Agency (2007). Pollution Prevention Guidelines: Works and maintenance in or near water: PPG5;
- Environment Agency (2009). Pollution Prevention Guidelines: Incident Response Planning: PPG 21;
- Environment Agency (2011). Pollution Prevention Guidelines: Above ground oil storage tanks: PPG 2;
- Scottish Environment Protection Agency (2009). Engineering in the Water Environment Good Practice Guide: Temporary Construction Methods, Stirling: Scottish Environment Protection Agency; and
- Scottish Environment Protection Agency (2010). Engineering in the water environment: good practice guide River crossings, Stirling: Scottish Environment Protection Agency.

9.3.10.6 A site waste management plan will be developed to minimise waste (e.g. peat and soils, contaminated materials), reuse materials were possible (i.e. re-use agricultural and clean soils from trench excavation for backfill), segregate wastes (e.g. keep potentially contaminated soils separate from others) and ensure storage does not pose a risk of pollution from runoff / spillage.

9.3.10.7 In relation to working on land with a potential contamination risk, a detailed site investigation and risk assessment will be completed to ascertain the issues of concern (see following mitigation measures discussing site investigations). Depending on the outcome of the assessment for individual contaminated sites, it may be necessary to supplement the EMP (and Health and Safety Plan) for individual sections of the route in relation to the handling of contaminated soils by construction workers (e.g. control of exposure by direct contact), monitoring for soil gases, control of dusts from contaminated materials and cleaning of excavation equipment in contact with contaminated soils prior to moving onto 'clean' sections of the onshore cable route. Earthworks, groundwater controls and temporary surface water drainage measures within sections of the route which have land contamination should be kept separate from adjacent sections of the route so that contaminated materials are contained and to prevent lateral migration pathways along the onshore cable route for contaminated runoff / groundwater. Additional contingency plans should also be in place to deal with unexpected findings (e.g. areas not known to have contamination) and if disturbance/leakage occurs from confined contaminated materials (e.g. damage of buried drums or pipes containing liquid waste).

9.3.10.8 A specific emergency contingency plan will be developed in conjunction with the contractor in relation to the potential for breakout of bentonite into watercourses during directional drilling.

9.3.10.9 **Effects mitigated:** Loss of agricultural soils and peat, water quality deterioration, human health effects from contaminated materials and disturbance / movement of contaminated materials.

Site Investigation

9.3.10.10 Once the exact route selection is made within the wider study area, detailed site investigation will be carried out to assess risks from potential existing land contamination. A site investigation strategy together with any additional research to further augment the conceptual site model will be developed for each individual site of potential existing land contamination along the route. The strategy for each will also be discussed with the Contaminated Land Officer at Aberdeenshire Council to give them an early opportunity to comment on the investigations proposed.

9.3.10.11 After implementation of the site investigation, detailed risk assessments will be carried out to understand the hazards posed by subsurface contamination if present. In some instances, the hazards may be such that remedial works may be necessary to address the hazards prior to construction.

9.3.10.12 Geotechnical site investigations will be carried out to characterise the ground and groundwater conditions in relation to the design of the engineering works, dewatering requirements, foundation design and design of directional drilling for crossing of sensitive watercourses. These will be designed in conjunction with a specialist directional drilling contractor to reduce the risks as much as possible in relation to break out of bentonite.

9.3.10.13 **Effects mitigated:** Alteration of groundwater levels and flow patterns, water quality deterioration, disturbance and movement of contaminated materials, human health effects from contaminated materials and damage to construction materials by contaminated ground.

Environmental Monitoring

9.3.10.14 A groundwater and surface water monitoring programme will be carried out to obtain baseline data, as well as data during construction works for identified sensitive water environment receptors (e.g. water supplies, major watercourses). These will be dependent on the final route alignment. The scope of this will be agreed with SEPA prior to implementation.

9.3.10.15 Once the final route alignment is determined detailed site investigations and review of water supplies in proximity to the route will be completed. If this identifies a potential effect on groundwater levels / flow regimes particularly in the vicinity of water supplies, a monitoring plan to review effects on groundwater levels / quality will be developed.

9.3.10.16 A surface water monitoring network for sensitive watercourses in relation to the final route alignment will be established six months prior to construction works. The monitoring network will consist of control monitoring points upstream of construction works as well as monitoring points downstream.

9.3.10.17 In addition to surface water monitoring, regular visual inspection of surface water management features such as drainage pipes and receiving watercourses will be carried out in order to establish whether there are increased levels of suspended sediment, erosion or deposition. It is likely that there will be an ongoing need to maintain these structures (for example: by the removal of debris) to ensure they continue to function as designed.

9.3.10.18 Regular visual inspection of watercourses will be carried out during construction, particularly during periods of high rainfall but also during low flow conditions, in order to establish that levels of suspended solids have not been significantly increased by on-site activities.

9.3.10.19 Monitoring may also be required as a condition of any discharge consents, abstraction licences or other environmental regulations.

9.3.10.20 **Effects mitigated:** Excessive erosion and sedimentation, alteration of groundwater levels and flow patterns, water quality deterioration and pollution of water supplies.

Drainage Systems and Sediment Control

9.3.10.21 To mitigate the effect on runoff, drainage and infiltration, an adequate drainage system will be implemented prior and during the construction activities. The drainage system will adopt sustainable drainage system (SUDS) principles as set out in best-practice guidance documents (Masters-Williams *et al.,* 2001; Murnane *et al.,* 2006; Water Research Centre *et al.,* 2007; Woods Ballard 2007).

9.3.10.22 The drainage system will also provide measures to reduce erosion and prevent sediment laden runoff entering surface water. For example: adequately sized settlement lagoons could be constructed to allow settlement of sediments prior to discharge to groundwater or surface water.

9.3.10.23 It is envisaged that the drainage system will incorporate some or all of the following components:

- Diversion or cut-off drains to direct nearby runoff away from the construction area;
- Drainage ditches, swales, infiltration areas etc. to capture runoff;
- Distribute discharge points and drainage outfalls (surface water or groundwater) to reduce flow rates and volumes;
- Check dams at regular intervals along ditches on a gradient to prevent high flow rates;
- Settlement lagoons and sediment traps to prevent water pollution and act as a buffer area in case of pollution incidents; and
- Temporary access track drainage to prevent surface water flooding.

9.3.10.24 Drainage arrangements for the construction phase will be further developed and described as part of the construction management plan.

9.3.10.25 For the proposed substation site, a permanent sustainable drainage system will be installed to ensure flood risk within the site and elsewhere is not increased. This drainage system will also provide adequate levels of water treatment to minimise any effect on water quality of receiving surface water or groundwater bodies.

9.3.10.26 **Effects mitigated:** changes to surface runoff and drainage patterns, subsoil compaction and reduced groundwater infiltration, localised overland flooding, excessive erosion and sedimentation, alteration of groundwater levels and flow patterns, water quality deterioration, pollution of water supplies.

Consulting Landowners Regarding Mineral Reserve Potential

9.3.10.27 Discussions will be held with relevant landowners on the route to determine if they know of economically viable minerals reserves in their ownership on the cable route and if they have any future plans for the exploitation of such.

9.3.10.28 **Effects mitigated:** Sterilisation of sand and gravel/granite reserves.

Watercourse Crossings Design

9.3.10.29 To mitigate the disturbance to small watercourses as part of the construction of crossings, the following working methods will be adopted:

- Minimise the duration over which watercourses are dammed to prevent backing up of flows and drying up of downstream channels;
- Overpump flow where construction requires more than 1 day or where flows are significant;
- Excavate cable trenches as narrow as possible across the river bed;
- Restore river beds and banks using original soils and gravels where possible; and.
- Provide additional scour and erosion protection to mitigate the risk of bare soils.

9.3.10.30 As part of the detailed design of the cable route, site specific crossing methods will be developed to take into account local issues and risks.

9.3.10.31 For large rivers, if working within the floodplain cannot be avoided, construction will be undertaken during periods of low flow only.

9.3.10.32 **Effects mitigated:** disturbance to (small) watercourses, disturbance to floodplains.

Maintaining Coastal Flood Protection

9.3.10.33 Depending on the exact location of the outfall, different measures will be taken to ensure that coastal flood protection levels are not reduced during the construction phase.

9.3.10.34 If the outfall location is situated along coastline with dunes, the route alignment may be designed to coincide with low areas within the dune system. If trenches are excavated in short sections there would be no risk of sea water inundate areas otherwise protected from flooding.

9.3.10.35 If the outfall location is situated within the developed area in Fraserburgh, a detailed construction method will be developed to ensure that at no point in time the defence level is reduced below the level currently provided.

9.3.10.36 In any case, the outfall location (and the nearshore and offshore cable route) will be constructed outside the storm season (October to March) to minimise risks associated with storm surges and wave action (see also Chapters 9.1: Hydrodynamics and 9.2: Sedimentary Processes).

9.3.10.37 **Effects mitigated:** increase of coastal flood risk.

9.3.11 Proposed Monitoring and Mitigation: Operation

9.3.11.1 The site investigation mitigation measures implemented during the construction phase will also address the operational phase effects of alteration to groundwater flow patterns and human health effects from contamination materials. Additional mitigation measures would include the remediation of contaminated land (if necessary) to reduce the risks from contaminated materials to health of future maintenance workers and substation staff. If remediation was not considered necessary, gas protection measures could be installed in the design of the future substation. In addition, Health and Safety File / EMP should document the areas of the cable route where contaminated materials/gases have been identified by site investigations in the subsurface so that maintenance works can be planned accordingly.

Sustainable Drainage System at the Sub-Station Location

9.3.11.2 For the proposed substation site, a permanent sustainable drainage system will be installed to ensure flood risk within the site and elsewhere is not increased. This drainage system will also provide adequate levels of water treatment to minimise any effect on water quality of receiving surface water or groundwater bodies. Site runoff rates will be attenuated taking into account Aberdeenshire Council's requirements.

9.3.11.3 The drainage system will be designed in accordance with the SUDS Manual (Woods Ballard 2007) and Control of water pollution from linear construction projects: technical guidance (Murnane *et al.,* 2006). If the system is to be adopted by Scottish Water the design will also take into account requirements of Sewers for Scotland (2nd ed.) (Water Research Centre *et al.,* 2007).

9.3.11.4 **Effects mitigated:** changes to runoff and drainage patterns.

9.3.12 Proposed Monitoring and Mitigation: Decommissioning

9.3.12.1 As previously discussed, there is no specific schedule for the scope of activities for the decommissioning phase at present and as such it is not possible to identify detailed mitigation measures. However as many of the potential effects could be similar and certainly no worse than that identified for the construction phase, the mitigation measures could be similar to those proposed therein.

9.3.13 References

Highways Agency (2009). Design Manual for Roads and Bridges; Volume 11,

Masters-Williams, H. *et al.,* (2001). Control of water pollution from construction sites: guidance for consultants and contractors, London: CIRIA.

Murnane, E., Heap, A. & Swain, A. (2006). Control of water pollution from linear construction projects : technical guidance, London: CIRIA.

Scottish Environment Protection Agency (2010). Indicative River & Coastal Flood Map

(Scotland). Available at: http://www.sepa.org.uk/flooding/flood_risk_maps/view_the_map.aspx.

Scottish Natural Heritage (2009). A handbook on environmental impact assessment; Guidance for Competent Authorities, Consultees and others involved in the Environmental Impact Assessment Process in Scotland, Edinburgh: SNH.

Water Research Centre *et al.,* (2007). Sewers for Scotland: a design and construction guide for developers in Scotland 2nd ed., Swindon: Water UK/WRc plc.

Woods Ballard, B. (2007). *The SUDS manual*, London: CIRIA.

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9.4 Noise (Onshore)

9.4.1 Summary

9.4.1.1 The purpose of this chapter is to assess the likely significant construction, operational and decommissioning noise and vibration effects associated with MORLs proposed onshore transmission infrastructure (OnTI) on noise sensitive receptors. For the purposes of this assessment 'noise sensitive receptors' only constitute dwellings.

9.4.1.2 This chapter contains relevant information on the OnTI to allow Scottish Ministers and Marine Scotland to make decisions on the applications for Section 36 consents and Marine Licences for the three proposed wind farm sites and the OfTI. Discussions are ongoing with landowners to determine the exact location and layout of the substation(s) on their land within the preferred onshore substation area. This will be finalised following production of a masterplan by the owner / operator of the Peterhead Power Station compound which forms part of the preferred area. Once the precise location and layout for the onshore substation(s) and export cable location has been confirmed, an application for planning permission for the OnTI will be submitted to Aberdeenshire Council and will be supported by this ES and such further information as is required to support the planning application.

Summary of Effects

9.4.1.3 This chapter only considers the effects of construction noise on sensitive receptors along the onshore export cable route and in the vicinity of the onshore substation(s). All predicted effects associated with construction noise are temporary and necessary in nature.

9.4.1.4 No significant effects of vibration are anticipated associated with any of the OnTI construction works therefore this has not been considered further.

9.4.1.5 In the respect of construction noise effects associated with the OnTI, no cumulative effects are predicted.

9.4.1.6 No significant effects of operational noise are anticipated along the onshore export cable route therefore this has not been considered further.

9.4.1.7 Effects of operational noise on sensitive receptors in the vicinity of the onshore substation(s) have not been considered in detail in this chapter. The final location and orientation of the substation(s) have yet to be confirmed. The details of construction, mechanical and electrical design and composition have also yet to be finalised. A technical appendix will be prepared in support of a separate planning application for the substation(s) which will address the likely operational effects of this element of the proposals.

9.4.1.8 Noise and vibration associated with construction of the offshore substation(s) platforms and cabling have not been considered in the context of the closest onshore sensitive receptors due to separation distances of 12 nm or greater. Consideration of underwater acoustics in relation to marine ecology is described in Chapter 3.6 (Underwater Noise).

Proposed Mitigation Measures and Residual Effects

9.4.1.9 Mitigation of construction noise will be provided in so far as is reasonably practicable by adopting the principles of *Best Practicable Means* as defined in the Control of Pollution Act (CoPA) (1974). The mitigation measures set out in this chapter will be included in the Construction Environmental Management Plan (CEMP) along with any site specific measures required by Aberdeenshire Council.

9.4.1.10 Providing the CEMP is enforced by the appointed Contractor throughout the construction period, the residual effect at all noise sensitive receptors is predicted to be **moderate adverse** where works are occurring in close proximity to dwellings (within 20 to 50 m, depending on the activity being undertaken) and **minor adverse or negligible** when occurring at greater separation distances. Overall, **no significant effects** are anticipated.

9.4.1.11 During more sensitive evening and weekend core periods (as defined in Table 9.4-3 below) and especially if works are to occur at night, separation distances between dwellings and noise sources should be maximized to reduce the likelihood of significant impacts occurring. The relationship between the likely effects of various construction activities and separation distance from dwellings is explored in detail later in this chapter. Table 9.4-1 below summarises the assessment of effects pre and post mitigation.

Table 9.4-1 Impact Assessment Summary

Receptor	Pre-Mitigation Effect	Mitigation	Post-Mitigation Effect
Construction			
All potential noise sensitive receptors along onshore export cable route	Worst case (works within corridor being assessed at location closest to sensitive receptors): Major to moderate adverse effect Typical case (works within corridor being assessed at greater distances from sensitive receptors): Minor adverse or negligible effect	Best Practicable Means as adopted in the CEMP and implemented by the Contractor	Worst case (works within corridor being assessed at location closest to sensitive receptors): Moderate adverse effect – **Not significant** Typical case (works within corridor being assessed at greater distances from sensitive receptors): Minor adverse or negligible effect – **Not significant**
All potential noise sensitive receptors in the vicinity of the preferred substation(s) locations	Worst case (works within corridor being assessed at location closest to sensitive receptors): Major to moderate adverse effect Typical case (works within corridor being assessed at greater distances from sensitive receptors): Minor adverse or negligible effect	Best Practicable Means as adopted in the CEMP and implemented by the Contractor	Worst case (works within corridor being assessed at location closest to sensitive receptors): Moderate adverse effect – **Not significant** Typical case (works within corridor being assessed at greater distances from sensitive receptors): Minor adverse or negligible effect – **Not significant**

Receptor	Pre-Mitigation Effect	Mitigation	Post-Mitigation Effect
Operation			
All receptors	TBC	TBC	TBC
Decommissioning			
All potential noise sensitive receptors along onshore export cable route	Worst case (works within corridor being assessed at location closest to sensitive receptors): Major to moderate adverse effect Typical case (works within corridor being assessed at greater distances from sensitive receptors): Minor adverse or negligible effect	Best Practicable Means as adopted in the CEMP and implemented by the Contractor	Worst case (works within corridor being assessed at location closest to sensitive receptors): Moderate adverse effect – **Not significant** Typical case (works within corridor being assessed at greater distances from sensitive receptors): Minor adverse or negligible effect – **Not significant**
All potential noise sensitive receptors in the vicinity of the preferred substation(s) locations	Worst case (works within corridor being assessed at location closest to sensitive receptors): Major to moderate adverse effect Typical case (works within corridor being assessed at greater distances from sensitive receptors): Minor adverse or negligible effect	Best Practicable Means as adopted in the CEMP and implemented by the Contractor	Worst case (works within corridor being assessed at location closest to sensitive receptors): Moderate adverse effect – **Not significant** Typical case (works within corridor being assessed at greater distances from sensitive receptors): Minor adverse or negligible effect – **Not significant**

9.4.2 Introduction

9.4.2.1 The cabling will make landfall at Fraserburgh beach and will then be installed underground within the route illustrated in Figure 1.1-4, Volume 6 a. The exact location of the cabling within this route has not yet been finalised. Export cables will be installed in the route using one of three undergrounding methodology options and will terminate at the substation(s), which is proposed in the vicinity of the existing Peterhead Power Station, Boddam.

9.4.2.2 Various locations for construction of the substation(s) are currently under consideration and are illustrated in Figure 1.1-5, Volume 6 a.

9.4.2.3 This chapter is necessarily technical in nature and a Glossary of Acoustic Terms has been provided in the Preface.

9.4.3 Rochdale Envelope Parameters Considered in the Assessment

9.4.3.1 The following Table 9.4-2 describes the extents of the construction noise assessment undertaken for the onshore elements of the MORL Project. It describes the worst case scenarios considered in the assessment of noise during each phase of construction, that is, when works are occurring at the closest possible point to sensitive receptors.

9.4.3.2 It should be noted that these worst case circumstances will arise infrequently during the construction period due to the mobile nature of the works; the degree to which any particular dwelling will be affected will depend on the final route selected. To provide a balanced assessment therefore, noise levels at incremental separation distances from various construction activities have also been considered in the assessment of magnitude and significance of effect discussed later in this chapter.

Table 9.4-2 Rochdale Envelope Parameter Relevant to the OnTI Noise Impact Assessment

Potential Effect	Rochdale Envelope Scenario Assessed
Construction & Decommissioning	
Adverse noise effects at the closest noise sensitive receptors to the cabling corridor	Cable laying activities in two separate phases by plough or trench at the closest point in the corridor to existing noise sensitive dwellings.
Adverse noise effects at the closest noise sensitive receptors to the areas of preference for the substation(s) location	Substation(s) construction activities in the area of preference closest to existing noise sensitive dwellings.

9.4.4 EIA Methodology

Assessment Methodology

9.4.4.1 The following guidance has been referred to in the course of this chapter:

- British Standard (BS) 5228 Code of practice for noise and vibration control on construction and open sites. Part 1: Noise;
- Control of Pollution Act (CoPA) (1974); and
- The draft findings of The Institute of Acoustics / Institute of Environmental Management and Assessment (IOA / IEMA) Working Party.

Scope

9.4.4.2 The scope of the assessment has been determined in the following way:

- Consultation with Aberdeenshire Council to confirm their specific requirements in terms of the scope of the assessment;
- A review of the onshore export cable route and preferred locations for substation(s) installation; and
- The results of construction noise predictions undertaken in accordance with the guidance set out in BS5228 Part 1: Noise.

Prediction of Construction and Decommissioning Noise Levels at Sensitive Receptors

9.4.4.3 The likely effects of construction noise on nearby sensitive receptors to the onshore cable route and preferred substation(s) construction locations have been predicted and assessed with reference to the guidance set out in British Standard (BS) 5228 *Part 1: Noise*.

9.4.4.4 The predicted effects are temporary and necessary in nature and will be controlled through implementation of the CEMP which will be based on the principles of *Best Practicable Means* (BPM), as defined in the Control of Pollution Act (CoPA) (1974).

9.4.4.5 In order to assess the scale of effect prior to implementation of the proposed mitigation measures, the predicted levels have been compared with suggested maximum cumulative thresholds for construction noise at sensitive dwellings. As neither the onshore export cable route through the corridor nor the location of the substation(s) has yet been finalised, representative sensitive dwellings in contours at incremental distances from source have been considered. This means that the assessment can be applied to dwellings adjacent to any route through the corridor or any substation location.

9.4.4.6 Technical Appendix E of BS5228 Part 1 provides guidance in the respect of deriving appropriate thresholds for the assessment of construction noise. A number of approaches are discussed, including that, depending on the magnitude and duration of the construction Project and the likely ambient acoustic environment in which the works will take place, variable limits should be applied; this approach has been adopted for the purposes of this assessment. Examples of variable limits are presented Technical Appendix E of BS5228 and these have been adopted to inform the assessment.

9.4.4.7 Given the variation between the areas through which the onshore export cable route will pass (predominantly rural and therefore likely to typically experience lower levels of ambient noise due to the lack of contributing sources) and the preferred substation(s) locations (suburban but with a precedent for industrial noise sources / road traffic noise therefore likely to typically more elevated levels of ambient noise from these sources), two sets of thresholds have been adopted for the purpose of this assessment. These varying thresholds for day, evening and night time periods are presented in Table 9.4-3 below.

Table 9.4-3 Noise Thresholds

Assessment Category and Threshold Value Core Period	Threshold Values (dB(A))	
	Cabling Works	Substation(s) Construction
Daytime **0700 to 1900 h weekdays** **0700 to 1300 h Saturdays**	65	70
Evenings and weekends **1900 to 2300 h weekdays** **1300 to 2300 h Saturdays** **0700 to 2300 h Sundays**	55	60
Night time **2300 to 0700 h**	45	50

9.4.4.8 The difference between the predicted level and the threshold level has been used to define the magnitude of effect of construction noise at sensitive receptors.

9.4.4.9 Noise propagation is assumed to be hemispherical and with no obstructions between source and receptor. No correction has been made for the topography between source and receptor, nor has there been any allowance made for acoustic attenuation from intervening soft ground or atmospheric absorption. The predicted noise levels are those under neutral weather conditions. These calculations are considered to be suitably robust for the purposes of this assessment.

9.4.4.10 Noise predictions have been made in terms of the maximum $L_{Aeq,T}$ noise levels that will be experienced at each receptor location. It is assumed that the predicted $L_{Aeq,T}$ noise level represents the average noise level over the core periods described in Table 9.4-3 above.

9.4.4.11 The predicted noise levels presented for sensitive receptors in each contour represent cumulative integrations of the sound power level for each piece of equipment assumed to be used in the works described (BS5228 Part 1 Annex C *Current sound level data on site equipment and site activities*), the number of pieces of equipment assumed to be operational, the distance between source and receptor and the assumed on-time of the equipment (as a percentage of the core period). Table 9.4-4 below summarises this information.

Table 9.4-4 Summary of Equipment Assumptions for Predictions of Construction Noise

Stage of Works	Description of Works	Assumed Plant Items	Number of Plant Items	Sound Power Level (Lw, dB) (BS5228 Part 1: Noise)	Assumed % on Time
Cable Installation	Cable plough	Tractor	1	108	80
		Tracked excavator	1	103	80
		Dozer	1	109	80
	Directional drilling	Directional drill (generator)	1	105	70
		Water pump	1	93	70
		Mounting supports for directional drill (hydraulic hammer)	1	115	40
	Open trench	Tractor	1	108	80
		Tracked excavator	1	103	80
		Dozer	1	109	80
Substation Construction	Ground preparation works	Tracked excavator	1	103	60
		Dozer	1	109	40
		Lorry (4 axle wagon)	1	108	80
	Concreting	Concrete pump and cement mixer truck (discharging)	1	103	50
		Poker Vibrators	2	106	70

Stage of Works	Description of Works	Assumed Plant Items	Number of Plant Items	Sound Power Level (Lw, dB) (BS5228 Part 1: Noise)	Assumed % on Time
Substation Construction (continued)		Generator (diesel)	1	92	100
	Construction	Lorry (4 axle wagon)	1	108	60
		Mobile telescopic crane	1	95	60
		Generator (Diesel)	1	92	100
		Cutting concrete floor slab	1	119	20
	Asphalting / road works	Articulated dump truck	1	109	60
		Road Planer	1	110	60
		Vibratory roller	1	105	60
		Tracked excavator	1	108	60
		Dozer	1	110	60
Decommissioning	Removal of OnTI	Tracked excavator	1	103	60
		Dozer	1	109	40
		Lorry (4 axle wagon)	1	108	80

9.4.4.12 The results of the predictions are presented in 9.4.5 of this chapter, together with an assessment of the magnitude of effect in relation to the adopted noise threshold values (Table 9.4-3 above) and its significance.

Defining Sensitivity of Receptors

9.4.4.13 The determination of significance of effects reflects judgements as to the sensitivity of the receptors being considered and the nature and magnitude of the predicted changes. For example: a brief or temporary effect on a sensitive receptor (e.g. construction noise during cabling installation) will be of lesser significance than a permanent effect (e.g. continuous operational road noise) on the same receptor. Equally, a major adverse effect on a receptor of high sensitivity (e.g. dwelling) will be of greater significance than the equivalent effect on a receptor of low sensitivity (e.g. offices). The nature of the predicted effects will also influence the perceived significance of the effect e.g. beneficial or adverse, reversible or irreversible.

9.4.4.14 For the purposes of this assessment, only those receptors considered to be of high sensitivity to noise (i.e. dwellings) have been considered. This is because noise is particularly pertinent to the inhabitants of dwellings and rooms intended for resting and sleeping (bedrooms, hotel rooms at night, etc.).

Defining Magnitude of Effect

9.4.4.15 It should be noted that official guidance on the assessment of noise effects is fragmentary, with various standards being applicable to one noise source but not to others.

9.4.4.16 Guidance relating to changes in noise levels, how they are perceived and their relative magnitude of effect is presented in the draft findings of The Institute of Acoustics / Institute of Environmental Management and Assessment (IOA / IEMA) Working Party. Based on this guidance, Table 9.4-5 below details the relationship between the exceedance of noise thresholds adopted for this assessment and the magnitude of the effect.

Table 9.4-5 Magnitude of Effect Based on Predicted Construction Noise Levels in Excess of the Adopted Thresholds (Table 9.4-3 above)

Exceedence of Noise Threshold (dB)	Magnitude of Effect
0.0 to 0.9	Negligible
1.0 to 2.9	Minor adverse effect
3.0 to 4.9	Moderate adverse effect
5.0 or greater	Major adverse effect

9.4.4.17 The following Table 9.4-6 defines the terms used in the scale of magnitude pertinent to this assessment (Table 9.4-5 above).

Table 9.4-6 Defining Magnitude of Effect

Magnitude of Effect	Definition
Negligible	Imperceptible change in noise level
Minor Adverse	A small but barely perceptible increase in noise level at a receptor of high sensitivity
Moderate Adverse	A noticeable increase in noise level at a receptor of high sensitivity
Major Adverse	A considerable increase in noise level at a receptor of high sensitivity

9.4.4.18 These tables have been referred to when evaluating the magnitude of the likely effects of construction noise associated with the onshore elements.

Defining Significance of Effect

9.4.4.19 In terms of defining the significance of the predictions of magnitude of effect detailed in 9.4.5 of this chapter, it is considered that only those identified as major adverse effects are significant in terms of Environmental Impact Assessment legislation (Table 9.4-7). This judgement reflects the temporary nature of the construction of the OnTI.

Table 9.4-7 Relating Magnitude of Effect to Significance for Temporary Construction Works

Magnitude of effect	Significance
Negligible	Not significant
Minor Adverse	Not significant
Moderate Adverse	Not significant
Major Adverse	Significant

9.4.5 Impact Assessment

Construction and Decommissioning

9.4.5.1 This section presents the results of predictions of noise levels for each set of construction activities associated with the OnTI and also the derived magnitude of these predictions relative to the thresholds previously described. Predictions have been undertaken for day, evening and weekend and night time periods as defined in Table 9.4-3 above.

9.4.5.2 It should be noted that all the effects identified in this assessment are direct, short term and temporary in nature.

9.4.5.3 For clarity, Table 9.4-9 to Table 9.4-17 (which present the results of the construction noise predictions) have been colour coded in accordance with the following key which illustrates the relevant magnitude of effect for each construction activity at dwellings at increasing distances from the sources of construction noise.

Table 9.4-8 Magnitude of Effect

Colour	Magnitude of Effect
(dark blue)	Major Adverse
(light blue)	Moderate Adverse
(pale blue-grey)	Minor Adverse
(white)	Negligible

Onshore Cabling Elements: Construction

9.4.5.4 Table 9.4-9 to Table 9.4-11 below present the results of the cabling installation construction noise predictions and the corresponding magnitude of effect for daytime, evenings and weekends and night time respectively.

Table 9.4-9 Predicted Onshore Noise Effects Associated with Cabling Installation: Daytime ($L_{Aeq,T}$)

Description of Cable Installation Methodology	Distance of Noise Sensitive Receptor from Construction Noise Sources (m)				
	20	50	100	200	500
Cable Plough	77	68	62	55	46
Directional Drilling	78	69	62	56	47
Open Trench	77	68	62	55	46

Table 9.4-10 Predicted Onshore Noise Effects Associated with Cabling Installation: Evenings and Weekends ($L_{Aeq,T}$)

Description of Cable Installation Methodology	Distance of Noise Sensitive Receptor from Construction Noise Sources (m)				
	20	50	100	200	500
Cable Plough	77	68	62	55	46

Description of Cable Installation Methodology	Distance of Noise Sensitive Receptor from Construction Noise Sources (m)				
	20	50	100	200	500
Directional Drilling	78	69	62	56	47
Open Trench	77	68	62	55	46

Table 9.4-11 Predicted Onshore Noise Effects Associated with Cabling Installation: Night Time ($L_{Aeq,T}$)

Description of Cable Installation Methodology	Distance of Noise Sensitive Receptor from Construction Noise Sources (m)				
	20	50	100	200	500
Cable Plough	77	68	62	55	46
Directional Drilling	78	69	62	56	47
Open Trench	77	68	62	55	46

Substation(s) Construction

9.4.5.5 Table 9.4-12 to Table 9.4-14 below present the results of the substation(s) construction predictions and the corresponding magnitude of effect for daytime, evenings and weekends and night time respectively.

Table 9.4-12 Predicted Onshore Noise Effects Associated with Substation(s) Construction: Daytime ($L_{Aeq,T}$)

Description of Works Relating to Substation(s) Construction	Distance of Noise Sensitive Receptor from Construction Noise Sources (m)				
	20	50	100	200	500
Ground Preparation Works	76	67	60	54	45
Concreting	74	66	59	52	43
Construction	79	70	64	57	48
Asphalting / Road Works	80	71	64	57	48

Table 9.4-13 Predicted Onshore Noise Effects Associated with Substation(s) Construction: Evenings and Weekends (LAeq,T)

Description of Works Relating to Substation(s) Construction	Distance of Noise Sensitive Receptor from Construction Noise Sources (m)				
	20	50	100	200	500
Ground Preparation Works	76	67	60	54	45
Concreting	74	66	59	52	43
Construction	79	70	64	57	48
Asphalting / Road Works	80	71	64	57	48

Table 9.4-14 Predicted Onshore Noise Effects Associated with Substation(s) Construction: Night Time ($L_{Aeq,T}$)

Description of Works Relating to Substation(s) Construction	Distance of Noise Sensitive Receptor from Construction Noise Sources (m)				
	20	50	100	200	500
Ground Preparation Works	76	67	60	54	45
Concreting	74	66	59	52	43
Construction	79	70	64	57	48
Asphalting / Road Works	80	71	64	57	48

9.4.5.6 From the results presented above, it can be seen that, during the daytime and with no mitigation, the magnitude of effect of all cable installation activities is predicted to be major adverse and therefore significant when taking place within 20 m of the closest dwelling. At 50 m separation distance and beyond, the magnitude of effect decreases and is no longer considered to be significant.

9.4.5.7 During evening and weekend core periods (as defined in Table 9.4-3 above) unmitigated cable installation noise levels are predicted to be significant at dwellings less than 200 m away. Unmitigated cable installation noise levels at night are predicted to be significant at dwellings less than 500 m away.

9.4.5.8 For construction activities associated with the substation(s), the magnitude of effect of unmitigated noise from works during the daytime within 20 m of the closest dwellings is predicted to be major adverse, and therefore significant, for all activities except concreting. Unmitigated noise levels associated with all activities at 50 m or more from the closest dwelling are not considered to be significant during this period.

9.4.5.9 During evening and weekend core periods, (as defined in Table 9.4-3 above) unmitigated substation(s) construction noise levels at dwellings less than 100 m away are predicted to be significant. Beyond 100 m, the predicted levels are not considered to be significant.

9.4.5.10 At night, unmitigated noise from construction and asphalting / road surfacing activities at locations less than 500 m away from dwellings are considered to be significant. For ground preparation works and concreting activities however, the predicted noise levels are only considered significant at dwellings less than 200 m from source.

9.4.5.11 Mitigation measures are discussed in 9.4.6 of this chapter.

Operation

9.4.5.12 No operational effects are anticipated in relation to the cabling installation.

Decommissioning

Decommissioning of Onshore Installations

9.4.5.13 Table 9.4-15 to Table 9.4-17 below present the results of the decommissioning predictions and the corresponding magnitude of effect for daytime, evenings and weekends and night time respectively. It is assumed that decommissioning activities will be equal to, or less than, construction activities.

Table 9.4-15 Predicted Onshore Noise Effects Associated with Decommissioning: Day time ($L_{Aeq,T}$)

Decommissioning Works	Distance of Noise Sensitive Receptor from Construction Noise Sources (m)				
	20	50	100	200	500
	76	67	60	54	45

Table 9.4-16 Predicted onshore noise effects associated with decommissioning: Evenings and weekends ($L_{Aeq,T}$)

Decommissioning Works	Distance of Noise Sensitive Receptor from Construction Noise Sources (m)				
	20	50	100	200	500
	76	67	60	54	45

Table 9.4-17 Predicted Onshore Noise Effects Associated with Decommissioning: Night Time ($L_{Aeq,T}$)

Decommissioning Works	Distance of Noise Sensitive Receptor from Construction Noise Sources (m)				
	20	50	100	200	500
	76	67	60	54	45

9.4.5.14 From the results presented above, unmitigated noise levels from decommissioning works occurring during day time core hours (as defined in Table 9.4-3 above) are considered to be significant at dwellings within 20 m of the works. At 50 m and beyond, predicted noise levels from the works are not considered to be significant.

9.4.5.15 During evenings and weekends, unmitigated noise levels at dwellings within 100 m of the works are considered to be significant. At night, this separation distance increases to 200 m.

9.4.5.16 Again, it is clear that noise break out from decommissioning activities also has the potential to cause disturbance.

9.4.5.17 Appropriate measures for mitigating construction noise is discussed in 9.4.6 of this chapter, in so far as is reasonably practicable to minimize the potential for significant impacts at sensitive dwellings along the cabling route and in the vicinity of the substation(s).

9.4.6 *Proposed Monitoring and Mitigation*

Mitigation of Construction and Decommissioning Noise Effects

9.4.6.1 Best Practicable Means (BPM), are measures taken to mitigate the effects of noise generated by essential works programmes. The legal definition of BPM as set out in the Control of Pollution Act (1974) incorporates two essential components:

- Practicable: this is defined as reasonably practicable, having regard, among other things, to local conditions and circumstances, the current state of technical knowledge and to financial implications; and
- Means: these are the means to be employed including the design, installation, maintenance, manner and periods of operation of plant and machinery, and the design, construction and maintenance of buildings and acoustic structures.

9.4.6.2 In practical terms, BPM attempts to strike a manageable balance between the operational imperatives of the contract works proceeding unhindered and the need to employ reasonable care to mitigate the environmental effects (in this case from noise) arising from the works in order to protect the interests of those in the immediate vicinity.

9.4.6.3 Paragraphs 9.4.6.4 to 9.4.6.8 below consider overarching means of mitigating noise from the construction works in order to limit the scale of any effects experienced at the closest identified noise sensitive receptors.

9.4.6.4 Without prejudice to any other requirements of the Project (e.g. Health and Safety considerations), the Contractor will comply with the following mitigation measures at all work locations.

Management of Programme of Works

- Deliveries should be programmed to arrive during daytime hours only;
- Care should be taken when unloading vehicles to minimise noise;
- Delivery vehicles should be routed so as to minimise disturbance to local residents;
- Delivery vehicles should be prohibited from waiting within or close to the site with their engines running, where possible; and
- Audible reverse alarms should not be used near to residential areas outwith normal working hours, except where this has been approved by the Local Authority or where required for over-riding safety purposes.

Working Methods

- Care should be taken when erecting or striking scaffolds to minimise effect noise from banging steel. All operatives undertaking such activities should be instructed on the importance of handling the scaffolds to reduce noise to a minimum;
- Plant which is known to emit noise strongly in one direction should be orientated in such a way that noise is directed away from noise-sensitive areas;
- Acoustic covers to engines must be kept closed when engines are in use and idling;

- Plant and equipment should be inspected on a daily basis for defects prior to the start of works and under no circumstances should defective plant be used;
- Shouting and raised voices should be kept to a minimum; and
- Radios (other than two-way radios used for communications relating to the works) and other forms of audio equipment with loudspeakers should not be operated on any work site.

Plant and Equipment

- Modern, silenced and well maintained plant fitted with effective attenuators, mufflers or acoustic covers, where appropriate, should be used wherever practicable;
- Any compressors or generators brought on to site should be silenced or sound reduced models fitted with acoustic enclosures;
- All pneumatic tools should be fitted with silencers or mufflers;
- All plant items should be properly maintained and operated according to manufacturers' recommendations in such a manner as to avoid causing excessive noise;
- All plant should be sited so that the noise effect at nearby properties is minimized;
- Semi-static plant should be sited and oriented as far as is reasonably practicable away from occupied buildings; localised screening should be considered where necessary;
- Noisy plant or processes should be replaced with less noisy alternatives;
- Machines should be shut-down or throttled-back to a minimum when not in use; machines shall not be left running unnecessarily;
- Engine compartments should be closed when equipment is in use; and
- There should be a general presumption towards the screening / enclosure of mobile and fixed plant as a simple and effective means of containing the noise at source, where required.

Training for Contractors

9.4.6.5 The following should be implemented to ensure that sufficient training and information is provided to appropriate personnel:

- Toolbox talks to raise awareness of unnecessary nuisance, including noise, should be delivered to appropriate personnel;
- Operatives should be trained to employ appropriate techniques to keep site noise to a minimum, and should be effectively supervised to ensure that BPM is implemented. All employees should be advised regularly of the following, as part of their training:
  - The proper use and maintenance of tools and equipment;
  - The positioning of machinery on site to reduce the emission of noise to the neighbourhood and to site personnel;
  - The avoidance of unnecessary noise when carrying out manual operations and when operating plant and equipment;

- The protection of persons against noise; and
- Special attention should be given to the use and maintenance of sound-reduction equipment fitted to power tools and machines.

Public Relations

9.4.6.6 Where works are proposed in the vicinity of noise sensitive locations, it is good practice to inform residents in advance of the works commencing. This notice should include the likely dates and times of the works to be carried out, a brief description of the works and contact details for a nominated individual who will deal with any noise complaints quickly and effectively.

9.4.6.7 The Local Authority will also be kept informed of intentions and progress as complaints are often channelled through them as a first port of call.

Working Hours

9.4.6.8 The Department of Environmental Health (DEH) at Aberdeenshire Council's core working hours, as shown in Table 9.4-18 below, will be adhered to.

Table 9.4-18 Aberdeenshire Council Standard Hours for Construction

Monday to Friday	0700 to 1900 h
Saturday	0700 to 1200 h
Sundays and Bank Holidays	No noisy equipment should operate

Residual Effects

9.4.6.9 Providing the CEMP is enforced by the appointed Contractor throughout the construction and decommissioning period, the residual effect at all noise sensitive receptors is predicted to be **moderate adverse** where works are occurring in close proximity to dwellings and **minor adverse or negligible** when occurring at more distant locations. Overall, **no significant effects** are anticipated.

9.4.6.10 During more sensitive evening and weekend core periods (as defined in Table 9.4-3 above) and especially if works are to occur at night, separation distances between dwellings and noise sources should be maximised to reduce the likelihood of significant impacts occurring.

9.4.7 References

British Standard (BS) 5228 (2009) Code of practice for noise and vibration control on construction and open sites. Part 1: Noise.

Control of Pollution Act (1974).

Department of the Environment Advisory Leaflet (AL) 72: Noise control on Building Sites.

The Institute of Acoustics/Institute of Environmental Management Assessment Working Party: Draft Guidelines for Environmental Noise Impact Assessment.

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