CHAPTER 8: WATER AND SEDIMENT QUALITY

Technical Summary

Survey data, from locations across the Firth of Forth Zone and the export cable route corridor, and information from desk based reviews have been used to inform the assessment of the impacts on water and sediment quality. Arsenic was the only contaminant found at high levels in sediments, however this metal is known to be present naturally in Firth of Forth sediments. The survey data showed an increase in background suspended sediments in the water column coincides with storm events.

During construction of Project Alpha and Project Bravo the impacts associated with the deterioration of water quality due to re-suspension of sediments or contaminants are assessed to be not significant. Sediment re-suspension will be constrained to the immediate area of disturbance and will quickly settle back to normal levels. Impacts during the export cable installation works in proximity to sensitive receptors at the shoreline are also predicted to be not significant.

The greatest impacts on water quality could occur during construction as a result of potential pollution from vessels and construction activities and from the introduction of non-native or alien marine species by construction vessels. Seagreen commits to preparation, planning and management of the construction and operation of the development and these impacts are therefore predicted to be not significant. Overall, no impacts are assessed to be significant in EIA terms and no cumulative impacts are anticipated with other projects.

INTRODUCTION

8.1. This chapter of the Environmental Statement (ES) describes the potential impact on water and sediment quality of the Seagreen Project, which includes the Project Alpha and Project Bravo sites as well as the Transmission Asset Project which connects the sites to the land at Carnoustie, off the east coast of Scotland. It discusses water and sediment quality, sediment size distribution, contamination levels and bathing and shellfish water quality.

8.2. This chapter provides a baseline description of these parameters followed by an assessment of the significance of the potential impacts resulting from the construction, operation and decommissioning of the Seagreen Project, as well as those resulting from cumulative interactions with other relevant existing or planned projects. Also provided are considerations with regard to potential mitigation measures and outline monitoring plans, where these are deemed appropriate.

8.3. This chapter of the ES was produced by Royal Haskoning and in addition to using existing available data the analysis utilises data collected by FugroGEOS (2011) and the Institute of Estuarine and Coastal Studies (IECS) (2011), as part of the survey data collection campaign to inform the Environmental Impact Assessment (EIA) for the Seagreen Project.

8.4. All figures can be found in ES Volume II: Figures. This chapter is supported by Appendices E2 and G1. Appendices can be found in ES Volume III: Appendices.

CONSULTATION

8.5. As part of on-going consultation, stakeholders have provided comment on the issues relating to water and sediment quality through review of Seagreen's Phase 1 Scoping Report produced as part of the EIA process (Seagreen, 2010).

8.6. Table 8.1 summarises the key issues of relevance to water and sediment quality that were highlighted by the consultees as being necessary to assess within the EIA, and indicates which sections of this chapter address each issue.

Table 8.1 Summary of consultation and issues

Date	Consultee	Issue	Relevant chapter or chapter paragraph
Jan 2011	Scottish Environment Protection Agency (SEPA)	Consult with SEPA (at an early stage) as the regulatory body responsible for the implementation of the Controlled Activities Regulations (CAR), to identify 1) if a CAR license is necessary and 2) clarify the extent of the information required by SEPA to fully assess any license application.	CAR license applications (if required) will be undertaken post marine license and S36 consent. Not considered in ES
Jan 2011	SEPA	Footprint information for the cable corridor and transition pit should be provided in the ES, to allow the River Basin Management Plan (RBMP) classification to be updated and the assessment of cumulative impacts within the Diel's Heid to Carnoustie, and Scurdie Ness to Diel's Heid water bodies.	Figure 8.2
Jan 2011	SEPA	Marine and transitional Special Areas of Conservation (SAC) and Special Protected Areas (SPA) are Water Framework Directive (WFD) Protected Areas. Therefore, their objectives are also RBMP objectives.	Chapter 9
Jan 2011	SEPA	Sensitive water uses, such as bathing waters and shellfish growing waters, and associated potential impacts should be assessed. The proximity to existing discharges and designated areas (i.e. estuarine abstractions and cooling water discharges), should also be assessed.	Paragraphs 8.121 – 8.255
Jan 2011	Association of Salmon Fishery Boards (ASFB)	Direct effects on fish of water quality changes through suspension of sediment in the water column disturbed during construction.	Chapter 12
Jan 2011	ASFB	Indirect effects of water quality changes through effects on food sources available to salmon and sea trout.	Chapter 12

8.7. Consultation was also carried out with Marine Scotland during the preparation of the Benthic Survey Technical Specifications to determine the requirement for survey work and associated sample analysis, including the physical characteristics of the sample sites, and the chemical properties of sediments sampled.

LEGISLATION

8.8. The Water Framework Directive (WFD) (Directive 2000/ 60/ EC 'establishing a framework for Community action in the field of water policy') was designed to produce an integrated approach to the protection, improvement and sustainable use of Europe's water bodies, which requires surface water bodies, such as lakes, streams, rivers, estuaries, and coastal waters, and groundwater bodies to be ecologically sound (i.e. achieving Good Ecological Status) by 2015.

8.9. In 2003, the WFD was transposed into Scottish law by the Water Environment and Water Services (Scotland) Act 2003 (WEWS Act). The Act created a new River Basin Management Planning (RBMP) process to achieve environmental improvements to protect and improve the water environment in a sustainable way. In addition it provides a framework of regulations designed to control any activities likely to have an impact on the water environment.

8.10. Under the WEWS Act, Scottish Ministers introduced requirements for SEPA to establish a register of protected areas. This was taken forward in 2004. The register presents information on the following types of protected areas as designated by Scottish Ministers.

- shellfish waters;
- freshwater fish waters;
- bathing waters;
- drinking water protected areas;
- nutrient sensitive areas such as Nitrate Vulnerable Zones (NVZs) and Urban Waste Water Treatment (UWWT) sites; and
- nature conservation sites for the protection of habitats and birds.

8.11. The Water Environment (Controlled Activities) (Scotland) Regulations 2011 (commonly known as CAR), were introduced under the WEWS Act. In Scotland, SEPA regulates activities which impact on the water environment, including activities such as discharges to groundwater, discharges to surface water, abstractions and removal of sediments. Under the WFD, water quality is monitored out to three nautical miles (nm) in coastal waters.

8.12. SEPA has introduced new water body monitoring and classification system that will provide data to support the aim of the WFD that all water bodies are of good ecological status, or similar status, by 2015. The new classification system covers all rivers, lochs, transitional, coastal and groundwater bodies, and is based on a new ecological classification system with five quality classes. It has been devised following EU and UK guidance (SEPA 2011a) and is underpinned by a range of biological quality elements, supported by measurements of chemistry, hydrology (changes to levels and flows) and morphology (changes to the shape and function of water bodies). These are designed to protect the environment and human health, while targeting those areas that need improvement.

8.13. The 'Priority Substances' Directive 2008/105/EC (PSD) is a 'daughter' Directive of the WFD which sets out a European 'priority list' of substances posing a threat to the aquatic environment, including ubiquitous persistent, bio accumulative and toxic substances. The PSD establishes Environmental Quality Standards for Priority Substances, which have been set at levels of concentration which are safe for the aquatic environment and for human health. As part of the WFD, the list of priority substances is reviewed every 4 years by the European Commission. A review is currently underway and it is expected that there will be further substances added to the current list of 33 priority substances (and groups of substances), when (or if) a new Directive is agreed.

8.14. The Fresh Water Fish Directive (78/659/EEC) on the quality of fresh waters needing protection or improvement in order to support fish life was adopted in 1978. The purpose of the directive is to protect or improve the quality of running or standing fresh waters which support or which, if pollution were reduced or eliminated, would become capable of supporting fish life.

8.15. Directive 78/ 659/ EEC prescribes Imperative (I) chemical and physical standards which must be met by designated fresh waters, and Guideline (G) values which member states must endeavour to observe.

8.16. The EC Shellfish Waters Directive (2006/ 113/ EEC 'on the quality required of shellfish waters') protects or improves shellfish waters in order to support shellfish life and growth, therefore contributing to the high quality of shellfish products for human consumption. It sets physical, chemical and microbiological water quality requirements that designated shellfish waters must either comply with ('mandatory' standards) or endeavour to meet ('guideline' standards). The directive is designed to protect the aquatic habitat of bivalve and gastropod molluscs, including oysters, mussels, cockles, scallops and clams. It does not cover shellfish crustaceans such as crabs, crayfish and lobsters. The directive will be repealed in 2013 by the EC Water Framework Directive, which will provide at least the same level of protection to shellfish waters (which the WFD classifies as protected areas).

8.17. Bathing water quality is assessed by the standards listed in the Revised Bathing Waters Directive (2006/ 7/ EC), which is implemented through the Bathing Waters Regulations 2008. The Bathing Waters Directive sets a number of microbiological and physicochemical standards that bathing waters must either comply with ('mandatory' standards) or endeavour to meet ('guideline' standards). The revised Directive introduces much tougher standards, but based on only two parameters – the water based pathogens, intestinal enterococci and Escherichia coliforms (E. Coli) - rather than the many measured before under the original Bating Waters Directive. It puts in place three new compliance categories - excellent, good (broadly equivalent to the existing guideline standard) and sufficient, as well as poor. The Scottish Government will be required to ensure that all bathing waters are of sufficient standard by 2015 and that appropriate measures are taken to increase the numbers classified as excellent or good. Classification will be based on four years' worth of data.

8.18. The WFD EQS have also been guided by legislation set out within the Convention for the Protection of the Marine Environment in the North East Atlantic of 1992 (further to earlier versions of 1972 and 1974), known as the Oslo and Paris Convention (OSPAR). This includes the consideration of non-native (alien) invasive species.

8.19. The EC Directives discussed above have been implemented through a range of Regulations in Scotland. SEPA is the competent authority for most of these but the actions and policies of other regulators are required to ensure Scotland, and the UK as member state complies with the requirements of the Directives. Along with the WEWS Act, the key Scottish regulations which implement the directives include:

- The Water Environment (Groundwater and Priority Substances) (Scotland) Regulations 2009;
- Surface Waters (Fish life) (Classification) (Scotland) Regulations 1997;
- Surface Waters (Shellfish) (Classification) (Scotland) Regulations 19971; and
- Water Environment (Controlled Activities) (Scotland) Regulations 2005.

ASSESSMENT METHODOLOGY

Study Area

8.20. Water and sediment quality is considered over two spatial scales:

- Immediate Study Area (ISA) – the Seagreen Project area that lies within the marine environment, including the ECR corridor. The ISA also includes the area between Project Alpha and the western boundary of the Zone, where further survey work was conducted prior to the final delineation of Project Alpha and Project Bravo; and
- Regional Study Area (RSA) – the Outer Forth and Tay coastal area surrounding the Seagreen Project site, over which remote impacts may occur and interact with other activities.

8.21. In the description of the existing environment, the ISA is divided into Project Alpha (west) and Project Bravo (east), along with the ECR corridor (Figure 8.1).

Data Collection and Survey

8.22. In order to inform the EIA process, metocean data (FugroGEOS, 2011) and sediment sample data (FugroGEOS, 2011 and IECS, 2011) were collected across the ISA. Subsequent further inshore metocean data collection was also undertaken (Partrac, 2012). A summary of the data that has been used to inform this chapter is discussed in the following paragraphs. See Figure 8.1 for sample and monitoring locations.

Physical characteristics of the water column

8.23. On behalf of the Applicants, FugroGEOS Ltd. undertook a programme of oceanographic measurements across the ISA between 13th December, 2010 and 7th June, 2011. The results are reported in FugroGEOS (2011). A summary of the resulting data produced by Intertek Metoc (2012) is provided in Appendix E2.

8.24. A total of eight moorings (A-H) were deployed throughout the ISA (Figure 8.1) to measure a variety of parameters; turbidity and seawater properties (temperature and salinity), water levels, wave height, wave period, wave direction, tidal current velocity at depths through the water column.

8.25. Partrac Ltd. completed a further oceanographic survey with data collected between 15th December, 2011 and 18th June, 2012. The survey captured data on turbidity and seawater properties (temperature), along with water levels, wave height, wave period, wave direction and tidal current velocity at depths through the water column. The survey report (Partrac, 2012) is provided in Appendix E2.

8.26. The time series of metocean parameters collected to inform this ES is listed in Table 8.2. The following terms are used within the table to describe the instrumentation used;

- ADCP (Acoustic Doppler Current Profiler) is an instrument that accurately measures current speed and direction throughout the water column.
- AWAC (Acoustic Wave and Current Meter) is a floating instrument that measures both the wave environment along with the current speed and direction within the water column;
- DWR (Directional Wave Rider) is a floating instrument which accurately records the wave environment including wave height, periodicity, wave length and direction, and,
- OBS (Optical Back Scatter) is an instrument which measures the turbidity of the water adjacent to the device. It is possible using water sampling calibration to calculate suspended sediment levels.

Table 8.2 Metocean data available from instrument deployments

Site	Deployment Date	Parameters (Instrumentation)	Comments
A	13 December 2010 – 5 June 2011	Wave/ Current/ Water level / Temperature/ Turbidity / Salinity (AWAC plus 14 day ADCP)	No data recovered in Dec 201 and Jan 2011, so AWAC redeployed and successful data recovery achieved over 10 weeks from March to June 2011. Near-bed ADCP deployed for 14 days in March 2011 to provide near bed current data
B	25 March to 6 June 2011	Current/ Water Level / Temperature/ Salinity (ADCP)	10 weeks of successful data recovery
C	24 March – 6 June 2011	Current/ Water Level / Temperature/ Salinity (ADCP)	10 weeks of successful data recovery
	12 December 2010 – 15 May 2012	Wave (DWR)	Directional wave rider buoy serviced and redeployed 4th August 2011
D	26 March – 6 June 2011	Current/ Water Level / Temperature/ Salinity (ADCP)	10 weeks of successful data recovery
E	18 January – 5 June 2011	Wave/ Current/ Water level / Temperature/ Turbidity / Salinity (AWAC)	No data recovered in Jan 2011, so AWAC redeployed and successful data recovery achieved over 10 weeks from March to June 2011.
	15 December 2011 – 18 June 2012	Wave/ Current/ Water level / Temperature/ Turbidity (OBS)	21 weeks of successful data recovery. No AWAC data obtained between 5th May and 18th June 2012
F	18 January – 7 June	Wave/ Current/ Water level / Temperature/ Turbidity / Salinity (AWAC)	No data recovered in Jan 2011, so AWAC redeployed and successful data recovery achieved over 10 weeks from March to June 2011
	15 December 2011 to 18 June 2012	Wave/ Current/ Water level/ Temperature / Turbidity (AWAC and OBS)	27 weeks of successful data recovery.
G	24 March – 6 June 2011	Current/ Water Level/ Temperature/ Salinity (ADCP)	10 weeks of successful data recovery
H	24 March – 6 June 2011	Wave/ Current/ Water level / Temperature/ Turbidity / Salinity (AWAC)	No data recovered in Dec 2010 and Jan 2011, so AWAC redeployed and successful data recovery achieved over 10 weeks from March to June 2011

Seabed sediments

8.27. A geophysical survey including swathe bathymetry, side scan sonar and sub-bottom profiling was undertaken across the ISA including the ECR corridor between 2010 and 2011 (see Gems, 2010 and Osiris, 2011, Appendix E2). The survey included provision of:

- a classification of the seabed sediments for the refinement of a detailed benthic survey;
- information on the shallow geology of the study area and to map any variations in thickness and mobile sediment cover – in particular the height, length and slopes of sandwaves;
- re-interpretation of gathered bathymetry data to determine seabed habitat types and locate biogenic features by means of Acoustic Ground Discrimination System (AGDS); and
- seabed stratigraphic sections summarising the range of inferred ground conditions for preliminary substructure/ foundation design.

Sediment sampling

8.28. IECS undertook a programme of benthic survey work in the Zone between February 2011 and April 2011, and the subsequent sample analysis was completed by August 2011. The results are reported in IECS (2011, Appendix G1) and sample locations presented in Figure 8.1.

8.29. The benthic survey covered 150 benthic sampling sites (with 100 prioritised for analysis) and 50 video and epibenthic trawl sites, all within the ISA (not including the ECR between the Zone and the coast), in addition to two potential meteorological mast sites. In addition, a further 13 grab stations, 12 video trawls, 3 benthic trawls and 5 contaminant grabs were taken along the ECR corridor. Figure 8.1 presents the locations of the benthic survey locations in relation to the Zone. A full description of the sampling methods and post survey analysis is provided in Chapter 11: Benthic and Intertidal Ecology and Appendix G1 of this ES.

8.30. A mini Hamon grab was deployed to collect each sample for infaunal analysis, with a Particle Size Analysis (PSA) sample also taken from each grab. A second grab was collected for contaminant analysis at 50 stations, 25 of which were prioritised and analysed. Five samples were collected for contaminant analysis from the ECR corridor.

8.31. The prioritised subset of 25 samples were analysed to assess presence of the following contaminants:

- arsenic;
- cadmium;
- copper;
- lead;
- mercury;
- nickel;
- zinc;
- polychlorinated biphenyls (PCBs);
- polycyclic aromatic hydrocarbons (PAHs); and,
- organotins.

8.32. Full details of the sampling campaign and the subsequent analyses are reported in IECS (2011) in Appendix G1.

8.33. Table 8.3 presents project specific survey data and reports as discussed above. The sampling strategy was designed to provide data for the ISA, where data was particularly sparse, and to rely on existing reports and monitoring data within the nearshore areas.

Table 8.3 Summary of key survey data

Title	Source	Year	Reference
Firth of Forth Offshore Wind Farm Export Cable Route: Geophysical Survey	Osiris Projects	2011	Osiris, 2011 (Appendix E2)
Firth of Forth Survey Report: Benthic	IECS	2011	IECS, 2011 (Appendix G1)
Firth of Forth Development – Metocean study	FugroGEOS	2011	FugroGEOS, 2011 (Summarised in Appendix E2)
Geophysical Results Report Phase 1	Gems	2010	Gems, 2010 (Appendix E2)
(Winter metocean survey Phase 1 Final Report 15th December 2011 – 19th June 2012.	Partrac	2012	Partrac, 2012 (Appendix E2)

8.34. In addition to these project-specific surveys, other data and literature was obtained, reviewed and in some cases further interpreted (e.g. bathing and shellfish water and sediment quality data from SEPA) to add value to the baseline understanding (see Table 8.4).

Table 8.4 Summary of key reports

Title	Reference	Year
RBMP Website and Factsheets	SEPA 2001b	2011
Bathing water quality data 1988 to 2011	SEPA 2011c	2011
Freshwater Fish Directive status	SEPA 2011d	2011
Shellfish water quality data	SEPA 2011e	2011

Approach to assessment

8.35. The assessment of impacts within this chapter follows the methodology set out in Chapter 6: EIA Process. For the assessment of water quality, the description of the baseline environment is based on the standards outlined in the WFD and Bathing Waters Directive.

The context of the contaminants found within the sediments of the Seagreen Project area in terms of implications for water and sediment quality are established through the use of recognised standards and action levels. There are no defined standards in the UK for sediments; therefore, the Canadian / United States (US) approach has been used to help inform this assessment (Cole et al, 1999; CMACS, 2010). This is in line with the approach taken on previous assessments for UK offshore wind farms. This approach involves the derivation of Interim Marine Sediment Quality Guidelines (ISQGs) and Probable Effect Levels (PEL) (see Table 8.5) from an extensive database containing direct measurements of toxicity of contaminated sediments to a range of aquatic organisms exposed in laboratory tests and under field conditions (Cole et al, 1999).

Table 8.5 Interim Sediment Quality Guidelines (ISQG) and Probable Effect Levels (PEL)*

Contaminant	ISQG	PEL
Arsenic	7.24	41.6
Cadmium	0.7	4.2
Copper	18.7	108
Lead	30.2	112
Mercury	0.13	0.7
Nickel	n/ a	n/ a
Zinc	124	271

Source: CMACS, 2010: *values given in µg/ g dry weight (from Cole et al., 1999.)

8.36. Another assessment tool that has been used for determining sediment quality is the Centre for Environment, Fisheries & Aquaculture Science (CEFAS) Action Levels (see Table 8.6). Action levels are derived from a combination of chemical and eco-toxicological data sets to establish a range of contaminant concentrations suitable for sea disposal. Action levels are currently used to assess the chemical quality of the dredged material that is proposed to be disposed at sea, and their use in this assessment has been suggested through consultation with Marine Scotland (see Table 8.1).

8.37. CEFAS Action Levels were derived to facilitate management decisions regarding the fate of dredged material within typical coastal/ estuarine environments, characterised by high levels of anthropogenic activity and possible contamination. They are useful guidance to supplement the parameters for assessment defined by Cole et al., (1999). The action levels do not constitute simple pass or fail criteria, as they are used as part of a weight of evidence approach to decision-making on the disposal of dredged material to sea. The action levels form the following three management decision making responses:

- below Action Level 1 contaminants in the dredged material are generally of no concern and are unlikely to influence the licensing decision about sea disposal. For example, Action Level 1 acts as a nominal background concentration for metals and a primary anthropogenic impact detection concentration for tributyltin (TBT);
- between Action Levels 1 and 2 contaminants in the dredged material require further consideration and testing before a decision can be made about sea disposal; and
- above Action Level 2 contaminants in the dredged material are generally considered unsuitable for sea disposal. This situation most often applies only to a part of a proposed dredging area and this may result in part of the proposed dredging area being excluded from disposal at sea and requiring disposal of dredged material by other routes (e.g. landfill).

8.38. The potential for release and dispersion of contaminated sediments has been informed by an assessment of scour potential for Project Alpha and Project Bravo substructure/ foundation options ((Royal Haskoning, 2012) provided in Appendix E4). The assessment describes the potential interaction of Project Alpha and Project Bravo on wave, tidal and sediment regimes, and establishes volumes of sediments released during construction and operation phases of the Seagreen Project, followed by a prediction of their subsequent dispersion and settlement. Further details on scour and its potential effects on the physical environment are presented in Chapter 7: Physical Environment of this ES.

Table 8.6 CEFAS Action Levels (µg/g)

Contaminant	Action Level 1	Action Level 2
Arsenic	20	100
Cadmium	0.4	5
Copper	40	400
Lead	50	500
Mercury	0.3	3
Nickel	20	200
Zinc	130	800
Organotins (i.e. TBT)	0.1	1
PCB's (ICES[1] 7)	0.01	None

8.39. The assessment of potential impacts on the water and sediment environment of construction, operation and decommissioning of the Seagreen Project is largely based on existing information supplemented by sediment quality and metocean data acquired during this EIA process.

1 International Council for the Exploration of the Sea Rectangle 7 is the area of sea within with the Transmission Asset falls.

8.40. The definition of magnitude of potential impacts follows that set out in Table 8.7.

Table 8.7 Definition of terms relating to the magnitude of change upon water and sediment quality receptors

Magnitude	Definition
High	Fundamental, permanent / irreversible changes, over the majority (>50%) of the feature / asset, and / or fundamental alteration to key characteristics or features of the particular environmental asset's character or distinctiveness. Impact certain or likely to occur.
Medium	Considerable, permanent / irreversible changes, over a significant proportion (>10%) of the feature / asset, and / or discernible alteration to key characteristics or features of the particular environmental aspect's character or distinctiveness. Impact certain or likely to occur.
Low	Discernible, temporary (throughout project duration) change, over a minority (<10%) of the feature / asset, and / or limited but discernible alteration to key characteristics or features of the particular environmental aspect's character or distinctiveness. Impact will possibly occur.
Negligible	Discernible, temporary (for part of the project duration) change, or barely discernible change for any length of time, over a small area (<1%) of the feature or asset, and/ or slight alteration to key characteristics or features of the particular environmental aspect's character or distinctiveness. Impact unlikely or rarely to occur.
No change	No loss of extent or alteration to characteristics, features or elements.

8.41. The sensitivity/ value of the receptor for each impact is characterised as one of four levels; high, medium, low or negligible. The definition of each level is given below in Table 8.8.

Table 8.8 Definition of terms relating to the sensitivity of water and sediment quality receptors

Receptor sensitivity / value	Definitions
High	Water body or sites dependant on water body, designated under international or national legislation (e.g. Ramsar Sites, SPA, SAC, SSSI). Water body or sites dependant on water body, containing Habitats Directive Annex 1 water dependant habitats, or sites supporting populations of international important water dependant species. Water body with excellent water quality. Water body of significant recreational or amenity value.
Medium	Water body with good water quality. Water body of moderate recreational or amenity value.
Low	Locally designated sites of varied quality Water body of low recreational or amenity value.
Negligible	Undesignated sites of varied quality Seriously polluted water system. Water body of no recreational or amenity value.

8.42. Table 8.9 combines the descriptions of magnitude with the level of sensitivity/ value/ importance of the receptor to provide a prediction of overall significance of the impact. Impacts classed as moderate or major significance on Table 8.9 are considered significant within an EIA context.

Table 8.9 Significance prediction matrix

Value / Sensitivity	Magnitude			
	High	Medium	Low	Negligible
High	Major	Major	Moderate	Minor
Medium	Major	Moderate	Minor	Negligible
Low	Moderate	Minor	Negligible	Negligible
Negligible	Minor	Negligible	Negligible	Negligible

EXISTING ENVIRONMENT

8.43. The existing environment for Project Alpha, Project Bravo and the Offshore Transmission Asset is described in the following paragraphs. For the purposes of water and sediment quality the Project Alpha and Project Bravo sites are considered as offshore. While the Offshore Transmission Asset area has elements which are offshore (including a small portion within the Project Alpha and Project Bravo sites), the primary impacts are associated with the nearshore environment.

8.44. The approach adopted towards the reporting of the assessment for Project Alpha and Project Bravo is to provide detailed baseline information for Project Alpha. In the main, it is expected that the Project Bravo baseline will be covered by the same information, given the proximity to Project Alpha. There may be differences spatially, however, that need to be described and therefore, for Project Bravo, only the differences from Project Alpha are stated.

Project Alpha

Water Quality

8.45. FugroGEOS Ltd (2011) reported on their metocean campaign during which seawater temperature and salinity variations were recorded at five sites. Site A was located 2.9 km west of Project Alpha, with Site B 0.5 km east of Project Alpha. Metocean Sites C, D, G and H were located in the southern half of the Zone, with Site E located close to the proposed Offshore Transmission Asset route, and Site F located south west of the Zone (see Figure 8.1).

8.46. Seawater temperatures were low throughout the deployment period (December 2010 to June 2011) with a maximum of 9.6°C recorded at Site B. Minimum seawater temperature was 5.25°C recorded at Site D. Measurements taken show that seawater temperatures were predominantly uniform with depth at the eight sites sampled. The mean water temperature was typically 6.7 to 7.6°C at six of the monitored locations (A, B, C, D, G and H) with a mean temperature of 5.5°C at Site E and 5.7°C at Site F (the latter two being near shore locations).

8.47. Salinity values remained consistent in all deployment locations with a maximum observed value of 34.9 practical salinity units (PSU) recorded at Site B on 1 April 2011, and a minimum observed value of 34.1 PSU recorded at Site D on 6 June 2011. Measurements show salinity values typically vary in the range between 34.7 and 33.4 PSU at all sites over the monitored timeframe.

8.48. Total Suspended Solids (TSS) was measured at four locations as part of the Zone wide metocean data collection (see Chapter 7: Physical Environment and Appendix E2 of this ES). TSS include all particles suspended in water and can include a wide variety of material, such as silt, decaying plant and animal matter, industrial wastes and sewage. TSS monitoring was undertaken for a period of 120 minutes (see Table 8.10) during each service check in March and June 2011.

8.49. Optical backscatter (OBS) turbidity data was collected by FugroGEOS at Sites A and E over the following timescales in the winter months of 2011:

- site A – OBS on a CTD probe recording internally, frame mounted at 0.1m above Seabed, deployment Dec2010 – June 2011;
- site A – OBS logged by the AWAC, deployed at 0.5m, deployment January 2011 – March 2011; and
- site E – OBS logged by the AWAC, deployed at 0.5m, deployment Jan2011 – Mar2011.

8.50. When compared against wave height and water level data for the same period, increases in turbidity levels at both Sites A (offshore) and E (nearshore) were correlated with both spring tides and periods of increased wave height (FugroGEOS Ltd (2011).

8.51. The extensive time series of data provided at site A was measured in Nephelometric Turbidity Units (NTU) (using a nephelometer, to measure how much light is scattered by suspended particles in the water) by optical means. Whilst giving a relatively accurate indication of changes in turbidity, without calibration using direct water samples the NTU data cannot be reliably converted to suspended sediment levels in milligrams per litre (mg/l).

8.52. Suspended Sediment Concentration (SSC) data were also recorded at Site E, from 15th December, 2011 to 1st March, 2012 (Partrac, 2012, provided in Appendix E2). The SSC data recorded over the deployment show a strong correlation to the wave climate with the highest SSC values (709 mg/l) coinciding with the storm events observed at the end of January whilst the mean value for all the data recorded at site E was 34 mg/l. The suspended sediment data from site F repeats this trend with a lower mean suspended sediment value of 9mg/l. Tidal variation is also seen to have an effect on suspended solids with a cyclical variation of approximately 5-10 mg/l during times of low wave heights.

8.53. Results from the water sampling carried out at the four metocean stations A, E, F and H during March and June 2011 show TSS to be low (Table 8.10). The majority of the samples were characterised by a TSS of <5mg/l with a maximum value recorded during March of 18mg/l (Site H, bottom, 30 and 90 minutes). As expected, the inshore Site E had generally higher TSS during March than the other sites; however, the results for samples collected in June showed no difference to other sites.

8.54. The results indicate that the temporal variation of TSS correlates with water depth (FugroGEOS, 2011); with the largest TSS values being recorded within close proximity to the seabed (see Table 8.10). This is to be expected, as near-bed tidal currents of sufficient velocity will mobilise fine sediments from the seabed, generating TSS increases within the water column.

Table 8.10 Total Suspended Solids (mg/l), March and June 2011.

Site	Time (m)	March					June				
		0	30	60	90	120	0	30	60	90	120
A	Top	10	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Middle	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Bottom	8	<5	5	<5	6	<5	<5	<5	<5	<5
E	Top	5	6	7	11	10	8	<5	<5	<5	<5
	Middle	6	8	10	10	11	<5	6	<5	<5	<5
	Bottom	11	10	11	10	11	<5	<5	<5	<5	<5
F	Top	7	6	7	<5	5	<5	<5	<5	<5	<5
	Middle	<5	5	<5	5	5	<5	<5	<5	6	<5
	Bottom	<5	5	5	5	<5	<5	<5	<5	<5	<5
H	Top	5	<5	<5	<5	<5	<5	<5	<5	<5	<5
	Middle	<5	<5	<5	10	<5	<5	<5	<5	<5	<5
	Bottom	6	18	<5	18	<5	6	<5	<5	<5	6

Seabed substrate

8.55. Over the course of four separate deployments between February and April 2011, IECS sampled at 150 benthic sites within the ISA and at two potential meteorological mast locations (see Figure 8.1). Of the sites, 49 were within the Project Alpha site, 39 were within the Project Bravo site, 17 were within that part of the ECR corridor within the Zone boundary. The remaining sampling locations were located within the ISA but outside the eventual Project Alpha and Project Bravo site boundaries.

8.56. As part of the metocean survey campaign further seabed sediments were retrieved for analysis at the metocean survey locations (see Figure 8.1). Sediments at Site E were classified as very fine sand, which could contribute to the higher TSS; however, this was not apparent in June 2011 when sediment samples collected were classified as coarse silt. Although all values are low, a slight increase in TSS is observed in March 2011. This distinction is more evident at Sites E and H and the variation in sediment monitored over the period indicates the spatial and temporal patterns of a relatively dynamic sedimentary environment.

8.57. Increases in suspended sediment concentrations can affect water quality and can mobilise contaminants that may be present in the sediments. HR Wallingford (2009) state *"there are limited details to define type, concentration and variability of suspended sediment offshore within the Firth of Forth region. The main sediment type available for suspension is likely to be the finer fractions (i.e. muds, silts and fine sand) which are easily transported within the water column, relative to coarse grained sediments"*.

8.58. Analysis of the geophysical datasets (see Chapter 7: Physical Environment of this ES) facilitated identification of seabed substrate and features including isolated boulders and sandbars, sandwaves and megaripples. Of these, megaripples are the predominant feature, with isolated sandwaves also present. Large boulders occur across both Project Alpha and Project Bravo sites individually and in clusters. All of these features are characteristic of various stages of sediment erosion and transportation, the most informative in terms of sediment transport direction and rates are megaripples as quantitative information can be derived from their geometry which can be directly related to near bed hydrodynamics.

8.59. Results from benthic sediment survey (see Chapter 11: Benthic Ecology and Intertidal Ecology of this ES) indicate that the predominant sediment types within the Project Alpha and Project Bravo sites are rippled medium to fine sand with varying amounts of coarse shell, and mixed mosaics of gravel, cobbles and coarse shell lying on or embedded within sand. The presence of gravel sediments are anticipated to derive from erosion of the Quaternary Formations present at the seabed.

8.60. According to IECS (2011) and GEMS (2011), the ISA was dominated by sandy sediments containing varying degrees of gravel (see Figure 7.7). Large boulders were occasionally recorded in sandy areas. The organic content of sediments collected was low, ranging from 0.20% to 2.49% with an average of 0.98%. Although sample density is low, the sample locations attain a good geographical spread across the ISA. Survey and data collection undertaken as part of the EIA works notes the predominant sediment type is coarse, typically sand and gravel (see Chapter 7: Physical Environment of this ES).

Sediment Quality

8.61. Marine and coastal sediment quality in general is affected by contaminants, which may enter the marine environment either directly from rivers, sewage effluent or industrial discharges or arrive on currents from sources further afield. Metals also occur naturally as a consequence of geological weathering processes and subsequent land run off. However, inputs are increased as a consequence of human activities.

8.62. Other contaminants, which also act to affect sediment quality in general, include man-made compounds such as pesticides and contaminants arising from the oil and gas industry. Harbours, marinas and busy waterways can also be contaminated with persistent organic contaminants such as tri-butyl tin (TBT) due to historic inputs. Contamination of marine sediments tends to be less prevalent within open and offshore marine environments, unless there are clearly established pathways for the transfer of contamination between nearshore contamination sources and offshore.

8.63. The location of the 25 grab stations sampled for contaminants, are shown in Figure 8.1. Sediment data for metal contaminants within the Project Alpha and Project Bravo sites are summarised in Table 8.11 which also highlights any failures of the sediment quality parameters as defined by Cole et al. (1999) utilised by CMACS (2010) within their contamination comparison analysis as explained in Table 8.11.

8.64. Arsenic was the only metal contaminant to be found at elevated levels during the benthic surveys. Arsenic was present at levels in excess of the 7.24µg/ g ISQG standard, in all but one of the samples. No samples contained levels in excess of the CEFAS Action Level 1 standards. This pattern of elevated arsenic in Firth of Forth sediment is consistent with results of sediment analysis work undertaken by Marine Scotland in 2005 (Hayes et al., 2005).

8.65. Arsenic levels within the Seagreen Project area may be attributable to a history of arsenic contaminated waste disposal or more likely naturally occurring arsenic present in sediment arising from estuaries, geological inputs and seabed rock weathering. The exact mechanism is not known, however, there are known to be elevated quantities of arsenic in the local geology, for example at Burntisland, Fife (SEPA 2011b), which may contribute to the raised levels within the Seagreen Project area observed.

8.66. For all other metals the levels found were below the CEFAS Action Level 1 standards and therefore are not considered to be of concern.

Table 8.11 Results of sediment analysis (µg/g), ISA, for metal contamination (highlighted cells correspond to levels above the ISQG levels – see Table 8.5)

Contaminant			Arsenic	Cadmium	Copper	Lead	Mercury	Nickel	Zinc
Contaminant Sample Point	85	Alpha	7.76	<0.02	3.07	4.58	<0.14	4.35	13.8
	138	Alpha	11.8	<0.02	<1.4	4.69	<0.14	4.71	12.5
	79	Alpha	8.37	<0.02	<1.4	3.65	<0.14	2.71	8.51
	77	Alpha	17.1	<0.02	11.5	9.59	<0.14	9.99	49.1
	67	Alpha	18.3	<0.02	<1.4	7.5	<0.14	4.58	14.6
	64	Alpha	18.4	<0.02	<1.4	7.31	<0.14	7.73	13
	59	Alpha	11.4	<0.02	8.7	12	<0.14	14.7	25.3
	48	Alpha	5.48	<0.02	<1.4	4.61	<0.14	3.29	12
	129	Bravo	8.35	<0.02	<1.4	5.25	<0.14	2.29	10.1
	81	Bravo	12.9	<0.02	1.86	4.78	<0.14	2.91	11.6
	124	Bravo	11.2	<0.02	<1.4	4.17	<0.14	1.46	8.61
	101	Bravo	9.37	<0.02	1.7	8.27	<0.14	3.13	13.8

8.67. Table 8.12 provides the results of the hydrocarbon contaminant analysis for the same grab sample sediments. PAH concentrations were below detectable levels throughout (<118 µg/g). Petroleum hydrocarbons were not found within sediment samples. TBT concentrations were below detectable levels throughout all samples.

8.68. Sediment PCB concentrations were below detectable levels (<3µg/g). In the aquatic environment, PCBs are usually found in much higher concentrations in sediments than in the overlying water as they have a high affinity for suspended solids which settle and become consolidated within the seabed sediments. There is no evidence to suggest that the sediments within the Seagreen Project area contain concentrations of PCB that would be of concern.

Table 8.12 Results of sediment analysis for hydrocarbon contamination

Determinant			Total Poly Aromatic Hydrocarbons (ng/g)	Total Petroleum Hydrocarbons (µg/g)	TBT (µg/g)	Total PCB ICES 7 (µg/g)
Contaminant Sample Point	138	Alpha	<118	N/A	<0.02	<3
	85	Alpha	<118	N/A	<0.02	<3
	79	Alpha	<118	N/A	<0.02	<3
	77	Alpha	<118	N/A	<0.02	<3
	67	Alpha	<118	N/A	<0.02	<3
	64	Alpha	<118	N/A	<0.02	<3
	59	Alpha	<118	N/A	<0.02	<3
	48	Alpha	<118	N/A	<0.02	<3
	129	Bravo	<118	N/A	<0.02	<3
	124	Bravo	<118	N/A	<0.02	<3
	101	Bravo	<118	N/A	<0.02	<3
	81	Bravo	<118	N/A	<0.02	<3

Project Alpha Summary

8.69. From the information and data presented above, it can be concluded that the baseline water and sediment quality within the Project Alpha site is good, with contaminant levels generally below those at which adverse effects on the benthos are seen. As discussed above, the elevated arsenic levels within the ISA have a number of potential origins; however, the source is unknown and these levels are still below the CEFAS Action 1 Levels above which they would be a potential cause for concern.

Project Bravo

Water Quality

8.70. Given the close proximity of the two sites, it is considered that the water quality baseline discussed for Project Alpha provides a suitable baseline for Project Bravo (see paragraphs 8.45 to 8.54). For reference, Metocean Sites A and B were located 15km and 0.4km from the Project Bravo site respectively.

Seabed substrate

8.71. As discussed above in paragraphs 8.55 to 8.60 the seabed substrate within the Project Bravo site is similar to that recorded for the Project Alpha site, with no significantly different seabed substrate types recorded between the two sites.

Sediment Quality

8.72. The sediment quality recorded within the Project Bravo site is also similar to that recorded for the Project Alpha site (paragraphs 8.61 to 8.69), with no significant differences in contaminants recorded between the two sites.

Project Bravo Summary

8.73. Baseline water and sediment quality within the Project Bravo site is good and with contaminant levels generally below those at which adverse effects on the benthos are seen. As discussed above, the elevated arsenic levels within the ISA have a number of potential origins; however, the source is unknown and these levels are still below the CEFAS Action 1 Levels above which they would be a potential cause for concern.

Transmission Asset Project

Infrastructure within the Project Alpha and Project Bravo site boundaries

8.74. The Offshore Substation Platforms (OSPs) form part of the Transmission Asset Project; however they are geographically located within the site boundaries of Project Alpha and Project Bravo. As such the OSPs are assessed within the Project Alpha and Bravo sections and hence the baseline for this infrastructure is covered by Project Alpha and Bravo above.

Export Cable Route (ECR) Corridor

Water quality

8.75. A number of activities influence water quality in the coastal areas adjacent to the proposed ECR landfall at Carnoustie. Discharge outlets are licensed by SEPA. Diffuse pollution, for example from agricultural run-off, is also inevitably carried to the coast via watercourses.

8.76. The landfall lies within the Deil’s Heid to Carnoustie RBMP, while a section of the ECR lies within the outer reaches of the Scurdie Ness to Diel‘s Heid RBMP.

8.77. The Deil's Heid to Carnoustie RBMP coastal water body covers an area of 72.9km^2 (see Figure 8.2), comprising the associated protected areas of:

- Arbroath (West Links) – designated Bathing Water; and
- Carnoustie - designated Bathing Water.

8.78. The nearest designated shellfish water is Elie to Fife Ness Shellfish Water.

8.79. Distances from the Seagreen Project to these sites are stated in Table 8.13, and location of bathing waters is shown on Figure 8.3.

Table 8.13 Distances of sensitive waters from the development areas

From	To	Distance (km)
Carnoustie Landfall	Fife Ness to Elie Shellfish Waters	25.0
Carnoustie Landfall	Arbroath Bathing Waters	8.6
Carnoustie Landfall	Carnoustie Bathing Waters	0.6
Project Alpha	Fife Ness to Elie Shellfish Waters	47.9
Project Alpha	Arbroath Bathing Waters	41.5
Project Alpha	Carnoustie Bathing Waters	47.4
Project Bravo	Fife Ness to Elie Shellfish Waters	50.6
Project Bravo	Arbroath Bathing Waters	44.9
Project Bravo	Carnoustie Bathing Waters	50.3

8.80. SEPA has classified the Deils Heid to Carnoustie RBMP coastal water body as having an overall status of Good with High confidence in 2008 (SEPA, 2011c) an overall ecological status of Good and an overall chemical status of Pass. SEPA has set environmental objectives for this water body over future river basin planning cycles in order that sustainable improvements to its status can be made over time, or alternatively that no deterioration in status occurs.

8.81. The current status of the water body meets the requirements of the WFD, thus SEPA must ensure no deterioration from Good status, unless resulting from a new activity providing significant specified benefits to society or the wider environment.

8.82. Elliot Water/ Rottenraw Burn discharges into the marine environment to the south of Arbroath at West Links, 8.3km from the proposed landfall at Carnoustie (see Figure 8.2). According to SEPA the status of this water body is classified as bad as a result of multiple pressures, including diffuse and point source pollution and water abstraction from the associated Carnoustie bedrock and localised sand and gravel aquifers.

8.83. The Carnoustie bedrock and localised sand and gravel aquifers are associated with the surface waters of not only the Elliot Water/ Rottenraw Burn, but also the Barry Burn, Black Burn, Buddon Burn and Monikie Burn. According to SEPA the current condition of the water bodies is poor. As with the Elliot Water/ Rottenraw Burn, this water body is subject to a number of pressures, namely diffuse source pollution and abstraction for arable farming and recreational purposes.

8.84. The Elliot Water/Rottenraw Burn is also designated as a Fresh Water Fish Directive Salmonid Water. According to SEPA (2011d) the current condition of the waters is Bad for ecology and Pass for chemical quality, with an overall status of Bad.

Shellfish waters

8.85. The Arbroath shellfish water area was de-designated in 2009. Currently the nearest designated area is Fife Ness to Elie. There are two areas designated as Shellfish Harvesting Areas by the Food Standards Agency (FSA), for surf clams *Spisula solida* and razor clams *Ensis arcuatus* that share some of the area with the Fife Ness to Elie Shellfish Water.

8.86. All samples in the Fife Ness to Elie Shellfish Waters have complied with the standards for contaminants in shellfish flesh until 2006 and 2007 when the guideline value for arsenic of 30mg/kg dry weight was just exceeded. The levels found, 36.6 mg/kg and 34.1mg/kg dry weight, are however well within the imperative level of 100mg/kg dry weight. This area failed again for arsenic guideline standard in 2010. It is thought that the source of the arsenic is the local geology (there are high levels of arsenic in the rock at Burntisland, in the Firth of Forth, (SEPA 2011b) as there are no known anthropogenic sources of arsenic in the area of the monitoring site at Ardross, south east Fife.

8.87. The Shellfish Waters in this region have consistently failed to comply with the guideline standard for faecal coliforms since 1999 to 2010 (SEPA 2011e).

Bathing waters

8.88. Bathing water standards are applied at designated beaches, where microbiology is the principle concern. Figure 8.3 presents the location of designated bathing waters in the vicinity of the proposed ECR landfall location.

8.89. During the bathing season (1 June to 15 September), designated bathing waters are monitored for faecal indicators (bacteria) and classified according to the levels of these indicators in the water. Further details are provided in paragraph 8.17 of this chapter.

8.90. The monitoring results are assessed for compliance with two sets of EU standards specified in the Revised Bathing Waters Directive (2006/7/EC): minimum quality standards (EU mandatory values) and more stringent quality targets (EU guideline values).

8.91. The Carnoustie designated bathing water is situated to the south of the town of Carnoustie, 0.6km from the proposed landfall. It was designated as a bathing water in 1987. During high and low tides the approximate distance to the water's edge can vary from zero to 300m This beach has achieved mandatory or guideline passes since 1992 (SEPA 2011c).

8.92. The other nearby designated bathing water is at Arbroath (West Links), a 1.3 km sandy bay situated to the south west of Arbroath, 8.6km from the ECR landfall site. The site was designated a bathing water in 1987 and a portion of it lies within the Elliot Links Site of Special Scientific Interest (SSSI). This beach has received mandatory or guideline passes since 2003 (SEPA 2011c).

Beach awards

8.93. Another indicator of coastal water quality is the Blue Flag Programme which is active in over 40 countries and works towards sustainable development at beaches and marinas. The award of Blue Flag status is based on compliance with 32 criteria covering the aspects of water quality, environmental education and information, environmental management, and safety and services (Marine Conservation Society, 2012).

8.94. Six of the seven current Scottish Blue Flag Beaches are in Fife, the nearest being St Andrews East Sands and St Andrews West Sands, both incorporating sandy beaches.

8.95. The Marine Conservation Society (MCS), through its annual 'Good Beach Guide', recommends beaches which have had excellent water quality in the latest tests (Summer 2011) and are not affected by badly treated, continuous waste water discharges. Arbroath (West Links) was recommended by the MCS in 2011.

Seabed substrate

8.96. Geophysical data indicate that variable, generally granular sediments are present on the seabed across much of the ECR corridor, with the exception of the nearshore areas, where outcropping rock is dominant to the north of the cable route (Osiris, 2011). In these areas the bedrock surface is very irregular, exhibiting numerous ridges and probably isolated boulders derived from the underlying sandstones. Where bedrock outcrops within the nearshore areas it is typically overlain by an irregular patchwork veneer of very silty sand.

8.97. Granular sediments range from very silty fine to coarse grained sands, with variable shell content, to coarser grained sandy gravels, with occasional cobbles and (generally small) boulders (Osiris, 2011) . For a more detailed analysis of seabed substrate data please refer to Chapter 7: Physical Environment of this ES.

Sediment quality

8.98. A dedicated sampling survey was undertaken of the ECR corridor (IECS, 2011) as part of the wider benthic survey campaign. As part of these surveys, five grab stations within the ECR were sampled. The locations for which contaminant analysis was carried out are shown in Figure 8.1.

8.99. Sediment contaminant data for metal contaminants and sediment quality parameters along the ECR corridor are summarised in Table 8.14, while Table 8.15 provides the results of the hydrocarbon contaminant analysis.

Table 8.14 Results of ECR sediment analysis (µg/g) for metal contamination (highlighted cells correspond to levels above the ISQG levels – see Table 8.5)

Contaminant	Station				
	Within ECR	Within ECR	Within ECR	Within ECR	North of ECR
	C1	C2	C3	C4	C5
Arsenic	10.3	4.72	12.3	9.0	4.9
Cadmium	0.383	0.293	0.27	0.277	0.245
Copper	5.86	85.9	15.5	9.54	9.08
Lead	16.3	8.92	6.39	9.42	6.56
Mercury	<0.14	<0.14	<0.14	<0.14	<0.14
Nickel	11.5	14.3	10.1	6.78	7.74
Zinc	31.1	47.9	22.5	21.9	23.1

8.100. Arsenic was the only metal contaminant to be found at elevated levels during the benthic surveys, which is consistent with results for Project Alpha and Project Bravo. Arsenic was present at levels in excess of the 7.24µg/g ISQG standard, in three of the five samples. It is likely that the arsenic originates from naturally occurring sources. No samples contained levels in excess of the CEFAS Action Level 1 standard and therefore this is not considered to be an issue.

8.101. Cadmium, copper, lead and zinc were present in all samples, but all concentrations were below quoted ISQG levels and the CEFAS Action Level 1. All samples contained nickel at concentrations below the CEFAS Action Level 1. Mercury concentrations were below detectable levels at all stations.

8.102. PAH and PCB concentrations were below detectable levels throughout (<118µg/g and (<3µg/g respectively) as shown in Table 8.15. Petroleum hydrocarbons were not found within sediment samples. TBT concentrations were below detectable levels throughout all samples.

Table 8.15 Results of ECR sediment analysis for hydrocarbon contamination

Determinand	Station				
	Within ECR	Within ECR	Within ECR	Within ECR	North of ECR
	C1	C2	C3	C4	C5
Total Poly Aromatic Hydrocarbons (ng/g)	<118	<118	<118	<118	<118
Total Petroleum Hydrocarbons (µg/g)	N/A	N/A	N/A	N/A	N/A
TBT (µg/g)	<5	<5	<5	<5	<5
Total PCB ICES[2] 7 (µg/g)	N/A	N/A	N/A	N/A	N/A

8.103. From the information and data presented above, it can be concluded that the baseline water and sediment quality for the ECR corridor area is generally good and contaminants present are below levels at which adverse effects on the benthos are seen, with the levels of arsenic considered typical for the region. As discussed for Project Alpha and Project Bravo, the elevated arsenic levels have a number of potential origins; however, the source is unknown and these levels are still below the CEFAS Action 1 Levels above which they would be a potential cause for concern.

Sediment transport

8.104. Due to the location of the Seagreen Project, close to a major port and estuary, there is a substantial amount of research concerning tidal conditions in the Tay Estuary that influences water and sediment movements (see Chapter 7: Physical Environment).

8.105. The net longshore drift of beach material along the coastline from Arbroath to Carnoustie is north to south, with the rate of sediment transport slowing notably to the north of Carnoustie, due to the geological character of the coastline.

2 International Council for the Exploration of the Sea Rectangle 7 is the area of sea within with the Transmission Asset falls.

Suspended sediment

8.106. A summary of total suspended solids (TSS), expressed as mg/l, as recorded at Site E during two recording events as part of the metocean deployment, is presented in Table 8.16. The following baseline characterisation therefore relates solely to the nearshore extent of the ECR.

Table 8.16 Total Suspended Solids (mg/l), March and June 2011 at site E

Site	Time (mins)	March					June				
		0	30	60	90	120	0	30	60	90	120
E	Top	5	6	7	11	10	8	<5	<5	<5	<5
	Middle	6	8	10	10	11	<5	6	<5	<5	<5
	Bottom	11	10	11	10	11	<5	<5	<5	<5	<5

8.107. TSS data were also recorded at Site E from 15th December, 2011 to 18th June, 2012 (Partrac, 2012). The TSS data recorded over the deployment show a strong correlation to the wave climate with the highest TSS values coinciding with the storm events observed at the end of January. Tidal variation is also seen to have an effect on suspended solids with a cyclical variation of ~5-10 mg/l during times of low wave heights.

8.108. The mean recorded TTS value is 25mg/l; the minimum recorded TTS value was recorded on multiple occasions to be 0mg/l. The maximum recorded value occurred on the 27th January 2012 at 709mg/l.

ASSESSMENT OF IMPACTS – SCENARIOS

8.109. Full details on the range of design options being considered by Seagreen are provided in Chapter 5: Project Description in this ES.

8.110. As detailed in Chapter 7: Physical Environment of this ES, the assessment of potential changes to the water and sediment quality during construction, operation and decommissioning of the Seagreen Project was informed by the Seagreen Rochdale Envelope principle, in which a range of scenarios were tested to determine the worst case design scenario on the physical environment (as these will influence hydrodynamics, seabed sediments, and water and sediment movements).

8.111. The definition of the worst case was required for the engineering parameters of substructure/foundation type and turbine array layout, to inform this assessment. The worst case scenario for foundation types was discussed with Marine Scotland, who supported the assumptions made and conclusions drawn (see Appendix E1).

8.112. No pre-defined layouts are proposed for assessment purposes. The final layout of the Seagreen Project will be selected post consent. To ensure that the largest, or worst case, effects for any potential layout is assessed, the minimal WTG separation distance of 5 rotor diameter spacings has been assumed in any direction between adjacent turbines. The minimum rotor diameter within the Rochdale Envelope is 122m and therefore the minimum spacing assessed is 610m between adjacent turbines within the array. If a greater spacing is utilised within the final constructed wind farm, the anticipated effects shall be reduced from the potential effect presented herein.

8.113. The substructure/ foundation details for the various scheme options tested to define the realistic worst case scenario(s) are set out in Table 8.17. It is important to note that the number of structures assessed is a function of the Rochdale Envelope principle. The maximum number of WTGs in either Project Alpha or Project Bravo will not exceed 75.

8.114. The worst case assessment has assumed that for WTGs a 72m baseplate diameter conical GBS will be used within Project Alpha and Project Bravo in areas of weak soils, assumed to be a maximum of 8 locations within each project area. Elsewhere, in areas of average strength soils, a 52m baseplate diameter conical GBS will be considered as a worst case foundation option. In reality, design optimisation will be undertaken to identify the foundations types that are best suited to the ground conditions and water depths that will be experienced at each foundation location. This is likely to mean that there will actually be relatively few locations across Project Alpha and Project Bravo where 72m baseplate conical GBS are required. It should be noted that the Rochdale Envelope also includes jackets with piles and jackets with suction piles, which could also be used but would have considerably lesser effect on the physical environment, as less ground preparation is required.

8.115. For purposes of defining the worst case for assessment, it is further assumed that foundations for meteorological masts will be the same as the worst case for the WTGs (this assumes that as there is more flexibility with the placement of the meteorological masts these will be placed on average soils and therefore use the smaller baseplate). There will be a maximum of three meteorological masts installed within each Project area in the worst case assessment, although in reality a maximum of three are likely to be distributed across the Seagreen Project.

8.116. Within the Transmission Asset Project, the worst case is considered to include up to three Offshore Substation Platforms (OSP) within Project Alpha and up to two OSP within Project Bravo (i.e. up to five collectively across the Transmission Asset Project. The worst case substructure / foundation for the OSP is a 100m x 75m rectangular GBS, with a baseplate thickness of 7.5m, at 1 location within Project Alpha and 40m x 40m square GBS, with a baseplate thickness of 7.5m, at up to four other locations. The maximum seabed preparation depth for OSPs is up to 5m.

Table 8.17 Foundation details that define the worst case scenario within each project area, with respect to the physical environment

Description	Structure type	Dimensions (m)	
WTG substructure / foundations for weak soils	Conical GBS	72m octagonal baseplate diameter	35.4m cone basal diameter
WTG and meteorological mast substructure / foundations for average soils	Conical GBS	52 m octagonal baseplate diameter	28.4m cone basal diameter
OSP (up to 1 location within Project Alpha)	Rectangular GBS	100m x 75m rectangular baseplate, 7.5m thickness	Six square columns each up to 15m x 15m aligned in 2 rows each containing 3 columns
OSP (up to 2 locations within Project Alpha and up to 2 locations within Project Bravo)	Square GBS	40m x 40m square baseplate, 7.5m thickness	Four square columns each up to 7.5m x 7.5m aligned in 2 rows each containing 2 columns

8.117. For these worst case substructure / foundation types, empirical tools have been used to calculate scour hole development arising under different combinations of wave and current action, assuming a further worst case that no scour protection is provided. These assessments are presented in full in Appendix E4 and summarised in Table 8.18. In the case of the rectangular GBS, the individual columns have been grouped in the assessments to simulate their influence as a single, larger, complete surface-piercing unit, which is a highly conservative assumption.

8.118. GBSs would also require seabed preparation prior to installation, unlike some other substructure / foundation options. For conical GBS, the worst case scenario assumes that this will be required to a maximum depth of up to 5m below existing bed level across the footprint of the structure at a maximum of 8 locations within each Project Area associated with the larger diameter GBSs, with any conical GBS used at other locations within each Project Area requiring sea bed preparation to a maximum depth of up to 3m. For the rectangular and square GBS used as a worst case for OSP, it has been assumed that seabed preparation of up to 5m will be required at each location. The worst case sea bed preparation volumes are summarised in Table 8.19.

Table 8.18 Worst case scour hole development

Substructure / Foundation	Scour Hole 1 in 1 year Event			Scour Hole 1 in 50 year Event			Method
	Area m^2	Depth m	Vol. m^3	Area m^2	Depth m	Vol. m^3	
Conical GBS (72m baseplate for use in areas of weak soils)	5,150	1.75	924	6,671	3.92	4,877	Khalfin (2007) Soulsby & Clarke (2002)
Conical GBS (52m baseplate for use in areas of average soils)	3,137	2.18	1,067	4,283	4.24	4,304	Khalfin (2007) Soulsby & Clarke (2002)
Rectangular GBS (100m x 75m) for use at up to 1 OSP location within Project Alpha	1,174	5.21	2,038	1,850	6.54	4,032	Khalfin (1983) Bos (2002)
Square GBS (40m x 40m) for use at up to 2 OSP locations within each of Projects Alpha and Bravo	137	1.78	81	518	3.46	597	Khalfin (1983) Bos (2002)

Table 8.19 Worst case seabed preparation volumes

Foundation	Baseplate diameter	Footprint	Maximum depth of Seabed preparation	Volume of seabed preparation material
Conical GBS (72m baseplate for use in areas of weak soils)	72m baseplate diameter	4,295m^2	5m *	21,475m^3
Conical GBS (52m baseplate for use in areas of average soils)	52m baseplate diameter	2,240m^2	3m	6,720m^3
Rectangular GBS (100m x 75m) for use at up to 1 OSP location within Project Alpha	100m x 75m rectangular baseplate	7,500m^2	5m	37,500m^3
Square GBS (40m x 40m) for use at up to 2 OSP locations within Project Alpha and up to 2 OSP locations within Project Bravo	40m x 40m square baseplate	1,600m^2	5m	8,000m^3

*Maximum 5m depth to be used for up to 8 WTG with GBS within Project Alpha and up to 8 locations within Project Bravo.

8.119. Establishing the worst case from the range of scenarios under consideration (see Chapter 5: Project Description) has ensured that this assessment is focused on the maximum potential adverse effect that could arise from the Seagreen Project.

8.120. The worst case scenarios for Project Alpha, Project Bravo and the Transmission Asset Project are defined in detail in Tables 8.20 to 8.22. As previously stated the OSPs have been considered only within the detailed assessments for Project Alpha and Project Bravo respectively. The outcome of the OSP assessments is then cross referenced where appropriate when describing the potential effects of the Transmission Asset Project.

Table 8.20 Worst case scenario for Project Alpha assessment (includes WTGs, meteorological masts, OSPs, array cables and ancillary structures and any activities to place maintain or remove these).

Effect	Worst case scenario	Justification
Construction		
Deterioration in water quality due to re-suspension of sediments.	Installation of up to 75 WTGs and up to 3 meteorological masts on conical GBSs at spacings of 610m. Installation of up to 1 OSP on rectangular (100m x 75m) GBS and up to 2 OSP on square (40m x 40m) GBS. Substructure / foundation installation to be complete within the 36 month offshore substructure and foundations activity programme, which runs from the 3rd Quarter 2016 to the 3rd Quarter 2019. Substructure / foundation installation via Heavy Lift Vessel (HLV) / 6-leg jack-up barge (each leg 4.5m x 4.5m square, with maximum seabed penetration of 2m at each leg). Anchoring of other installation support vessels is so insignificant that this does not form part of the worst case assessment. **Substructures / Foundations:** Release of up to 642,200m^3 of seabed material side-cast to seabed adjacent to substructure or returned to water column from dredger hopper during seabed preparation works for conical GBS used for WTG and metrological masts. A further 53,500m3 of seabed material similarly disposed during seabed preparation works for rectangular/square GBS used for OSPs. **Array cables:** 355km of array cabling buried to depths of between 0.5m and 2.1m across a 3m wide trench. Cable burial achieved using jetting ROV within the 36 month offshore cabling activity programme (from the 3rd Quarter 2016 to the 3rd Quarter 2019).	Maximum potential number of WTGs and meteorological masts at closest possible spacings and using largest cross-sectional area substructure / foundation type. Maximum potential number of OSP using largest cross-sectional area substructure / foundation type. A minimum period of 6 months over each of 2 years will be required for foundation and substructure installation. Offshore working may be restricted to between April and September each year. Installation of up to 2 substructure / foundations simultaneously. Maximum total number of vessels at any one time is small, the presence of each anchor is temporary and the area of seabed potentially affected by each anchor is very small (4m2). Assumes 72m diameter conical GBS at up to 8 sites within Project area and 52m diameter conical GBS at other locations, with total of 75 WTG and 3 meteorological masts / 100m x 75m rectangular GBS used at up to 1 OSP location and 40m x 40m square GBS used at up to 2 OSP locations. No material re-use as ballast. Includes for potential use of suction cutter dredging. **Maximum trench dimensions.** Assumes an indicative installation rate using jetting of 237.5m/hr, which is slower than for cutter and plough. Jetting fluidises or liquefies the sediment, making it more readily re-suspended. Offshore working may be restricted to between April
Deterioration in water quality due to re-suspension of contaminants		
Deterioration in water and / or sediment quality due to accidental spillage of construction materials.	Maximum build programme of four years. Construction taking place all year, 24 hours a day – This is worst case scenario to allow for availability of vessels and appropriate weather windows.	Higher likelihood of an incident occurring as a result of more activities taking place over a longer time period. It should be noted that there are no significant discharges associated with wind farm construction.

Effect	Worst case scenario	Justification
Introduction of non-native / alien marine species	Maximum build programme of four years. Construction taking place all year, 24 hours a day – This is worst case scenario to allow for availability of vessels and appropriate weather windows.	It is not currently known what vessels will be working on site, or their previous locations, and therefore the worst case scenario is for vessels carrying ballast water from potentially contaminated areas
Operation		
Effects on suspended sediment concentrations and transport resulting from scour due to the presence of foundation structures and rock protection measures.	Scour hole formation on the seabed adjacent to each substructure under a 1 in 50 year storm. Total volume of material released from seabed due to scour hole development around conical GBS is 340,296m³. A further 5,226m³ released from scour around rectangular / square GBS. In the event that scour protection is provided, no scour will occur, but there will be the physical footprint on the seabed caused by the scour protection materials.	Assumes that no scour protection is provided. Conical GBS causes greatest scour volumes of all substructure / foundation types during a 1 in 50 year storm condition due to combined wave and current action. Assumes 72m diameter conical GBS at up to 8 locations within Project area and 52m diameter elsewhere, with total of 75 WTG and 3 meteorological masts. Rectangular (100m x 75m) GBS used at up to 1 OSP location and square (40m x 40m) GBS used at up to 2 OSP locations. Secondary scour around the limits of the scour protection will be insignificant.
Deterioration in water and sediment quality due to accidental spillages.	Access to installations by boat and use of a mothership. Bi-annual maintenance and inspection visits. Requirement for retrofitting and upgrading works. Maximum number of operations and maintenance personnel (30) and vessels (4). Five vessels per day travelling to/from the OWFs. Unscheduled repair activities equal to one visit per turbine per month. Thermal discharge from HVDC convertor station at 20°C above ambient at flow rate of up to 125l/s	This worst case scenario provides for the maximum level of operational activity and therefore, the highest likelihood of an incident occurring due to increased vessels / activities.
Introduction of non-native/ alien marine species	Access to installations by boat and use of a mothership. Bi-annual maintenance and inspection visits. Requirement for retrofitting and upgrading works. Maximum number of operations and maintenance personnel (30) and vessels (4). Five vessels per day travelling to/from the OWFs. Unscheduled repair activities equal to one visit per turbine per month.	It is not currently known what vessels will be working on site, or their previous locations, and therefore the worst case scenario is for vessels carrying ballast water from potentially contaminated areas
Decommissioning		
Impacts due to re-suspension of sediments and contaminants.	Removal of all WTG and meteorological mast foundations and array cables (based on the worst case assumptions detailed under the construction phase). Removal of all OSP foundations.	The worst case scenario comprises that which would result in the maximum level of sediment disturbance. A full Decommissioning Plan for the project will be drawn up and agreed with Marine Scotland, at which point the worst case scenario and impacts will be fully assessed. Until the arrangements have been clarified, the worst case scenario is that all structures will be removed.

Table 8.21 'Worst-case' scenario for Project Bravo assessment (includes WTGs, meteorological masts, OSPs, array cables and ancillary structures and any activities to place maintain or remove these).

Effect	Worst case scenario	Justification
Construction		
Deterioration in water quality due to re-suspension of sediments.	As for Project Alpha, but with up to two OSP (instead of up to three OSP for Project Alpha) founded on square (40m x 40m) GBS.	As for Project Alpha, but with up to two OSP (instead of up to three OSP for Project Alpha) founded on square (40m x 40m) GBS.
Deterioration in water quality due to re-suspension of contaminants	As for Project Alpha, but with release of up to 642,200m³ of seabed material side-cast to seabed adjacent to substructure or returned to water column from dredger hopper during seabed preparation works for conical GBS used for WTG and meteorological masts. A further 16,000m³ of seabed material similarly disposed during seabed preparation works for square (40m x 40m) GBS	As for Project Alpha, but with up to two OSP considered on square (40m x 40m) GBS.
Deterioration in water and / or sediment quality due to accidental spillage of construction materials.	Maximum build programme of four years. Construction taking place all year, 24 hours a day – This is worst case scenario to allow for availability of vessels and appropriate weather windows.	Higher likelihood of an incident occurring as a result of more activities taking place over a longer time period. It should be noted that there are no significant discharges associated with wind farm construction.
Introduction of non-native / alien marine species	Maximum build programme of four years. Construction taking place all year, 24 hours a day – This is worst case scenario to allow for availability of vessels and appropriate weather windows.	It is not currently known what vessels will be working on site, or their previous locations, and therefore the worst case scenario is for vessels carrying ballast water from potentially contaminated areas
Operation		
Effects on suspended sediment concentrations and transport resulting from scour due to the presence of foundation structures and rock protection measures.	As for Project Alpha, but with up to two OSP (instead of up to three OSP for Project Alpha) founded on square (40m x 40m) GBS. As for Project Alpha, but with total volume of material released from seabed due to scour hole development around conical GBS of 340,296m³. A further 1,194m³ released from scour around square (40m x 40m) GBS.	As for Project Alpha, but with up to two OSP (instead of up to three OSP for Project Alpha) founded on square (40m x 40m) GBS. As for Project Alpha, but with up to two OSP considered on square (40m x 40m) GBS.
Deterioration in water and sediment quality due to accidental spillages.	Access to installations by boat and use of a mothership. Bi-annual maintenance and inspection visits. Requirement for retrofitting and upgrading works. Maximum number of operations and maintenance personnel (30) and vessels (4). Five vessels per day travelling to/from the OWFs. Unscheduled repair activities equal to one visit per turbine per month.	This worst case scenario provides for the maximum level of operational activity and therefore, the highest likelihood of an incident occurring due to increased vessels / activities.

Effect	Worst case scenario	Justification
Introduction of non-native/ alien marine species	Access to installations by boat and use of a mothership. Bi-annual maintenance and inspection visits. Requirement for retrofitting and upgrading works. Maximum number of operations and maintenance personnel (30) and vessels (4). Five vessels per day travelling to/from the OWFs. Unscheduled repair activities equal to one visit per turbine per month.	It is not currently known what vessels will be working on site, or their previous locations, and therefore the worst case scenario is for vessels carrying ballast water from potentially contaminated areas
Decommissioning		
Impacts due to re-suspension of sediments and contaminants.	Removal of all WTG and meteorological mast foundations and array cables (based on the worst case assumptions detailed under the construction phase). Removal of all OSP foundations.	The worst case scenario comprises that which would result in the maximum level of sediment disturbance. A full Decommissioning Plan for the project will be drawn up and agreed with Marine Scotland, at which point the worst case scenario and impacts will be fully assessed. Until the arrangements have been clarified, the worst case scenario is that all structures will be removed.

Table 8.22 Worst-case' scenario for Transmissions Asset Project assessment (Includes OSPs and export cable route to landfall at Carnoustie)

Effect	Worst case scenario	Justification
Construction		
Deterioration in water quality due to re-suspension of sediments.	The installation of up to 1 OSP on rectangular (100m x 75m) GBS and up to 4 OSPs on square (40m x 40m) GBS has already been assessed in detail as part of the Project Alpha and Project Bravo assessments (where they have greatest potential for cumulative impact), but the findings are cross-referenced within this assessment because OSPs form part of the Transmissions Asset Project consent application. Substructure and foundation installation to be complete within the 36 month offshore substructure and foundations activity programme, which runs from the 3rd Quarter 2016 to the 3rd Quarter 2019. Substructure / foundation installation via Heavy Lift Vessel (HLV) / 6-leg jack-up barge (each leg 4.5m x 4.5m square, with maximum seabed penetration of 2m at each leg). Anchoring of other installation support vessels is so insignificant that this does not form part of the worst case assessment. <u>Substructure / Foundations:</u> The release of up to 69,500m³ of seabed material side-cast to the seabed adjacent to the substructure or returned to the water column from the dredger hopper during seabed preparation works has already been assessed in detail for OSPs as part of the Project Alpha and Project Bravo assessments (where they have greatest potential for cumulative impact), but the findings are cross-referenced within this assessment because OSPs form part of the Transmissions Asset Project consent application. <u>Export cables:</u> 530km of export cabling buried to depths of between 0.5m and 3m across a 3m wide trench Cable burial achieved using jetting ROV within the 36 month offshore cabling activity programme (from the 3rd Quarter 2016 to the 3rd Quarter 2019). HDD to achieve burial at landfall at Carnoustie.	Maximum potential number of OSPs using worst case substructure / foundation for OSP. A minimum period of 6 months per year for two years will be required for substructure / foundation and OSP installation. Offshore working may be restricted to between April and September each year. Installation of up to two substructures / foundations simultaneously. Maximum total number of vessels at any one time is small, the presence of each anchor is temporary and the area of seabed potentially affected by each anchor is very small (4m2). Assumes the installation of up to one OSP on rectangular (100m x 75m) GBS and up to four OSPs on square (40m x 40m) GBS, with seabed preparation for each type of GBS to a depth of up to 5m. No material re-use as ballast. Includes for potential use of suction cutter dredging. Up to six 275kv export cables (HVAC) to be installed along an indicative 70km export cable corridor to landfall at Carnoustie. Maximum trench dimensions and buried cable length Assume an indicative installation rate using jetting of 237.5m/hr, which is slower than for cutter and plough. Jetting fluidises or liquefies the sediment, making it more readily re-suspended. Offshore working is restricted to between April and September each year.
Deterioration in water quality due to re-suspension of contaminants.		

Effect	Worst case scenario	Justification
Deterioration in water and / or sediment quality due to accidental spillage of construction materials.	Maximum build programme of four years. Construction taking place all year, 24 hours a day – This is worst case scenario to allow for availability of vessels and appropriate weather windows.	Higher likelihood of an incident occurring as a result of more activities taking place over a longer time period. It should be noted that there are no significant discharges associated with wind farm construction.
Operation		
Effects on suspended sediment concentrations and transport resulting from scour due to the presence of foundation structures and rock protection measures.	The scour hole formation on the seabed adjacent to each substructure under a 1 in 50 year storm has already been assessed in detail as part of the Project Alpha and Project Bravo assessments (where they have greatest potential for cumulative impact), but the findings are cross-referenced within this assessment because OSPs form part of the Transmissions Asset Project consent application.. Total volume of material released from seabed due to scour hole development is 6,420m$^{3.}$ In the event that scour protection is provided, no scour will occur, but there will be the physical footprint on the seabed caused by the scour protection materials	Assumes the presence of up to one OSP on rectangular (100m x 75m) GBS and up to four OSPs on square (40m x 40m) GBS Assumes that no scour protection is provided around rectangular/square GBS. Secondary scour around the limits of the scour protection will be insignificant.
Deterioration in water and sediment quality due to accidental spillages.	Access to installations by boat and use of a mothership. Bi-annual maintenance and inspection visits. Requirement for retrofitting and upgrading works. Maximum number of operations and maintenance personnel (30) and vessels (4). Five vessels per day travelling to/from the OWFs. Unscheduled repair activities equal to one visit per turbine per month.	This worst case scenario provides for the maximum level of operational activity and therefore, the highest likelihood of an incident occurring due to increased vessels / activities. It should be noted that there are no significant discharges associated with wind farm operation activities.
Decommissioning		
Impacts due to re-suspension of sediments and contaminants.	Removal of all foundations and cables (based on worst case assumptions detailed under construction).	The worst case scenario comprises that which would result in the maximum level of sediment disturbance. A full Decommissioning Plan for the project will be drawn up and agreed with Marine Scotland, at which point the worst case scenario and impacts will be fully assessed. Until the arrangements have been clarified, the worst case scenario is that all structures will be removed.

IMPACT ASSESSMENT – CONSTRUCTION PHASE

Project Alpha

Deterioration in water quality due to re-suspension of sediments

8.121. During construction, seabed sediments may be re-suspended as a result of activities such as seabed preparation, foundation installation (including the removal of spoil material), installation of array cables and the placement of scour material on the seabed and / or construction vessel activity (i.e. from the placement of anchors or jack up barge feet). This could result in direct impacts on water quality associated with decreased light levels and water clarity, and indirect impacts upon biological receptors.

8.122. Potential changes to seabed sediment distribution patterns and mobile bedforms at the Project Alpha site are related to the temporary disturbance of the seabed by the removal of seabed materials for foundation preparation activities and array cable installation. It is anticipated that the volume of seabed disturbed would be generally confined to the immediate footprint of the foundation (conical GBS) and cable routes, and therefore be relatively localised.

GBS foundation installation

8.123. The worst case scenario is identified in Table 8.20. The effect of this will depend on the nature of the seabed where the footprint occurs. For the WTG and meteorological masts, the worst case is associated with the seabed preparation activities that may be required associated with the installation of conical GBS foundations in order to provide a sufficiently level area of seabed. This is because this activity has the potential to release the greatest volume of material into the water column or seabed. The scenario assumes that conical GBS foundations a will require up to 5m depth of seabed preparation for up to 8 WTGs, and up to 3m depth elsewhere. For the OSP, the worst case involves installation of GBS at up to 3 locations with seabed preparation up to 5m depth. As up to two foundations will be installed at any one time the release of this material during construction activities will be phased over the construction period.

8.124. At present the volume of seabed preparation at each location and the dredge methods to be used in seabed preparation are not defined and remain subject to ongoing design optimisation. However, in many areas of seabed the approach is likely to involve the removal and either immediate side-casting or dredging and removal of material from under the direct footprint of the structure. Under this scenario, a proportion the material that is dredged or side-cast onto the seabed adjacent to the foundation location may become re-mobilised from the seabed, entrained as a plume and subsequently transported in suspension in the water column by tidal currents.

8.125. In line with the worst case assessment presented above, it is assumed that the installation of a proportion of WTG foundation structures will occur within close proximity to areas of mobile bedforms (megaripples and sand waves). However, it is also assumed that the installation of a proportion of WTG foundation structures will occur on areas of the seabed devoid of mobile bedforms.

8.126. The disturbance would be relatively short-lived at each location (likely to be a few days per foundation), localised (confined to the immediate vicinity of each foundation due to the general course nature of the sediments present) and reversible (i.e. the seabed would return to its pre-construction state relatively rapidly (days to weeks)).

8.127. In a small number of locations, likely to be confined to where the greater, up to 5m, depth of seabed preparation are required, cutter suction dredging may be required. If using this approach, sediment plumes may arise from: (i) the action of the drag head on the seabed causing a physical disturbance; (ii) overflow from the hopper; and (iii) deliberate on-board screening of recovered sediments and their return to the sea. Collectively, these processes are likely to result in enhanced suspended sediment concentrations in the water column during the dredging operations and remaining until a short timescale thereafter.

8.128. Measurement of plumes generated by the drag head of cutter suction operations alone has shown that the volume of sediment lifted into suspension is negligible (John et al., 2000), indicating that the principal contributors of sediment to the plume are the processes of overflow and deliberate screening. Where screening is not required (i.e. where all material is retained in the hopper and taken away from the dredge site), the volume of material discharged from the vessel is considerably smaller, and the effects of a sediment plume are usually confined to within the dredge area (Hitchcock & Bell, 2004; Newell et al., 2004).

8.129. Any material released from the vessel will create a plume of sediment that comprises a dynamic plume and passive plume phase (Whiteside et al., 1995). The dynamic plume is influenced by the rapid downward mode of release from the dredger, typically resulting in deposition of the vast majority of the material within a few hundred meters of the activity. The passive plume involves a smaller proportion of the sediment load that is either stripped from the dynamic plume or re-suspended from the seabed, but can have an influence over a wider seabed area as tidal currents transport the material further away until it settles.

8.130. Tillin et al. (2011) reported plume modelling, undertaken for multiple aggregate extraction licence areas, that showed the highest suspended sediment concentrations would occur for a short time around high water and remain within the dredger tracks, not extending extend beyond the licensed dredging area. Plumes containing lower suspended sediment concentrations (e.g. typically enhancements of background concentrations by as little as 5-10mg/ l) were predicted to extend across much greater distances, along the direction of the tidal flows, but these were barely distinguishable from background levels. These generally comprised the finest sediment fractions only, as coarser material became deposited on the seabed a relatively short distance from its point of release back into the water column.

8.131. When considered across the whole of Project Alpha, some 642,200m^3 of material could cumulatively be excavated from the seabed and side-cast adjacent to the foundations or returned from a dredger to the water column if, as a worst case, 72m diameter baseplates GBS are used at up to 8 locations and 52m baseplate diameter elsewhere. An additional 67,500m^3 of material could cumulatively be released from installation of the OSP at up to three locations. However, only two foundations will be installed simultaneously over any three-day period across Project Alpha during the minimum 6 months construction duration and therefore the release of this material during construction activities will be phased over time.

8.132. The effect that the release of material from seabed preparation will have on suspended sediment concentrations will depend on the mobility of the seabed, the transportation of sediment within a plume, and the presence, or absence, of any sensitive receptors.

8.133. For material released from the dredger (if used), the vast majority will fall to the seabed as part of a dynamic plume. Any material released as a passive plume will be in low concentrations and remain for a relatively short duration, becoming widely dispersed in the area of tidal currents. Once material is returned to the seabed from the dynamic plume (if a cutter suction dredger is used) or is side cast directly onto the seabed, it will remain in situ until the shear stresses acting on the sediment grains exceeds the threshold for motion of that particular grain size, whereupon sediment mobilisation will become initiated. The shear stresses are caused by tidal and wave-induced currents.

8.134. As discussed in Chapter 7: Physical Environment of this ES, under mean neap tide conditions no sediment with the characteristics of that sampled from Project Alpha can be mobilised from the seabed by current action. However, during mean spring tide conditions a larger proportion of sediment can become mobilised at times of peak flow and this proportion further increases under both 1 in 1 year and 1 in 50 year current events. It should be noted, in addition to tidal currents, that wave-stirring of bed sediment during storm events can also increase forces acting on the seabed and initiate motion, as previously shown in Plot 7.9 in Chapter 7.

8.135. Further, there is insufficient coarse sediment present to provide natural armouring of the seabed. Consequently, during the peak of a spring tide and during storm events, a proportion of the side cast material is likely to become re-mobilised from the seabed and dispersed by tidal currents until it drops from suspension and becomes re-deposited on the seabed at some distance away from its origin.

8.136. As material deposited during the dynamic plume phase from a cutter suction dredger (if used) or material that has been side-cast becomes mobilised, it will locally increase the turbidity of the water column. This process will be observed at times when the background suspended sediment concentration is naturally towards its highest values, although the metocean data demonstrate that suspended concentrations are generally relatively low. The greatest suspended sediment concentrations will likely be towards the seabed (rather than extensively through the water column right to the water surface) and deposition would occur when current speeds fall below the critical threshold for sediment transport. Due to this, there will be a low magnitude effect in terms of elevating suspended sediment concentrations, but this is likely to be a temporary duration and localised effect. The effect will also be phased over time as the foundations are installed over a minimum 6 months duration over the three year construction period with no more than two foundations being installed simultaneously at any one time.

Array cable installation

8.137. The assessment of sediment plume creation and dispersal of sediment from array cable burial follows the rationale above for foundation assessments. Elevated concentrations of sediment will be short-term (days) and, assuming that the installation activities occur continuously across the seabed within Project Alpha, will only experience limited release of sediments.

8.138. The worst case scenario for array cable installation equates to some 355km of cable, installed using jetting to a depth of between 0.5m and 2.1m, along a corridor of 3.0m width.

8.139. The total volume of seabed sediments that might be mobilised will be released in a phased manner dependent upon the rate of excavation and across the 3 year construction period. Furthermore, the jetting approach will fluidise or liquefy the seabed sediments and therefore they will remain near to the bed. Consequently, there will not be the bulk loading of sediment into the marine environment in significant quantities. Indeed, much of the sediment released by jetting within Project Alpha is likely to settle back in the immediate vicinity of its release due to its relatively coarse grain size. Any sediment that does remain in suspension will become dispersed by the prevailing tidal currents in low concentrations.

8.140. Due to this, the jetting of seabed sediments for array cabling will have a low magnitude effect upon suspended sediment concentrations. However, any effects are likely to be of a temporary duration and occur relatively locally to the source of material release.

8.141. It should be noted that the sediment volumes upon which these estimates are based provide an over-estimate of the volume of material to be released as a result of the installation of each structure, as a result this is a conservative assessment (as detailed in Chapter 7: Physical Environment of this ES).

8.142. The sensitivity of the receptor is also considered to be low as the nearest sensitive water quality features (namely, shellfish waters and designated bathing sites) are all at significant distance (over 40km) from Project Alpha and therefore, are well removed from the areas where suspended sediments levels may be temporarily increased. The dispersion of the sediment plume by the prevailing hydrodynamic processes discussed in Chapter 7: Physical Environment of this ES will result in TSS variations returning to natural background levels further afield so that TSS levels outwith the Project Alpha site will not be discernible from natural background TSS variations. The impact of re-suspension of sediments during construction at Project Alpha, is therefore considered to be negligible and **not significant**.

Mitigation

Mitigation

The assessment includes the possibility of various seabed preparation methods to be used, including cutter suction dredging. In practice, site specific assessments will be made at each foundation location to determine the preferred foundation type and seabed preparation requirements and methods. This will seek to minimise the extent of ground preparation required. If the need for seabed preparation is determined, a licence will be applied for under the Marine (Scotland) Act 2010 for Dredging and Deposit of Solid Waste in the Territorial Sea and UK Controlled Waters Adjacent to Scotland. This will necessarily consider details of the areas and materials to be dredged and a Best Practicable Environmental Option (BPEO) Assessment for deposit of the materials, including consideration of re-use of material as foundation ballast, beneficial use and disposal at sea.

Residual Impact

8.143. The potential impacts will remain at negligible and **not significant**. This is not significant under EIA regulations.

Deterioration in water quality due to re-suspension of contaminants

8.144. The re-suspension of seabed sediments could also lead to the release of contaminants present within them, which may affect compliance with water quality standards. Similarly, should any pathogens be associated with the sediment, these may also be released into the water column with the potential to cause direct impacts on bathing water and other biological receptors.

8.145. The data in Table 8.10 shows that the levels of most contaminants in the sediments are below the ISQG, PEL and CEFAS Action levels. Arsenic was present at levels in excess of the 7.24µg/ g ISQG standard, in all but one of the samples. However, no samples contained levels of arsenic in excess of CEFAS Action Level 1.

8.146. From the information and data presented in the Existing Environment section of this chapter, it can be concluded that the baseline water and sediment quality for the Project Alpha site is good and generally below levels at which adverse effects on the benthos are seen. The release of sediment with a relatively high arsenic contamination could contribute to an increase in freely available arsenic within the water column; however, given the level of contaminants within the sediments, the potential magnitude of any impact will be low.

8.147. As discussed above, under mean neap tide conditions no sediment with the characteristics of that sampled from Project Alpha can be mobilised from the seabed by current action. However, during mean spring tide conditions a larger proportion of sediment can become mobilised at times of peak flow and this proportion further increases under both 1 in 1 year and 1 in 50 year current events. It should be noted that, in addition to tidal currents, wave-stirring of bed sediment during storm events can also increase forces acting on the seabed and initiate motion, as previously shown in Plot 7.9.

8.148. Further, there is insufficient coarse sediment present to provide natural armouring of the seabed. Consequently, during the peak of a spring tide and during storm events, a proportion of the side cast or dredged material is likely to become re-mobilised from the seabed and dispersed by tidal currents until it drops from suspension and becomes re-deposited on the seabed at some distance away from its origin.

8.149. As material deposited during the dynamic plume phase from a cutter suction dredger (if used) or material that has been side-cast becomes mobilised, it will locally increase the turbidity of the water column. This process will be observed at times when the background suspended sediment concentration is naturally towards its highest values, although the metocean data demonstrate that suspended concentrations are generally relatively low. The greatest suspended sediment concentrations will likely be towards the seabed (rather than extensively through the water column right to the water surface) and deposition would occur when current speeds fall below the critical threshold for sediment transport. Due to this, there will be a low magnitude effect in terms of elevating suspended sediment concentrations, but this is likely to be a temporary duration and localised effect. The effect will also be phased over time as the foundations/ substructures and array cables are installed over a minimum 6 months per year within an overall 3 year construction duration, with no more than two foundations being installed simultaneously at any one time.

8.150. The dispersion of the sediment plume by the prevailing hydrodynamic processes will result in SSC variations returning to natural background levels further afield so that SSC levels outwith the Project Alpha site will not be discernible from the natural background. Therefore any small concentrations of contaminants within the sediment plume would largely remain within the vicinity of the works and would only temporarily be re-suspended.

8.151. The sensitivity of the receptor is also considered to be low as the nearest sensitive water quality features (namely, shellfish waters and designated bathing sites) are all at significant distance (over 40km) from Project Alpha and, therefore, well removed from the areas where suspended sediments levels may be temporarily increased. The impact of re-suspension of contaminants during construction at Project Alpha is therefore considered to be negligible and **not significant**.

Mitigation

Mitigation
No mitigation is proposed

Residual Impact

8.152. The potential impacts will remain as negligible and **not significant**. This is not significant under EIA regulations.

Deterioration in water and / or sediment quality due to accidental spillage of construction materials

8.153. There is potential for pollution from spills or leaks of fuel, oil and lubricants during construction and from construction materials that may enter the water column and subsequently the sediments. The risk of pollution events will be minimised by adherence to the MARPOL Convention regulations (IMO, 1973), as well as following standard good practice, such as the Pollution Prevention Guidelines issued by SEPA. Additionally, any chemicals used during construction will be in line with the Offshore Chemicals (Amendment) Regulations 2010 and any lubricants will be non toxic, biodegradable and capable of dispersal in sea water.

8.154. Given these management strategies and controls it is expected that even should a spill occur, its scale and the nature of the contaminant will result in a temporary and localised impact of medium magnitude (as a worst case, although this will be dependent on the materials spilled). The nearest sensitive water quality features are all at considerable distance (over 40km) from Project Alpha, therefore the sensitivity of the receptor is considered to be low. Therefore, on a precautionary basis, there is potential for an impact of minor adverse and **not significant** on water quality.

Mitigation

Mitigation
Seagreen is committed to ensuring the installation contractors are required to put in place appropriate Construction Environmental Management Plans (CEMP) and Pollution Control and Spillage Response Plans. In addition these plans will be agreed with the Regulatory Authorities prior to offshore construction activities commencing. The plans will to reduce the potential for accidental pollution and in the unlikely event of a pollution incident, would ensure a rapid and appropriate response.

Residual Impact

8.155. Following best practice, plans and guidance put in place, the residual impact on sediment or water quality from accidental spillage of construction materials will be negligible and **not significant**.

Introduction of marine non-native / alien species

8.156. It has been suggested (OSPAR, 2010) that OWF structures and works associated with them may provide an opportunity for colonisation by non-native or alien species.

8.157. There is a potential for vessels used during construction activities to transport marine non-native species in ballast waters. The risk of this is greatest with the use of installation vessels such as jack-up barges, which are used (and in construction) at a number of locations internationally, and the level of risk depends on previous locations of these vessels and whether they are mobilising from areas with species present which may pose a risk as marine non-natives at the development site or en route.

8.158. The value of the waters around the development sites is considered to be low as the nearest sensitive water quality features (namely, shellfish waters and designated bathing sites) are all at significant distance (over 40km) from Project Alpha and, therefore, well removed. In addition, the nearest, relevant nature conservation site, the Berwickshire and North Northumberland Coast marine SAC, for which rocky reefs are a feature (see Chapter 9: Nature Conservation Designations of this ES) lies over 60km away. The risk of transporting marine non-natives is conservatively considered to be an impact of medium magnitude, depending on where vessels are travelling from and the type of alien species introduced. This contributes to a potential impact of minor adverse and not significant.

Mitigation

Mitigation
Once the vessels for construction are confirmed, a risk assessment will be conducted taking account of vessel activities, previous locations, and planned routes that could introduce marine non-native species to the area. The assessment will also recommend any proactive management measures which can be taken to minimise risk of introduction of alien species. The approach and measures will be developed with the contractors and agreed with Marine Scotland prior to works commencing. If the risk assessment identifies a concern, further consultation with be undertaken with SNH and SEPA, with the aim of compliance with Water Framework and Marine Strategy Framework Directive objectives.

Residual Impact

8.159. Following the mitigation stated above, the likelihood of transporting marine non-natives to the site is reduced to negligible magnitude, reducing the impact to negligible and **not significant.**

Project Bravo

Deterioration in water quality due to re-suspension of sediments

8.160. The impact assessment described in paragraphs 8.121 to 8.143 for Project Alpha, are the same as for the Project Bravo site. The presence of only two OSPs (compared with three OSPs in Project Alpha) does not make a material difference in effect on suspended sediments.

8.161. Chapter 7: Physical Environment of this ES assesses the potential increases in TSS for foundation installation. These are likely to be of minor significance in terms of change to existing conditions, as a result the magnitude of the effect on water quality is anticipated to be low. The sensitivity of the receptor is also considered to be low as the nearest sensitive water quality features (namely, shellfish waters and designated bathing sites) are all at significant distance (over 40km) from and Project Bravo and, therefore, well removed from the areas where suspended sediments levels may be temporarily increased. The impact of re-suspension of sediments during construction at Project Bravo is therefore considered to be negligible and **not significant**.

Mitigation

Mitigation
No mitigation is proposed

Residual Impact

8.162. The potential impacts will remain at negligible and not significant. This is not significant under EIA regulations.

Deterioration in water quality due to re-suspension of contaminants

8.163. The impact assessment described above for Project Alpha is considered the same as for Project Bravo. The presence of only two OSPs (compared with three OSPs in Project Alpha) does not make a material difference in effect on suspended sediments.

8.164. As discussed in Chapter 7: Physical Environment of this ES, the dispersion of the sediment plume by the prevailing hydrodynamic processes will result in SSC variations returning to natural background levels further afield. Therefore that SSC levels outwith the Project Bravo site are not expected to be discernible from natural background SSC variations.

8.165. As a result of these short term and localised effects, the low concentrations of contaminants present in the sediments will not be dispersed widely into the marine environment. Consequently, the magnitude of the effect on water quality is anticipated to be low. The sensitivity of the receptor is also considered to be low as the nearest sensitive water quality features (namely, shellfish waters and designated bathing sites) are all at significant distance (over 40km) from the Project Alpha and Project Bravo sites and, therefore, well removed from the areas where suspended contaminants levels may be temporarily increased. The impact of re-suspension of contaminants during construction at the proposed Bravo site is therefore considered to be negligible and **not significant**.

Mitigation

Mitigation
No mitigation is proposed

Residual Impact

8.166. The potential impacts will remain at negligible and **not significant**. This is not significant under EIA regulations.

Deterioration in water and / or sediment quality due to accidental spillage of construction materials

8.167. As per Project Alpha, the risk of pollution events will be minimised by adherence to the standard regulations as well as following standard good practice. Additionally, any chemicals used during construction will be in line with the Offshore Chemicals (Amendment) Regulations 2010 and any lubricants will be non toxic, biodegradable and capable of dispersal in sea water.

8.168. Given these management strategies and controls it is expected that even should a spill occur, its scale and the nature of the contaminant will result in a temporary and localised impact of medium magnitude (as a worst case, although this will be dependent on the materials spilled). The nearest sensitive water quality features are all at considerable distance from Project Bravo, therefore the sensitivity of the receptor is considered to be low. Therefore, there is potential for an impact of minor adverse and not significant on water quality.

Mitigation

Mitigation

The installation contractors will be required by Seagreen to put in place appropriate Construction Environmental Management Plans (CEMP) and Pollution Control and Spillage Response Plans that would have been agreed with the Regulatory Authorities prior to offshore construction activities commencing. These plans will act to reduce the potential for accidental pollution and in the unlikely event of a pollution incident, would ensure a rapid and appropriate response.

Residual Impact

8.169. Following the best practice, plans and guidance put in place, the residual impact on sediment or water quality from accidental spillage of construction materials will be negligible and not. This is not significant under EIA regulations.

Introduction of marine non-native / alien species

8.170. The impact and assessment will be as determined for Project Alpha.

8.171. The sensitivity of the waters around the development sites is considered to be of low value as the nearest sensitive water quality features (namely, shellfish waters and designated bathing sites) are all at significant distance (over 40km) from Project Bravo and, therefore, well removed. In addition, the nearest, relevant nature conservation site, the Berwickshire and North Northumberland Coast marine SAC, for which rocky reefs are a feature (see Chapter 9: Nature Conservation Designations of this ES) lies over 60km away. The risk of transporting marine non-natives could be as high as medium magnitude, depending on vessels are travelling from and this contributes to a potential impact of minor adverse and **not significant**.

Mitigation

Mitigation

Once the vessels for construction are confirmed, a risk assessment will be conducted taking account of vessel activities, previous locations, and planned routes that could introduce marine non-native species to the area. The assessment will also recommend any proactive management measures which can be taken to minimise risk of introduction of alien species. The approach and measures will be developed with the contractors and agreed with Marine Scotland prior to works commencing. If the risk assessment identifies a concern, further consultation with be undertaken with SNH and SEPA, with the aim of compliance with Water Framework and Marine Strategy Framework Directive objectives.

Residual Impact

8.172. Following the mitigation stated above, the likelihood of transporting marine non-natives to the site is reduced to negligible magnitude, reducing the impact to negligible and **not significant**.

Transmission Asset Project

Deterioration in water quality due to re-suspension of sediments

8.173. The effects on suspended sediment concentrations and transport during the construction phase of the Transmission Asset Project will be considerably less than previously described for Project Alpha and Project Bravo in terms of the seabed material side cast during seabed preparation activities.

Export cable installation

8.174. In addition, there will be construction effects associated with the burial of the export cable. The worst case scenario for export cable installation equates to some 530km of cable, installed using jetting to a depth of between 0.5m and 3.0m, along the ECR corridor.

8.175. The total volume of seabed sediments that might be mobilised will be released in a gradual phased manner dependent upon the rate of excavation and will extend across a minimum duration of 9 months within the 2 year construction period. Furthermore, the jetting approach will fluidise or liquefy the seabed sediments and therefore they tend to remain near to the bed. Consequently, elevated concentrations of suspended sediment at each point of release along the ECR corridor will be short-term (days). In addition, there will not be a loading of sediment into the marine environment in significant quantities. Much of the sediment released by jetting within the ECR corridor is likely to settle back in the immediate vicinity of its release due to its relatively coarse grain size. Any sediment that does remain in suspension will become dispersed by the prevailing tidal currents in low concentrations. As detailed in Chapter 7: Physical Environment of this ES, with progression between the Project Alpha site or Project Bravo site and the Carnoustie shore, the axis of the tidal ellipses changes, adopting a more shore-parallel axis closer to shore. Consequently, any sediment released along the ECR corridor will become widely dispersed according to the tidal ellipses that prevail at the release point, rather than resulting in all released material becoming transported to a common destination.

8.176. Due to this, the jetting of seabed sediments for export cabling will have a negligible magnitude effect upon suspended sediment concentrations. In addition, any effects are likely to be of a temporary duration and occur relatively locally to the source of material release. The sensitivity of the receiving water body is considered to be low to medium, depending on proximity to the coastline. Therefore the significance of any potential impact is assessed to be negligible and **not significant**.

8.177. This finding is supported by a Technical Report on a review of cabling techniques and environmental effects applicable to the offshore wind farm industry (BERR, 2008) which drew its conclusions from a review of findings from studies undertaken for a number of UK and wider European offshore wind farms. In these studies, marginal, short term increases in background suspended sediment concentrations were noted, but most sediment was rapidly re-deposited on the seabed and suspended sediment concentrations reduced to background levels within a very short distance from the trenches. Finer-grained material, where released, was transported considerably further distances by tidal currents, but in very low concentrations and became widely dispersed.

Export cable installation at landfall

8.178. Horizontal directional drilling (HDD) technique will used to install ducts from the transition pit location (located above MHWS and subject to a separate planning application).The drill rig area will be located behind (above) the coastal defences and a borehole will be drilled from the transition pit, under the sea defences and out towards the mean low water mark. There exists the possibility that work to the exit borehole within the intertidal may require the presence of a vehicle. The cables will be pulled to shore from an offshore vessel suspended by floats. The cables will be installed in ploughed or excavated trenches up to the entrance to the ducts, and then drawn through the ducts to the transition pit location by winches (See Chapter 5: Project Description of this ES) the disturbance of which will re-suspend sediments from the seabed near to the coastline. As discussed, in Chapter 7: Physical Environment of this ES, the HDD activities will have a low effect on increased suspended sediments at the coastline.

8.179. Short-term and localised changes to sediments and sedimentary structures during the construction phase of the proposed works are an unavoidable consequence of the Seagreen Project. Best practice guidance will be followed to ensure that potential damage to environmental features is minimised throughout the proposed works.

8.180. The proposed landfall at Carnoustie is located approximately 8.5km from the designated Arbroath Bathing Waters, and 570m from the Carnoustie Bathing Waters, which are classed within this EIA as being of medium sensitivity. As discussed above, the impacts will be localised, short term to a few days, and re-suspended sediments will be quickly dispersed within the marine environment, therefore the magnitude of the effect is considered to be low.

8.181. Consequently the potential for deterioration in water quality due to re-suspension of sediments is assessed to be minor adverse and not significant for the designated bathing waters.

Mitigation

Mitigation
No mitigation is proposed

Residual Impact

8.182. As no mitigation beyond following best practice is proposed, there will be a minor adverse **not significant** residual impact upon the designated bathing waters.

Deterioration in water quality due to re-suspension of contaminants

8.183. The mechanism for suspension of contaminants is described above in paragraphs 8.173 to 8.177.

8.184. Short-term and localised changes to sediments and sedimentary structures during the construction phase of the proposed works are an unavoidable consequence of the Seagreen Project. Best practice guidance will be followed to ensure that potential damage to environmental features is minimised throughout the proposed works.

8.185. The proposed landfall at Carnoustie is located approximately 8.5km from the designated Arbroath Bathing Waters, and 570m from the Carnoustie Bathing Waters, which are classed within this EIA as being of medium sensitivity. As discussed above, the impacts will be localised and short term, limited to a number of days, and although there is limited evidence of contaminants recorded within the cable route, there is potential for arsenic or settled microbiological agents to be re-suspended during the installation activities. Given the very short term nature of effects and that any re-suspended sediments will be quickly dispersed within the marine environment, the magnitude of the effect is considered to be low.

8.186. Consequently the potential for deterioration in water quality due to re-suspension of contaminants is assessed to be minor adverse and not significant.

Mitigation

Mitigation
No mitigation is proposed.

Residual Impact

As no mitigation beyond following best practice is proposed, there will be minor adverse and **not significant** impacts upon features of interest.

Deterioration in water and / or sediment quality due to accidental spillage of construction materials

8.187. As per the Project Alpha and Project Bravo assessments, the risk of pollution events will be minimised by adherence to the standard regulations as well as following standard good practice. Additionally, any chemicals used during construction will be in line with the Offshore Chemicals (Amendment) Regulations 2010 and any lubricants will be non toxic, biodegradable and capable of dispersal in sea water.

8.188. During HDD activities, drilling fluids (likely to be bentonite or a similar drilling fluid) and cuttings will enter the marine environment at the point of break through. Bentonite is highly soluble in water and will rapidly disperse due to the tide and current conditions at the site. The Material Safety Data Sheet (MSDS) for bentonite does not indicate that this substance is likely to cause significant harm to water quality.

8.189. Given these management strategies and controls it is expected that even should a spill occur, its scale and the nature of the contaminant will result in a temporary and localised impact of medium magnitude (as a worst case), although this will be dependent on the materials spilled. In regard to sensitivity, the proposed landfall at Carnoustie is located approximately 8.5km from the designated Arbroath Bathing Waters, and 570m from the Carnoustie Bathing Waters, which are classed as being of medium sensitivity. Therefore, there is potential for a moderate adverse and **significant** impact on water quality.

Mitigation

Mitigation

The installation contractors will be required by Seagreen to put in place appropriate Construction Environmental Management Plans (CEMP) and Pollution Control and Spillage Response Plans that would have been agreed with the Regulatory Authorities prior to offshore construction activities commencing. These plans will act to reduce the potential for accidental pollution and in the unlikely event of a pollution incident, would ensure a rapid and appropriate response.

- a Competent Person will be present on site during HDD activities. The HDD Contractor shall contain, handle, and dispose of drilling fluids in accordance with the following requirements:
- a method statement showing how drilling mud releases to the environment will be minimised shall be submitted and agreed with Marine Scotland:
- excess drilling fluid shall be confined in a containment pit/ vessel at the entry and exit locations until recycled or removed from the site;
- precautions shall be taken to ensure that drilling fluid does not enter roadways, streams, storm or sewer pipes, and/ or any other drainage system or body of water;
- unintended surfacing of drilling fluid shall be contained at the point of discharge and recycled or removed from the site;
- drilling fluids that are not recycled and reused shall be removed from the site and disposed at an approved disposal site; and
- drilling fluids shall be completely removed from the construction site prior to back filling or restoring the site.

Residual Impact

8.190. Following the best practice, plans and guidance put in place, the residual impact on sediment or water quality from any accidental spillage of construction materials will be minor adverse and **not significant**.

Introduction of marine non-native / alien species

8.191. The sensitivity of the waters around the coastline is considered to be of medium value as the nearest sensitive water quality features (namely, shellfish waters and designated bathing sites) are all at significant distance (over 40km) from Project Bravo and, therefore, well removed. In addition, the nearest, relevant nature conservation site, the Berwickshire and North Northumberland Coast marine SAC, for which rocky reefs are a feature (see Chapter 9: Nature Conservation Designations of this ES) lies over 60km away. The risk of transporting marine non-natives could be as high as medium magnitude, depending on where vessels are travelling from and this contributes to a potential impact of moderate adverse and **significant**.

Mitigation

Mitigation

Once the vessels for construction are confirmed, a risk assessment will be conducted taking account of vessel activities, previous locations, and planned routes that could introduce marine non-native species to the area. The assessment will also recommend any proactive management measures which can be taken to minimise risk of introduction of alien species. The approach and measures will be developed with the contractors and agreed with Marine Scotland prior to works commencing. If the risk assessment identifies a concern, further consultation with be undertaken with SNH and SEPA, with the aim of compliance with Water Framework and Marine Strategy Framework Directive objectives.

Residual Impact

8.192. Following the mitigation stated above, the likelihood of transporting marine non-natives to the site is reduced to negligible magnitude, reducing the impact to negligible and **not significant**.

IMPACT ASSESSMENT – OPERATION

Project Alpha

Deterioration of water and sediment quality as a result of scour impacts at WTG structures

8.193. There is potential for impacts upon water and sediment quality as a result of scour occurring around the bases of the WTGs and ancillary infrastructure (i.e. OSPs and meteorological masts) foundations caused by local acceleration of current flow. The depth of scour will depend on the physical conditions, the thickness of the mobile layer and the cohesiveness of the substrate.

8.194. The process by which scour holes develop in the absence of scour protection is described in Chapter 7: Physical Environment of this ES. The resulting area, depth and volume of scour in the seabed will depend on the physical conditions, the thickness of the mobile seabed layer and the cohesiveness of the substrate.

8.195. Empirical scour assessments have been undertaken on a number of turbine foundation options to derive the worst case scenario for scour footprint areas for both 1 in 1 and 1 in 50 return periods. This has demonstrated that the greatest scour potential occurs under a 1 in 50 year return period wave event combined with tidal currents acting around a 72m conical base GBS (see Appendix E4 for full details).

8.196. For the worst case substructure / foundation type and dimensions, a scour hole footprint will occur under a 1 in 50 year event across 6,671m^2 of seabed adjacent to each of the 72m baseplate diameter conical GBS and across 4,283m^2 of seabed adjacent to each of the 52m baseplate diameter conical GBS. At the OSP locations, a scour hole footprint around the rectangular (100m x 75m) GBS will occupy up to 1,850m^2 of seabed under these conditions and around the square (40m x 40m) GBS up to 518m^2. When considered across the whole of Project Alpha, the cumulative seabed area affected by scour hole development during a 1 in 50 year event would be 356,044m^2. This represents <0.2% of the Project Alpha seabed area and following scour hole development during the event, the scour hole would become partially infilled during more quiescent conditions. Within this context, the effect is considered low magnitude.

8.197. The total volume of material associated with scour development is small in comparison to worst case seabed preparation activities for foundation installation.

8.198. In addition, the above worst case scenario may not manifest in full or at all as scour protection measures may be applied, as detailed in Chapter 5: Project Description of this ES. The final volume and type of scour protection will be determined by a Scour Protection Study as part of the final detailed design process.

8.199. Any changes are anticipated to be localised (see Chapter 7: Physical Environment of this ES and Appendix E4) in waters of low sensitivity. Given that the predicted impact on deterioration of water and sediment quality due to increases in suspended sediment and re-suspension of contaminants during construction activities are assessed to be of negligible (see paragraphs 8.121 to 8.152 above). It follows that the impacts from scour (incorporating a lower volume of sediments released into the water column) will also be negligible and **not significant**.

Mitigation

Mitigation

As a matter of good practice, the detailed design of the project will consider scour protection to reasonably reduce the potential for scour hole formation. It should be noted that scour will always have the potential to occur around any static structure within the dynamic marine environment. Whether the degree of scour can be tolerated in design terms (i.e. volume and depth) will be dependent upon the nature of the surrounding seabed.

Visual or bathymetric surveys will be undertaken at selected locations within the OWF site to assess the magnitude and extent of scour formation and development, and the effectiveness of any scour protection. Subsequent surveys will be planned depending on the results of initial monitoring. The requirement for visual or bathymetric surveys will be discussed with Marine Scotland and other key stakeholders and agreement reached to the detail on future monitoring requirements.

Residual Impact

8.200. With mitigation measures such as those described above in place, it is anticipated that the residual effect on the physical environment will be negligible and **not significant** regardless of the foundation type taken forward in the final project design.

Deterioration in water quality due to accidental spillages and waste water

8.201. There are a number of materials which could enter the marine environment during the operational phase of the Seagreen Project and potentially cause deterioration of marine water quality and sediment quality. Lubricants, oils and greases will be required to ensure the operational parts of the WTG work efficiently and there is the potential that accidental spillages of these materials may occur. In addition vessels used during maintenance will have their own associated fuels and lubricants which could also enter the marine environment. As per the construction phase, the risk of pollution events will be minimised by adherence to the MARPOL Convention regulations, as well as following standard good practice, such as the Pollution Prevention Guidelines issued by SEPA.

8.202. The activities associated with the routine operation of an offshore wind farm are unlikely to introduce significant volumes of contaminants to the marine environment; therefore the potential impacts on water and sediment quality during this phase are likely to be restricted to accidental spillages during maintenance activities.

8.203. In regard to waste produced if an accommodation platform is installed, waste will be segregated on the platform before being returned to shore, with any generated waste recycled where possible. Discharges associated with grey water will be treated and discharged in line with the relevant legislation, primarily MARPOL 73/78 Annex IV[3] (Regulations for the Prevention of Pollution by Sewage from Ships (revised)). In addition the grey water will be minimal and will be discharged and diluted rapidly in the marine environment.

8.204. If an HVDC convertor station is constructed within an OSP, a seawater cooling system will be required. The maximum seawater cooling water volume required would be for a 1 Gigawatt (GW) single circuit system (HVDC Connection Scenario 1). At full capacity this will require a cooling water flow rate of up to a maximum of 125 litres per second (l/s) with a resultant outlet water temperature rise of approximately 20°C above ambient. The flow rate and temperature rise would be proportionately reduced when operating at outputs below full capacity. As a comparison, this flow rate is approximately 0.13% of the flow rate of the Longannet Power Station in the Firth of Forth (Scottish Government 2011) and 4 – 20% of the operational cooling water flow for a large LNG tanker (Oregon LNG, 2008). In addition, the HVDC convertor station will be located offshore in an exposed environment where wave and wind action will cause mixing of the warmer waters within the water column, therefore it is anticipated the thermal plume will be readily dispersed. Currently there are no limits from oil rigs for sewage or cooling water discharges (UKOOA 2010).

8.205. Dosing of seawater cooling water with biocide may be required to prevent biofouling in the cooling water system.

8.206. Considering the uncertainty regarding thermal waste water and the potential use of biocides and risk of accidental spills a precautionary assessment of the impact is for it to be of medium magnitude (as a worst case). In regard to sensitivity, although the nearest sensitive water quality features are all at considerable distance from the Project Alpha, there is the potential for thermal pollution and/or sediments to become contaminated. The sensitivity of the receptor is therefore considered to be low. The potential impact from accidental spillages will be, at worst, minor adverse and **not significant**.

3 MARPOL 73/78 also defines a ship to include "floating craft and fixed or floating platforms" and these are required where appropriate to comply with the requirements similar to those set out for vessels. Thus for sewage the basic equipment and operational requirements set out for other vessels will apply to offshore installations. (http://www.ukooaenvironmentallegislation.co.uk/contents/topic_files/offshore/sewage_foodwaste.htm)

Mitigation

Mitigation

As described for mitigation of potential impacts for Project Alpha construction, best practice for pollution prevention will be considered during the operational phases of Project Alpha to mitigate the risk from accidental spillages.

Although it is not anticipated for the impact for thermal pollution to be significant in EIA terms, if standards are introduced prior to or during construction and operation of the offshore wind farm, plume modelling may be conducted to ensure thermal plumes are within acceptable limits.

Once the proposed biocide treatment approach has been identified, a discussion will be undertaken with the relevant authorities to seek consent to discharge.

Residual Impact

8.207. Following the best practice, plans and guidance put in place, the impact significance on sediment or water quality during operation of the Project Alpha will be negligible and **not significant**. This is not significant under EIA regulations.

Introduction of marine non-native / alien species

8.208. The presence of OWF foundations provide substrate for colonisation by a range of species that prefer hard surfaces, and which might be found in the Project Alpha currently. This could be viewed positively in terms of increased biodiversity in the ISA, however, if some of the species establishing on the structures are non-native or alien species, such an impact would be viewed as negative. It has been suggested (OSPAR, 2010) that OWF structures may provide an opportunity for colonisation by non-native species.

8.209. Most vessels routinely undertaking operation and maintenance works within the Project Alpha site, post construction, will be locally or at least regionally based, with limited potential to bring in non-native or alien species. However, some works may require larger specialist vessels which may routinely operate in more distant areas and these may have potential to transport marine non-native species in ballast waters. The level of risk depends on previous locations of these vessels and whether they are mobilising from areas with species present which may pose a risk as marine non-natives at the development site or en route.

8.210. Although the permanent structures in Project Alpha still lie relatively close to the UK coast (27km) in the context of the wider North Sea, they are not considered constitute significant potential to bridge between the UK coastline and the near continent. In addition, seabed survey data for the Project Alpha site shows that although mainly sedimentary in nature, there are also a number of occurrences of hard substrata, including areas of boulders, supporting their own attached faunal ecology (see Chapter 11: Benthic Ecology and Intertidal Ecology of this ES). It is not considered that structures associated with development will act as a significant stepping stone for marine non-native species above the potential for the existing hard substrata within the Project Alpha site to do so.

8.211. The value of the waters around the development sites is considered to be low as the nearest sensitive water quality features (namely, shellfish waters and designated bathing sites) are all at significant distance (over 40km) from Project Alpha and, therefore, well removed. In addition, the nearest, relevant nature conservation site, the Berwickshire and North Northumberland Coast marine SAC, for which rocky reefs are a feature (see Chapter 9 Nature Conservation Designations of this ES) lies over 60km away. The risk of transporting marine non-natives could be as high as medium magnitude, depending on vessels are travelling from and this contributes to a potential impact of minor adverse significance.

Mitigation

Mitigation

Once the vessels for operation are confirmed, a risk assessment will be conducted taking account of vessel activities, previous locations, and planned routes that could introduce marine non-native species to the area. The assessment and measures indicated by the assessment will be agreed with Marine Scotland.

If the risk assessment identifies a concern, further consultation with be undertaken with SNH and SEPA, with the aim of compliance with Water Framework and Marine Strategy Framework Directive objectives.

Residual Impact

8.212. Following the mitigation stated above, the likelihood of transporting marine non-natives to the site is reduced to negligible magnitude, reducing the impact to negligible and **not significant**.

Project Bravo

Deterioration of water and sediment quality as a result of scour impacts at WTG structures

8.213. The impact assessment for the deterioration of water and sediment quality as a result of scour impacts around foundations within the Project Bravo site will be similar to that for the Project Alpha discussed above.

8.214. Any changes are anticipated to be localised (see Chapter 7: Physical Environment of this ES). In addition, given that the predicted impact on water and sediment quality due to increases in suspended sediment and re-suspension of contaminants during preparation activities are assessed to be negligible and that the impacts on water quality from scour (incorporating a lower volume of sediments released into the water column) will also be negligible and **not significant**.

Mitigation

Mitigation

As a matter of good practice, the detailed design of the project will consider scour protection to reasonably reduce the potential for scour hole formation. It should be noted that scour will always have the potential to occur around any static structure within the dynamic marine environment. Whether the degree of scour can be tolerated in design terms (i.e. volume and depth) will be dependent upon the nature of the surrounding seabed

Visual or bathymetric surveys will be undertaken at selected locations within the OWF site to assess the magnitude and extent of scour formation and development, and the effectiveness of any scour protection. Subsequent surveys will be planned depending on the results of initial monitoring. The requirement for visual or bathymetric surveys will be discussed with Marine Scotland and other key stakeholders and agreement reached to the detail on future monitoring requirements.

Residual Impact

8.215. With mitigation measures such as those described above in place, it is anticipated that the residual effect on the physical environment will be negligible and **not significant** regardless of the foundation type taken forward in the final project design.

Deterioration in water quality due to accidental spillages and waste water

8.216. The potential impact assessment for the deterioration of water and sediment quality as a result of accidental spillages within the Project Bravo site will be similar to that for Project Alpha discussed above. The risk of pollution events will be minimised by adherence to the MARPOL Convention regulations, as well as following standard good practice, such as the Pollution Prevention Guidelines issued by SEPA.

8.217. The activities associated with the routine operation of an offshore wind farm are unlikely to introduce significant volumes of contaminants to the marine environment; therefore the potential impacts on water and sediment quality during this phase are likely to be restricted to accidental spillages during maintenance activities. Waste water will be treated as discussed in paragraph 8.203.

8.218. Thermal discharges from OSP and the potential need to use biocide systems are discussed in relation to Project Alpha in paragraph 8.203 to 8.207 above. Taken together with a consideration of accidental spillages, the impact has the potential, from a precautionary standpoint, to be of medium magnitude. In regard to sensitivity, although the nearest sensitive water quality features are all at considerable distance from the Project Bravo, there is the potential for thermal pollution and/ or sediments to become contaminated. The sensitivity of the receptor is therefore considered to be low. The potential impact from accidental spillages will be, at worst, minor adverse and **not significant**.

Mitigation

Mitigation
As described for mitigation of potential impacts for Project Alpha construction, best practice for pollution prevention will be considered during the operational phases of Project Alpha to mitigate the risk from accidental spillages. Although it is not anticipated for the impact for thermal pollution to be significant in EIA terms, If standards are introduced prior to or during construction and operation of the offshore wind farm, modelling will be conducted to ensure thermal plumes are within acceptable limits. Once the proposed biocide treatment approach has been identified discussion will be undertaken with the relevant authorities to seek a consent to discharge.

Residual Impact

8.219. Following the best practice, plans and guidance put in place, the impact significance on sediment or water quality during operation of the Project Bravo will be negligible and **not significant**.

Introduction of marine non-native / alien species

8.220. The potential impacts will be the same as those identified for Project Alpha. It is not considered that Project Bravo will act as a 'stepping stone' or have a significant effect over and above the potential for such an effect from existing hard substrata within the site.

8.221. The value of the waters around the development sites is considered to be low as the nearest sensitive water quality features (namely, shellfish waters and designated bathing sites) are all at significant distance (over 40km) from Project Alpha and Project Bravo and, therefore, well removed. In addition, the nearest, relevant nature conservation site, the Berwickshire and North Northumberland Coast marine SAC, for which rocky reefs are a feature (see Chapter 9: Nature Conservation Designations of this ES) lies over 60km away. The risk of transporting marine non-natives could be as high as medium magnitude, depending on vessels are travelling from and this contributes to a potential minor and **not significant** impact.

Mitigation

Mitigation

Once the vessels for operation are confirmed, a risk assessment will be conducted taking account of vessel activities, previous locations, and planned routes that could introduce marine non-native species to the area. The assessment and measures indicated by the assessment will be agreed with Marine Scotland.

If the risk assessment identifies a concern, further consultation with be undertaken with SNH and SEPA, with the aim of compliance with Water Framework and Marine Strategy Framework Directive objectives.

Residual Impact

8.222. Following the mitigation stated above, the likelihood of transporting marine non-native species to the site is reduced to negligible magnitude, reducing the impact to negligible and **not significant**.

Transmission Asset Project

Effects on suspended sediment concentrations and transport resulting from scour due to the presence of foundation structures and rock protection measures.

8.223. The effects on sediments and sedimentary structures during the operation phase of the Transmission Asset Project will be considerably less than previously described for Project Alpha and Project Bravo in terms of scour hole development in the seabed adjacent to OSP foundations. Impacts associated with the OSP construction are already assessed in the impact assessment for Project Alpha and Project Bravo above. The residual impact is assessed to be negligible, and the OSPs are a small component of the activities leading to this assessment.

8.224. Any changes are anticipated to be localised (see Chapter 7: Physical Environment of this ES and Royal Haskoning (2011) provided in Appendix E4). In addition, given that the predicted impact on deterioration of water and sediment quality due to increases in suspended sediment and re-suspension of contaminants during preparation activities are assessed to be of negligible it follows that the impacts from scour (incorporating a lower volume of sediments released into the water column) will also be negligible and **not significant**.

Mitigation

Mitigation

As a matter of good practice, the detailed design of the project will consider scour protection to reasonably reduce the potential for scour hole formation. It should be noted that scour will always have the potential to occur around any static structure within the dynamic marine environment. Whether the degree of scour can be tolerated in design terms (i.e. volume and depth) will be dependent upon the nature of the surrounding seabed.

Visual or bathymetric surveys will be undertaken at selected locations within the OWF site to assess the magnitude and extent of scour formation and development, and the effectiveness of any scour protection. Subsequent surveys will be planned depending on the results of initial monitoring. The requirement for visual or bathymetric surveys will be discussed with Marine Scotland and other key stakeholders and agreement reached to the detail on future monitoring requirements.

Residual Impact

8.225. With mitigation measures such as those described above in place, it is anticipated that the residual effect on the physical environment will be negligible and **not significant** regardless of the substructure/ foundation type taken forward in the final project design. This is not significant under EIA regulations.

Deterioration of water and sediment quality as a result of scour impacts associated with ECR and cable protection measures

8.226. There is potential for impacts upon water and sediment quality as a result of scour occurring around the cable protection measures caused by local acceleration of tidal current flow. The depth of scour will depend on the physical conditions, the thickness of the mobile layer and the cohesiveness of the substrate.

8.227. Scour will only occur around cables if the necessary physical conditions exist and if the cable does not attain sufficient burial depth. If sufficient burial is achieved then scour shall not develop. If required, cable protection will be achieved by using concrete mattresses or placed rock. Secondary scour may develop around the edges of any cable protection materials, however, once the secondary scour has developed, long-term suspension of sediment is not anticipated. The effect of secondary scour associated with the export cables on the existing hydrodynamic and sedimentary regimes, is likely to be small and highly localised. In the context of the wider sediment transport processes no effects are anticipated.

8.228. Any changes are anticipated to be localised. In addition, given that the predicted impact on deterioration of water and sediment quality due to increases in suspended sediment and re-suspension of contaminants during construction activities are negligible it follows that the impacts from scour will also be negligible and **not significant**.

Mitigation

Mitigation

No mitigation is proposed

Residual Impact

8.229. Following the best practice, plans and guidance put in place, the residual impact on sediment or water quality from scour associated with the ECR and cable protection will be negligible and **not significant**.

Deterioration in water and / or sediment quality due to accidental spillage of construction materials

8.230. As per Project Alpha and Project Bravo, the activities associated with the routine operation of an offshore wind farm are unlikely to introduce significant volumes of contaminants to the marine environment; therefore the potential impacts on water and sediment quality during this phase are likely to be restricted to accidental spillages during maintenance activities. The risk of pollution events will be minimised by adherence to the MARPOL Convention regulations, as well as following standard good practice, such as the Pollution Prevention Guidelines issued by SEPA.

8.231. If any accidental spillages were to occur, the impact has the potential to be of negligible magnitude (as a worst case, although this will be dependent on the materials spilled). In regard to sensitivity, the proposed landfall at Carnoustie is located approximately 8.5km from the designated Arbroath Bathing Waters, and 570m from the Carnoustie Bathing Waters, which are classed within this EIA as being of medium sensitivity. Therefore, there is potential for an impact of negligible and **not significant** on water quality.

Mitigation

Mitigation
Contractors will be required by Seagreen to put in place appropriate Site Environmental Management Plans (SEMP) and Pollution Control and Spillage Response Plans that would have been agreed with the Regulatory Authorities prior to offshore activities commencing. These plans will act to reduce the potential for accidental pollution and in the unlikely event of a pollution incident, would ensure a rapid and appropriate response.

Residual Impact

8.232. Following the best practice, plans and guidance put in place, the residual impact on sediment or water quality from any accidental spillage of construction materials will remain negligible and **not significant**.

IMPACT ASSESSMENT – DECOMMISSIONING

Project Alpha

Impacts due to re-suspension of sediments and release of contaminants

8.233. During decommissioning it is anticipated that array cables may be removed or left in situ, or a combination of both, reflecting current regulatory thinking. The foundation structures will be removed which could result in disturbance to sediments and any contaminants present.

8.234. Re-suspension of sediments will be less than that anticipated during construction (as ground preparation will not be necessary) and will be of negligible significance. Likewise the potential for re-suspension of contaminants will be lower and will also be negligible and **not significant**.

8.235. WTG and ancillary structures will contain fluids and oils, with any leakages that have occurred over the operational life of the project being contained with the structure itself (see Chapter 5: Project Description of this ES). Upon removal there is therefore, a potential for accidental release of any leaked fluids and oils. The risk of pollution events will be minimised by adherence to the MARPOL Convention regulations, as well as following standard good practice, such as the Pollution Prevention Guidelines issued by SEPA and will be detailed in the decommissioning plan.

Mitigation

Mitigation
As detailed in Chapter 5: Project Description of this ES, a decommissioning plan will be established and agreed with the regulators that will ensure that work associated with this phase of the project will fully assess all potential impacts and put in place mitigation measures, where necessary.

Residual Impact

8.236. Following the decommissioning plan and implementation of best practice and guidance, it is anticipated that the residual impact on sediment or water quality during decommissioning of the offshore wind farms will be negligible and **not significant.** This is not significant under EIA regulations.

Introduction of marine non-native / alien species

8.237. The potential impacts will be the same as those identified for construction. It is not considered that Project Alpha will act as a 'stepping stone' or have a significant effect over and above the potential for such an effect from existing hard substrata within the site.

8.238. The value of the waters around the development sites is considered to be low as the nearest sensitive water quality features (namely, shellfish waters and designated bathing sites) are all at significant distance (over 40km) from Project Alpha and Project Bravo and, therefore, well removed. In addition, the nearest, relevant nature conservation site, the Berwickshire and North Northumberland Coast marine SAC, for which rocky reefs are a feature (see Chapter 9: Nature Conservation Designations of this ES) lies over 60km away. The risk of transporting marine non-natives could be as high as medium magnitude, depending on vessels are travelling from and this contributes to a potential impact of minor adverse and **not significant**.

Mitigation

Mitigation
Once the vessels for decommissioning are confirmed, a risk assessment will be conducted taking account of vessel activities, previous locations, and planned routes that could introduce marine non-native species to the area. The assessment and measures indicated by the assessment will be agreed with Marine Scotland. If the risk assessment identifies a concern, further consultation with be undertaken with SNH and SEPA, with the aim of compliance with Water Framework and Marine Strategy Framework Directive objectives.

Residual Impact

8.239. Following the mitigation stated above, the likelihood of transporting marine non-native species to the site is reduced to negligible magnitude, reducing the impact to negligible and **not significant**.

Project Bravo

Impacts due to re-suspension of sediments and contaminants

8.240. As per Project Alpha, it is likely that decommissioning will require the removal of foundations but it is anticipated that array cables may be removed, left in situ or a combination of both. Impacts will be negligible and **not significant** for both re-suspension of sediments and contaminants. The risk of pollution events (from the removal of WTGs and ancillary infrastructure) will be minimised by adherence to the MARPOL Convention regulations, as well as following standard good practice, such as the Pollution Prevention Guidelines issued by SEPA and will be detailed in the decommissioning plan.

Mitigation

Mitigation

As detailed in Chapter 5: Project Description of this ES, a decommissioning plan will be established and agreed with the regulators that will ensure that work associated with this phase of the project will fully assess all potential impacts and put in place mitigation measures, where necessary.

Residual Impact

8.241. Following the decommissioning plan and implementation of best practice and guidance, it is anticipated that the residual impact on sediment or water quality during decommissioning of the offshore wind farms will be negligible and **not significant.**

Introduction of marine non-native / alien species

8.242. The potential impacts will be the same as those identified for Project Alpha. It is not considered that Project Bravo will act as a 'stepping stone' or have a significant effect over and above the potential for such an effect from existing hard substrata within the site.

8.243. The value of the waters around the development sites is considered to be low as the nearest sensitive water quality features (namely, shellfish waters and designated bathing sites) are all at significant distance (over 40km) from Project Alpha and Project Bravo and, therefore, well removed. In addition, the nearest, relevant nature conservation site, the Berwickshire and North Northumberland Coast marine SAC, for which rocky reefs are a feature (see Chapter 9: Nature Conservation Designations of this ES) lies over 60km away. The risk of transporting marine non-natives could be as high as medium magnitude, depending on vessels are travelling from and this contributes to a potential minor and not **significant impact**.

Mitigation

Mitigation

Once the vessels for decommissioning are confirmed, a risk assessment will be conducted taking account of vessel activities, previous locations, and planned routes that could introduce marine non-native species to the area. The assessment and measures indicated by the assessment will be agreed with Marine Scotland.

If the risk assessment identifies a concern, further consultation with be undertaken with SNH and SEPA, with the aim of compliance with Water Framework and Marine Strategy Framework Directive objectives.

Residual Impact

8.244. Following the mitigation stated above, the likelihood of transporting marine non-native species to the site is reduced to negligible magnitude, reducing the impact to negligible and **not significant**.

Transmission Asset Project

Impacts due to re-suspension of sediments and contaminants

8.245. During decommissioning it is anticipated that array and export cables may be removed or left in situ, or a combination of both. The foundation structures will be removed which could result in disturbance to sediments and any contaminants present as described for Project Alpha and project Bravo. Given the number of structures (a maximum of 5 OSPs) there would be a negligible and **not significant** impact.

Mitigation

Mitigation

As detailed in Chapter 5: Project Description of this ES, a decommissioning plan will be established and agreed with the regulators that will ensure that work associated with this phase of the project will fully assess all potential impacts and put in place mitigation measures, where necessary.

Residual Impact

8.246. Following the decommissioning plan and implementation of best practice and guidance, it is anticipated that the residual impact on sediment or water quality during decommissioning of the offshore wind farms will remain negligible and **not significant**.

Introduction of marine non-native / alien species

8.247. The sensitivity of the waters around the coastline is considered to be of medium value as the nearest sensitive water quality features (namely, shellfish waters and designated bathing sites) are all at significant distance (over 40km) from Project Bravo and, therefore, well removed. In addition, the nearest, relevant nature conservation site, the Berwickshire and North Northumberland Coast marine SAC, for which rocky reefs are a feature (see Chapter 9: Nature Conservation Designations of this ES) lies over 60km away. The risk of transporting marine non-natives could be as high as medium magnitude, depending on vessels are travelling from and this contributes to a potential moderate adverse and **significant** impact.

Mitigation

Mitigation

Once the vessels for decommissioning are confirmed, a risk assessment will be conducted taking account of vessel activities, previous locations, and planned routes that could introduce marine non-native species to the area. The assessment will also recommend any proactive management measures which can be taken to minimise risk of introduction of alien species. The approach and measures will be developed with the contractors and agreed with Marine Scotland prior to works commencing. If the risk assessment identifies a concern, further consultation with be undertaken with SNH and SEPA, with the aim of compliance with Water Framework and Marine Strategy Framework Directive objectives.

Residual Impact

8.248. Following the mitigation stated above, the likelihood of transporting marine non-natives to the site is reduced to negligible magnitude, reducing the impact to negligible and **not significant**. This is not significant under EIA regulations.

IMPACT ASSESSMENT – CUMULATIVE AND IN-COMBINATION

8.249. The post mitigation impacts identified during the construction, operation and decommissioning phases of the Seagreen Project that have the potential to result in cumulative effects comprise:

- deterioration in water quality due to re-suspension of sediments and contaminants;
- deterioration in water and or sediment quality due to accidental spillage of fluids, lubricants and or oils during operation; and
- introduction of marine non native / alien species.

8.250. Impacts occurring during the construction of the Seagreen Project are anticipated to persist for a short duration (i.e. days to weeks) suggesting that cumulative impacts are likely to be spatially and temporally restricted. The potential cumulative effects however are likely to manifest immediately and dissipate with time as the surrounding environment adapts to the new regime.

8.251. Cumulative impacts are identified in Table 8.23.

Seagreen cumulative impact with other schemes

8.252. Two other OWFs are currently in the planning process and are considered relevant in terms of cumulative impact; these are the Inch Cape Offshore Wind Farm (Inch Cape) and Neart na Gaoithe Offshore Wind Farm which will both be located inshore of the Seagreen project, along with future phases of the Firth of Forth OWF immediately south of the Seagreen project. Inch Cape will be located approximately 10km west of the Project Alpha and Neart na Gaoithe will be located approximately 30km south west

8.253. The unmitigated impacts of the Seagreen Project that have the potential to result in cumulative effects comprise:

- deterioration in water quality due to re-suspension of sediments and contaminants;
- deterioration in water and or sediment quality due to accidental spillage of fluids, lubricants and or oils during operation; and
- introduction of non- native species.

8.254. Impacts occurring during the construction of the Seagreen Project are anticipated to be localised and persist for a short duration (i.e. days to weeks) suggesting that cumulative impacts are likely to be spatially and temporally restricted. It is considered unlikely that impacts on water and sediment quality arising from the construction and operation of the Seagreen project will interact or create a cumulative impact with Inch Cape or Neart na Gaoithe OWFs or other phases of the Firth of Forth OWF. As discussed in Chapter 7: Physical Environment of this ES, the results from the cumulative assessment presented in Chapter 9 of the Neart na Gaoithe OWF ES (Mainstream Renewable Power, 2012), incorporating numerical modelling of potential impacts included increased suspended sediments, show that cumulative effects on the physical environment and sedimentary processes are negligible or low and support the conclusion that no cumulative effect on the physical environment is envisaged. It is also not anticipated that there will be any interaction or cumulative impacts arising from Seagreen project in combination with any other marine or coastal development projects in the region.

8.255. The geographical spacing of Project Alpha, Project Bravo and the transmission infrastructure with respect to both: (i) future phases of the Firth of Forth OWF; and (ii) other OWF in Scottish Territorial Waters should mean that effects in combination with these developments will not be significant.

Table 8.23 Cumulative impacts of Seagreen projects (Project Alpha, Project Bravo, Transmission Asset)

Impact	Project Alpha	Project Bravo	Transmission Asset	Cumulative	Justification
Construction					
Deterioration in water quality due to re-suspension of sediments	Negligible	Negligible	Minor adverse	Minor adverse **Not significant**	Impacts will be localised and short lived, and not anticipated to spread beyond the Seagreen Project, and therefore the worst case single impact (upon the bathing waters during construction of the Transmission Asset) is assessed to be the worst case cumulative impact.
Deterioration in water quality due to re-suspension of contaminants	Negligible	Negligible	Minor adverse	Minor adverse **Not significant**	Impacts will be localised and short lived, and not anticipated to spread beyond the Seagreen Project, and therefore the worst case single impact (upon the bathing waters during construction of the Transmission Asset) is assessed to be the worst case cumulative impact.
Deterioration in water and / or sediment quality due to accidental spillage of construction materials	Negligible	Negligible	Minor adverse	Minor adverse **Not significant**	Impacts will be localised and short lived, and not anticipated to spread beyond the Seagreen Project, and therefore the worst case single impact (upon the bathing waters during construction of the Transmission Asset) is assessed to be the worst case cumulative impact.
Introduction of marine non native / alien species	Negligible	Negligible	Negligible	Negligible **Not significant**	Risk assessment will remove mechanism for contamination
Operation					
Deterioration of water and sediment quality as a result of scour impacts at WTG structures and other ancillary infrastructure	Negligible	Negligible	Negligible	Negligible **Not significant**	Impacts will be localised and short lived, and not anticipated to spread beyond the Seagreen Project
Deterioration of water and sediment quality as a result of scour impacts associated with export cable protection measures	-	-	Negligible	Negligible **Not significant**	Impacts are along the Transmission Asset project only
Deterioration in water quality due to accidental spillages	Negligible	Negligible	Negligible	Negligible **Not significant**	Impacts will be localised and short lived, and not anticipated to spread beyond the Seagreen Project and therefore the worst case single impact (effects to the bathing waters during construction of the Transmission Asset) is assessed to be the worst case cumulative impact.
Introduction of marine non native / alien species	Negligible	Negligible	-	Negligible **Not significant**	Risk assessment will remove mechanism for contamination
Decommissioning					
Impacts due to re-suspension of sediments and contaminants	Negligible	Negligible	Negligible	Negligible **Not significant**	Impacts will be localised and short lived, and not anticipated to spread beyond the Seagreen Project
Introduction of marine non native / alien species	Negligible	Negligible	Negligible	Negligible **Not significant**	Risk assessment will remove mechanism for contamination

ENVIRONMENTAL STATEMENT LINKAGES

8.256. Table 8.24 presents ES linkages in and between water and sediment quality and other environmental parameters.

Table 8.24 ES Linkages

Inter-relationship	Relevant section	Linked chapter
Baseline sediment suspension characteristics	Paragraphs 8.121 – 8.249	Chapter 7 Physical Environment
Potential for suspended contaminants and sediments	Paragraphs 8.121 – 8.249	Chapter 10 Ornithology, Chapter 11 Benthic Ecology, Chapter 12 Fish and Shellfish Resources, Chapter 14 Commercial Fisheries
Deterioration in water quality due to accidental spillages	Paragraphs 8.121 – 8.249	Chapter 10 Ornithology, Chapter 11 Benthic Ecology, Chapter 12 Fish and Shellfish Resource, Chapter 14 Commercial Fisheries
Potential for scour	Paragraphs 8.121 – 8.249	Chapter 7 Physical Environment
Potential for cumulative impacts with other marine activities	Paragraphs 8.249 – 8.256	Chapter 20 Other Marine Users and Activities

OUTLINE MONITORING AND MANAGEMENT

8.257. It is considered that it will not be necessary to carry out any water quality monitoring during the construction, operation and decommissioning of the Seagreen Project. This is in part due to the impact assessment concluding minimal impacts as a result of the construction, operation and decommissioning of the Seagreen Project.

8.258. Any requirement for monitoring of sediment quality in the vicinity of the Seagreen Project will be discussed with consultees. However, given the anticipated lack of impact from the Seagreen Project and experience of the impacts from Round 1 and 2 developments, it is unlikely that such monitoring will be required.

SUMMARY

8.259. A summary of impacts, mitigation and residual impacts are provided in Table 8.25a (Project Alpha and Project Bravo) and Table 25b (Transmission Asset Project).

Table 8.25a Summary of Project Alpha and Project Bravo Impacts

Description of Impacts	Impacts	Potential Mitigation Measures	Residual Impact
Construction Phase			
Deterioration in water quality due to re-suspension of sediments	Negligible	If the need for seabed preparation is determined, a licence will be applied for under the Marine (Scotland) Act 2010 for Dredging and Deposit of Solid Waste in the Territorial Sea and UK Controlled Waters Adjacent to Scotland. This will necessarily consider details of the areas and materials to be dredged and a BPEO Assessment for deposit of the materials, including consideration of re-use of material as foundation ballast, beneficial use and disposal at sea.	Negligible **Not significant**
Deterioration in water quality due to re-suspension of contaminants	Negligible	No mitigation is proposed	Negligible **Not significant**
Deterioration in water and / or sediment quality due to accidental spillage of construction materials	Minor adverse	Construction Environmental Management Plans (CEMP) and Pollution Control and Spillage Response Plans will be agreed with the Regulatory Authorities prior to offshore construction activities commencing.	Negligible **Not significant**
Introduction of marine non-native / alien species	Minor adverse	Once the vessels for construction are confirmed, a risk assessment will be conducted. The assessment and measures indicated by the assessment will be agreed with Marine Scotland. Further consultation with SNH and SEPA may be required	Negligible **Not significant**
Operation Phase			
Deterioration of water and sediment quality as a result of scour impacts at WTG structures	Negligible	As a matter of good practice, the detailed design of the project will consider scour protection Visual or bathymetric surveys will be undertaken at selected locations within the OWF site Further monitoring requirements will be determined through consultation with Marine Scotland and other key stakeholders.	Negligible **Not significant**
Deterioration in water quality due to accidental spillages	Minor adverse	Best practice for pollution prevention will be considered during the operational phases to mitigate the risk from accidental spillages.	Negligible **Not significant**
Introduction of marine non-native / alien species	Minor adverse	Once the vessels for operation are confirmed, a risk assessment will be conducted. The assessment and measures indicated by the assessment will be agreed with Marine Scotland. Further consultation with SNH and SEPA may be required	Negligible **Not significant**
Decommissioning Phase			
Impacts due to re-suspension of sediments and contaminants	Negligible	As detailed in Chapter 5: Project Description, a decommissioning plan will be established and agreed with the regulators	Negligible **Not significant**
Introduction of marine non-native / alien species	Minor adverse	Once the vessels for construction are confirmed, a risk assessment will be conducted. The assessment and measures indicated by the assessment will be agreed with Marine Scotland. Further consultation with SNH and SEPA may be required	Negligible **Not significant**

Table 8.25b Summary of Transmission Asset Project Impacts

Description of Impact	Impact	Potential Mitigation Measures	Residual Impact
Construction Phase			
Deterioration in water quality due to re-suspension of sediments	Minor adverse	Best practice guidance will be followed to ensure that potential damage to environmental features is minimised throughout the proposed works.	Minor adverse **Not significant**
Deterioration in water quality due to re-suspension of contaminants	Minor adverse	No mitigation proposed.	Minor adverse **Not significant**
Deterioration in water and / or sediment quality due to accidental spillage of construction materials	Moderate adverse	CEMP and Pollution Control and Spillage Response Plans will be agreed with the Regulatory Authorities prior to offshore construction activities commencing. Management plan will be in place for HDD activities at landfall.	Minor adverse **Not significant**
Introduction of marine non-native / alien species	Moderate adverse	Once the vessels for construction are confirmed, a risk assessment will be conducted. The assessment and measures indicated by the assessment will be agreed with Marine Scotland. Further consultation with SNH and SEPA may be required	Negligible **Not significant**
Operation Phase			
Effects on suspended sediment concentrations and transport resulting from scour due to the presence of foundation structures and rock protection measures.	Negligible	As a matter of good practice, the detailed design of the project will consider scour protection Visual or bathymetric surveys will be undertaken at selected locations within the OWF site Further monitoring requirements will be determined through consultation with Marine Scotland and other key stakeholders.	Negligible **Not significant**
Deterioration of water and sediment quality as a result of scour impacts associated with ECR and cable protection measures	Negligible	No mitigation is proposed	Negligible **Not significant**
Deterioration in water and / or sediment quality due to accidental spillage of construction materials	Negligible	CEMP and Pollution Control and Spillage Response Plans will be agreed with the Regulatory Authorities prior to offshore construction activities commencing.	Negligible adverse **Not significant**
Introduction of marine non-native / alien species	Moderate adverse	Once the vessels for construction are confirmed, a risk assessment will be conducted. The assessment and measures indicated by the assessment will be agreed with Marine Scotland. Further consultation with SNH and SEPA may be required	Negligible **Not significant**

Description of Impact	Impact	Potential Mitigation Measures	Residual Impact
Decommissioning Phase			
Impacts due to re-suspension of sediments and contaminants	Negligible	As detailed in Chapter 5: Project Description, a decommissioning plan will be established and agreed with the regulators	Negligible **Not significant**
Introduction of marine non-native / alien species	Moderate adverse	Once the vessels for construction are confirmed, a risk assessment will be conducted. The assessment and measures indicated by the assessment will be agreed with Marine Scotland. Further consultation with SNH and SEPA may be required	Negligible **Not significant**

REFERENCES

BERR (Department for Business, Enterprise and Regulatory Reform), 2008. *Review of Cabling Techniques and Environmental Effects Applicable to the Offshore Wind Farm Industry*. Technical report. January 2008.

Buchanan (1984) Buchanan, J.B. 1984. Sediment analysis. In: Holme N.A., McInyre A.D. (eds), *Blackwell scientific publications (Methods for the study of marine benthos)*, 2nd ed, 41-65

CMACS, (2010). *Galloper Offshore Wind Farm Benthic Survey* Technical Report 2010.

Cole, S., Codling, I.D., Parr, W. & Zabel, T., (1999). *Guidelines for managing water quality impacts within UK European marine sites. Prepared for the UK Marine SAC Project*. Natura 2000.

FugroGEOS (2011). Seagreen Wind Energy Limited: Firth of Forth Zone Development – Metocean Study.

GEMS (2010). *Firth of Forth Offshore (Round 3) Wind Farm Development Project*. Draft Survey Report.

Hayes, P., Russell, M., Packer, G. (2005) Surveys of Dredged *Material and Wastewater Sludge Sea Disposal Sites for the East Coast of Scotland*. FRS Internal report No 08/05 (http://www.scotland.gov.uk/Uploads/Documents/IR0805.pdf)

Hitchcock, D.R. & Bell, S. (2004). *Physical impacts of marine aggregate dredging on seabed resources in coastal deposits*. Journal of Coastal Research 20 (10), 101-114.

HR Wallingford (2009). *Firth of Forth and Tay Developers Group, Collaborative Oceanographic Survey, Specification and Design*. Work Package 1. Review of existing information.

IECS (2011). *Firth of Forth Offshore (Round 3) Wind Farm Development Project*: Post Survey Report Benthic Services

IMO (1973) *International Convention for the Prevention of Pollution From Ships*, 1973 as modified by the Protocol of 1978

Mainstream Renewable Power (2012). *Neart na Gaoithe OWF Environmental Statement*.

Marine Conservation Society(2012) (http://www.goodbeachguide.co.uk/).

Intertek Metoc (2012). *Summary of Seagreen Firth of Forth Metocean Surveys To Date*. Report Ref. P1398G-R2981, June 2012.

John, S.A., Challinor, S.L., Simpson, M., Burt, T.N., & Spearman, J. (2000). *Scoping the assessment of sediment plumes from dredging*. Construction Industry Research and Information Association (CIRIA) Publication. ISBN 0 86017 547 2.

Newell, R.C., Seiderer, L.J., Robinson, J.E., Simpson, N.M., Pearce, B. & Reeds, K.A. (2004). *Impacts of overboard screening on seabed and associated benthic biological community structure in relation to marine aggregate extraction*. Technical Report to the Office of the Deputy Prime Minister (ODPM) and Minerals Industry Research Organisation (MIRO). Project No SAMP.1.022. Marine Ecological Surveys Limited, St.Ives. Cornwall. pp.152.

Oregon LNG (2008) https://s3-us-west-2.amazonaws.com/oregonlng/oregonlng/pdfs3/appendices/RR-2/appendices/appendix2f.pdf

Osiris Projects (2011). *Firth of Forth Offshore Wind Farm Export Cable: Geophysical Survey*, Volume 2 – Report

OSPAR (2010). *Quality Status Report* - http://qsr2010.ospar.org/en/media/chapter_pdf/QSR_complete_EN.pdf

Partrac (2012). *Winter metocean survey Final Report: 15th December 2011 – 19th June 2012*.

Royal Haskoning (2012) Foundation / substructure Assessments: Round 3 Firth of Forth Offshore Wind

Scottish Government *Marine Atlas* (2011)
http://www.scotland.gov.uk/Publications/2011/03/16182005/71

Seagreen (2010). *Phase 1 Scoping Report*. Document No. A6SW/SEAG-Z-DEV230-SWR-020-A3, July 2010.

SEPA (2011a) http://www.sepa.org.uk/water/monitoring_and_classification.aspx

SEPA (2011b) http://www.sepa.org.uk/water/river_basin_planning.aspx

SEPA (2011c) http://www.sepa.org.uk/water/bathing_waters/bathing_water_profiles.aspx

SEPA (2011d) http://www.sepa.org.uk/water/protected_areas/freshwater_fisheries.aspx

SEPA (2011e) http://apps.sepa.org.uk/shellfish/pdf/4.pdf