Total Quality. Assured.

ALCATEL SUBMARINE NETWORKS

Havhingsten - Ireland

Appendix H - Sediment Suspension for the Irish component of Havhingsten

P2228_R4693_Rev0 App H | July 2019

Intertek Energy & Water Consultancy Services
Exchange House, Station Road, Liphook, Hampshire GU30 7DW, United Kingdom

CONTENTS

LIST OF TABLES AND FIGURES

Tables

1. SEDIMENT DISTURBANCE ASSOCIATED WITH CABLE INSTALLATION

During the marine cable installation some seabed sediment will be re-suspended into the water column. The cable laying activities will involve either jetting and/or ploughing which will cause localised and temporary resuspension of seabed sediments into the water column. Such activities are likely to affect species in the immediate vicinity of the proposed cable route. calculations of three different sediment component fractions (gran size) was performed to quantify the zone of influence (i.e. spatial extent) and layer depth associated with ploughing or jetting. The calculations for sediment resuspension associated with ploughing or jetting are presented in Tables 1-2 for the nearshore during spring tide current velocity and in Tables 3-4 for the offshore during spring tide current velocity in the Irish sea. Spring tide current velocity was obtained using a regional hydrodynamic model of the Irish Sea (Metoc 2003).

Table 1-1 Sediment resuspension caused by ploughing during spring tide current velocity for the nearshore Irish Sea

Sediment component	Settling velocity Vs (m s^{-1})	Settling time, ts (s)	Median settling distance (m)	Maximum component (%)	Volume released (m^3 m^{-1})	Median Layer depth (m)	Median Layer depth (mm)
Silt	0.00009874	50638.0393	5114.441969	33.2	0.0498	9.73713E-06	0.009737133
Sand	0.02820125	177.2971056	17.90700767	84.5	0.12675	0.007078235	7.07823453
Gravel	0.2514	19.88862371	2.008750994	2.73	0.004095	0.00203858	2.038580198

Notes:

Spring tide current velocity for the nearshore location (53.543 N, -6.076 E) = 0.202m s^{-1} (Metoc 2003).

10% of initial trench volume (1.5m^3 m^{-1}) sediments released into the water column by plough.

Sediment resuspension height = 5m (representative of conservative estimate for ploughing).

Table 1-2 Sediment resuspension caused by jetting during spring tide current velocity for the nearshore Irish Sea.

Sediment component	Settling velocity Vs (m s^{-1})	Settling time, ts (s)	Median settling distance (m)	Maximum component (%)	Volume released (m^3 m^{-1})	Median Layer depth (m)	Median Layer depth (mm)
Silt	0.00009874	101276.0786	10228.88394	33.2	0.0996	9.73713E-06	0.009737133
Sand	0.02820125	354.5942112	35.81401534	84.5	0.2535	0.007078235	7.07823453
Gravel	0.2514	39.77724741	4.017501989	2.73	0.00819	0.00203858	2.038580198

Notes:

Spring tide current velocity for the nearshore location (53.543 N, -6.076 E) = 0.202m s^{-1} (Metoc 2003). 10% of initial trench volume (1.5m^3 m^{-1}) sediments released into the water column by jet. Sediment resuspension height = 10m (representative of conservative estimate for jetting).

Table 1-3 Sediment resuspension caused by ploughing during spring tide current velocity for the offshore Irish Sea.

Sediment component	Settling velocity Vs (m s^{-1})	Settling time, ts (s)	Median settling distance (m)	Maximum component (%)	Volume released (m^3 m^{-1})	Median Layer depth (m)	Median Layer depth (mm)
Silt	0.00009874	50638.0393	15318.00689	33.2	0.0498	3.25108E-06	0.003251076
Sand	0.02820125	177.2971056	53.63237445	84.5	0.12675	0.002363311	2.363311364
Gravel	0.2514	19.88862371	6.016308671	2.73	0.004095	0.00068065	0.680649917

Notes:

Spring tide current velocity for the offshore location (53.744 N, -5.307 E) = 0.605m s^{-1} (Metoc 2003).

10% of initial trench volume (1.5m^3 m^{-1}) sediments released into the water column by plough. Sediment resuspension height = 5m (representative of conservative estimate for ploughing).

Table 1-4 Sediment resuspension caused by jetting during spring tide current velocity for the offshore Irish Sea.

Sediment component	Settling velocity Vs (m s^{-1})	Settling time, ts (s)	Median settling distance (m)	Maximum component (%)	Volume released (m^3 m^{-1})	Median Layer depth (m)	Median Layer depth (mm)
Silt	0.00009874	101276.0786	30636.01377	33.2	0.0996	3.25108E-06	0.003251076
Sand	0.02820125	354.5942112	107.2647489	84.5	0.2535	0.002363311	2.363311364
Gravel	0.2514	39.77724741	12.03261734	2.73	0.00819	0.00068065	0.680649917

Notes:

Spring tide current velocity for the offshore location (53.744 N, -5.307 E) = 0.605m s^{-1} (Metoc 2003). 10% of initial trench volume (1.5m^3 m^{-1}) sediments released into the water column by jet. Sediment resuspension height = 10m (representative of conservative estimate for jetting).

Tidal current velocities within the Irish Sea are highly variable depending on the geographical location. Depth-averaged values exceed 1m s^{-1} at spring tides generally throughout the St. George's Channel, northwest of Anglesey, north of the Isle of Man and in the North Channel. Within these areas particularly high values can be found locally near headlands, for instance exceeding 2m s^{-1} at spring tides northwest of Anglesey. Areas of very weak tidal currents, less than 0.25m s^{-1} at spring tides, occur to the south-west of the Isle of Man, towards Dundrum and Dundalk Bays, and slightly less weak, 0.5m s^{-1}, between the Isle of Man and the Cumbrian coast, both as a consequence of this being the region where the two tidal waves meet (Howarth 2005). Due to the geographic variability in current velocity, two values for spring tidal current velocity was used for the calculations of the settling distance associated with resuspended sediments. Spring tidal current velocities were derived from the regional hydrodynamic model of the Irish Sea (Metoc 2003) from two locations representative of nearshore and offshore tidal currents.

The sediment fraction released into the water column by Jetting represents 20% of the initial sediment volume, while the remaining 80% remains settled, whereas the sediment fraction released by ploughing represents 10% of the initial sediment volume. The initial sediment volume influenced by the plough or jet represents a volume of 1.5m^3 m^{-1}. The maximum height of sediment resuspension into the water column was assumed to be 10m by jetting and 5m by ploughing, both representing a conservative estimate. Grain-size-specific settling velocities were used for each of the sediment fractions (silt, sand and gravel) were used in the calculations.

The maximum sediment component represents the maximum percentage of each sediment fraction (silt, sand and gravel) from the sediment samples collected during the environmental survey within the Proposed Development.

Ploughing

The calculations of sediment resuspension associated with ploughing activities during high tide current velocity show that gravel will settle out of suspension at 2.0m from the source, leading to a median layer depth of 2.039mm based on the nearshore tidal currents in the Irish Sea (0.202 m s^{-1}; Metoc 2003), and 6.0m with a layer depth of 0.680mm based on the offshore tidal currents in the Irish Sea (0.605 m s^{-1}; Metoc 2003). Ploughing caused sus-pended sand particles to settle out of suspension at 17.9m at a median layer depth of 7.078mm based on the nearshore of tidal current velocity, while settling out at 53.6m at a median layer depth of 2.363mm based on the offshore tidal current velocity. Resuspended silt particles caused by ploughing settled out of suspension 5114.4m from the source of disturbance when ex-posed to the nearshore tidal currents at a median layer depth 0.010mm, while settling out 15318.0m from the source, at a median layer depth of 0.003mm based on the offshore tidal currents.

Jetting

The calculations of sediment resuspension associated with ploughing activities during high tide current velocity show that gravel will settle out of suspension at 4.0m from the source, leading to a median layer depth of 2.039mm based on the nearshore tidal currents in the Irish Sea (0.202 m s^{-1}; Metoc 2003), and 12.0m with a layer depth of 0.681mm based on the offshore tidal currents in the Irish Sea (0.605 m s^{-1}; Metoc 2003). Jetting caused suspended sand particles to settle out of suspension at 35.8m at a median layer depth of 7.078mm based on the nearshore tidal current velocity, while settling out at 107.3m from the source at a median layer depth of 2.363mm based on the offshore tidal current velocity. Resuspended silt particles caused by jetting settled out of suspension 10228.9m from the source of disturbance when exposed to the nearshore tidal currents at a median layer depth 0.010mm, while settling out 30636.0m from the source, at a median layer depth of 0.003mm based on the offshore tidal currents.

While silt particles will remain in suspension for extended periods of time (up to 28.1 hours), suspended sand particles and gravel will settle out of the water column relatively quickly. Changes in sediment properties are unlikely to be detectable beyond 100m of the trench.

Potential impacts

The marine cable installation will cause resuspension of sediments from the seabed into the water column. Jet trenching will cause a greater level of sediment suspension compared to the use of ploughing equipment. However, the impact is a small, localised and temporary increase in turbidity, with subsequent re-deposition and potential of smothering of species.

Although modern equipment and installation techniques have reduced the re-suspension of sediment during cable trenching activities, remaining suspended sediment dispersed into the water column has the potential to affect sessile filter feeders and, once settled out, could potentially smother organisms within the deposition area. Suspended sediments can obstruct the filtration mechanisms of some benthic and pelagic species. For example, some types of worm and brittlestars can be affected through the clogging of gills or damage to feeding structures. Suspended sediments can also attach to fish eggs causing abnormalities or death. It can also affect the growth of the macrobenthos and may have a lethal effect on some species.

To determine the sensitivity of habitats within the Proposed Development an assessment has been carried out using information provided on the Marine Life Information Network (MarLIN). Table 1-5 identifies that the subtidal habitats identified within the Proposed Development generally have low to medium sensitivity to the pressure smothering and heavy siltation rate changes.

Table 1-5 Sensitivity of habitats within the Proposed Development to the pressures of smothering and siltation rate changes (heavy).

EUNIS habitat	Resistance	Resilience	Sensitivity	Confidence*
A4.21: Echinoderms and crustose communities on circalittoral rock	*Medium*	*Medium*	*Medium*	*Low*
A5.26: Circalittoral muddy sand	*Low*	*Medium*	*Medium*	*Medium-High*
A5.231 Infralittoral mobile clean sand with sparse fauna	Low	High	Low	High-Medium
A5.261: *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment	Low	Medium	Medium	Medium
A5.351 *Amphiura filiformis*, *Kurtiella bidentata* and *Abra nitida* in circalittoral sandy mud	Low	Medium	Medium	Low

Italics and grey colour = Assessment has been based on sublevel habitat assessments.

*Confidence is specific to sensitivity and is based on the quality of evidence, applicability of evidence and degree of concordance (i.e. agreement between studies).

The sensitivity of subtidal habitats has been assessed as medium recognising the differing sensitivities (identified in Table 1-5) within the Proposed Development. No habitats were found to be highly sensitive to changes in resuspension and smothering. *Abra alba* and *Nucula nitidosa* in circalittoral muddy sand or slightly mixed sediment is the most sensitive habitat identified within the marine cable corridor. It should be mentioned that due to the lack of sensitivity information, three biotopes have been represented by the most sensitive sublevel habitat and not the actual habitat identified within the Proposed Development. Due to the short duration, the localised spatial extent of the trenching activities and the relatively small volume of sediments resuspended, the overall significance of the effect has been assessed as Negligible and Not Significant.

1.2 Assumptions

The following information sets out the assumptions made in calculation of the sediment dispersion calculations.

Table 1-6 Parameter assumptions used in the calculations.

Parameter	Value
Jet fraction released	20 %
Initial volume	1.5 m s^{-1}
Receiving volume	10 m^3
Injection at	5 m
Sediment volume	0.3 m^3
Sediment density	2.5 s.g.
Weight of sediment	750000 g
Settling velocity (V_s)	0.0000987 m s^{-1}
Settling time (ts)	50638 s
Silt content	100 %
Initial particulate concentration	75000 mg l^{-1}

Table 1-7 Current speed for landfall location along the Proposed Development in the Irish Sea.

Location	Latitude	longitude	Max. current speed
Loughshinny landfall	53.543	-6.076	0.202

Note:
The current speed value was obtained from the Irish Sea and Welsh regional hydrodynamic model (Metoc 2003).

Table 1-8 Distance (L) from source at which silt concentrations equals background levels (N = 10 mg l-1; CEFAS 2016) for each of the landfall locations.

Location	Median settling distance ($L_{0.5}$)	L
Loughshinny landfall	5114m	5966m

Table 1-9 Current speed for the crossing location along the Proposed Development in the Irish Sea.

Location	Latitude	longitude	Max. current speed
Interconnector 1, Ireland	53.744	-5.307	0.605

Table 1-10 Distance (L) from source at which silt concentrations equals background levels (N = 10 mg l-1; Water Framework Directive) for each of the crossing locations.

Location	Median settling distance ($L_{0.5}$)	L
Interconnector 1, Ireland	15318m	17869m

1.3 Calculations

Settling time (ts)

$$Settling\ time = \frac{resuspension\ height}{Settling\ velocity}$$

Median settling distance

$$Median\ settling\ distance = \frac{ts\ \times Current\ velocity}{2}$$

Volume released

$$Volume\ released = \frac{initial\ volume \times fraction\ released \times max.component\ fraction}{100}$$

Median layer depth

$$Median\ layer\ depth = \frac{Volume\ released}{Settling\ distance}$$

Concentration of suspended sediments

$$C_L = C_0 \times 0.5^{\frac{L}{L_{0.5}}}$$

Where C_L is the concentration of suspended sediments, in this case silt, in the water column at a given distance from the source of disturbance, C_0 is the initial concentration of suspended sediments in the water column at the source of disturbance (i.e. 0m) and L is the distance from the source of disturbance at which C_L is equal to background sediment concentrations (i.e. 10 mg l^{-1}).

The equation above can be rearranged to:

$$= Log\left(\frac{C_L}{C_0}\right) \times L_{0.5} \times \frac{1}{Log(0.5)}$$

1.4 References

1 CEFAS (2016). Monthly averages of non-algal SPM (doi:10.14466/CefasDataHub.31).

2 Howarth, M. J. (2005), Hydrography of the Irish Sea SEA6 Technical Report, POL internal Document No 174, Proudman Oceanographic Laboratory, Liverpool.

3 MarLIN. (2019). The Marine Life Information Network. [online] Available at: www.marlin.ac.uk (Accessed May 2019).

4 Metoc (2003). Costal Modelling System for Wales, Calibration and Verification of the Irish Sea and Welsh Regional Hydrodynamic Models. November 2003. Metoc Report No: 1138.