How does this affect the overall quality status?

There are ecological impacts at the local level and regional level, in particular for certain ecosystem types, for example estuaries and intertidal mud flats and associated species in the southern and eastern North Sea. Generally, Contracting Parties have put in place license and control systems which help minimise impacts through best environmental practice recommended by the OSPAR Guidelines. The literature review indicates that physical, biological and chemical impacts do occur, but are localised within or close to (< 5 km) the boundaries of the disposal site (OSPAR, 2008b). Though disposal is regulated so that only sediments that meet established environmental quality criteria (action levels) are dumped, it is noted that defined action levels can vary strongly between Contracting Parties. In addition, there are only action levels for a limited number of contaminants and for example none for "new" substances such as brominated flame retardants.

Dredged sediment can have a relatively high content of organic matter. It is concluded from field studies that dredged sediment with a relatively high content of organic matter can act as a food supply for benthic organisms, which can result in an increase in opportunistic species (for example worms) at the disposal site. In this case, the disposal of dredged sediment results in a change in the benthic community structure (OSPAR (2008b).

Dredged sediment disposal can adversely affect the benthic community both by direct burial and habitat alterations due to a change in sediment structure (Zimmerman *et al.*, 2003). Direct burial will often result in the immediate mortality of benthos. Habitat alteration can have long-term effects on the benthic community (Morton, 1977). Habitat alterations have been observed due to the deposition of fine-grained sediments on coarse grained natural sediments (BfG, 2001; Stronkhorst *et al.*, 2003; Zimmerman *et al.*, 2003; Van Dalfsen and Lewis, 2006). It is concluded that dredged sediment disposal can adversely affect the benthic community if the sediment structure of the dredged sediments differs too much from the sediment structure of the natural occurring sediments at the disposal site. Negative effects due to a change in sediment structure can be minimized by selecting receiving sites that have similar sedimentary characteristics to the dredged sediments to be disposed.

Enhanced sedimentation is the most cited impact of dredged sediment disposal. Excessive deposition of dredged sediment leads to burial, smothering or crushing of the benthos. Most benthic organisms live in the top 10 cm of the seabed and must maintain some connection to the sediment-water interface for ventilation and feeding (Miller *et al.*, 2002). This connection is disturbed by excessive sediment deposition. In cases where the quantity of sediment disposed does not differ greatly from natural sedimentation in high energy systems, the effects are relatively small as many of the species are capable of migrating up through the deposited sediments (for example Bijkerk, 1988; Essink, 1999; Schratzberger *et al.*, 2006; Wilber *et al.*, 2007). Often however, the amount deposited is too great to allow species to survive burial and recovery occurs via recolonization of and/or immigration to the new sediment surface (for example Stronkhorst, 2003; Bolam *et al.*, 2006a, 2006b). The long-term effects in such cases may be more severe since recovery of benthic communities, a major food source for many other animals (for example fish) will be more prolonged. Relocation/disposal in high energy systems like tidal estuaries or coasts has less effect than relocation/disposal in low energy systems like for example lagoons with merely moving sediments.

Disposal of dredged material will cause local and temporal (re)suspension of sediments, causing increased turbidity. High turbidity results in low levels of transmitted light and can therefore negatively affect functioning of light-dependent organisms such as phytoplankton, eelgrass and visual predators, for example fish and fish-eating birds (Essink, 1999). Increased turbidity can be both caused by natural processes, such as storm events and tides, and human activities, for example the disposal of dredged sediment at sea. Phytoplankton production is directly dependent on light penetration into the water column. Increased water turbidity results in a decrease in light penetration, which is likely to affect phytoplankton adversely (Essink, 1999). However this effect will be localised in space and time and therefore have little impact on the total primary production of an estuary or of a tidal basin in which disposal took place. From field studies, it is concluded that disposal of dredged sediments will cause local and temporal (re)suspension of sediments causing increased turbidity. However, it is also concluded that naturally occurring turbidity elevations, induced by flood tides and weather activities, have a more significant effect than the periodic increased levels caused by disposal activities of dredged sediment. This means that the impact of dredged sediment disposal of light-dependent organisms due to increased turbidity is unlikely to have a greater impact than naturally occurring turbidity elevations, induced by flood tides and weather activities. By selecting appropriate time windows during which dredged sediment may be disposed of, possible adverse effects of increased turbidity can be minimized (Essink, 1999).

During disposal of dredged sediment at sea large amounts of sediment may be brought into suspension (Essink, 1999). Increased suspended particulate matter (SPM) concentrations may interfere with food intake of filter-feeding benthos (bivalves) and copepods, and functioning of gills of fish may be impaired due to clogging (Essink, 1999). According to Widdows *et al.* (1979) growth of filter-feeding bivalves may be impaired at SPM concentrations > 250 mg/l. Bolam *et al.* (2006a, 2006b) used a number of numerical techniques to assess impacts at 18 different disposal sites. They concluded that ecological effects associated with dredged sediment disposal were site-specific and any assessment of the consequences of sediment disposal at sea must take account of site-specific variation in prevailing hydrographic regimes and in ecological status, along with information on the disposal activity itself (mode, timing, quantity, frequency and type of material). Impacts to the benthic community at disposal sites typically are near-field and short-term (for example Leuchs and Nehring, 1996; Bolam and Rees, 2003; Stronkhorst *et al.*, 2003; CEFAS, 2005; Bolam *et al.*, 2006a, 2006b). At the disposal site of Loswal Northwest, on the Netherlands Continental Shelf, Stronkhorst *et al.* (2003) determined the impacts of sediment disposal at the disposal and an 8 km eastwards transect. During the time of disposal, the species richness and abundance of benthic invertebrates declined over an area extending about 1-2 km eastwards. Leuchs and Nehring (1996) determined the spatial impact of the disposal of dredged sediment in the Elbe Estuary, Germany. They showed that the disposal had an impact on macrozoobenthos in an area extending about one kilometre upstream and downstream of the disposal site.

In many studies the impacts of disposal are monitored in time (for example Harvey *et al.* 1998; Blanchard and Feder, 2003; Stronkhorst *et al.*, 2003; Bolam *et al.*, 2006a and review of recovery rates in Bolam and Rees, 2003). Often these studies are conducted to determine the time needed for the fauna to recover. De Grave and Whitaker (1999) suggest that recovery is not a suitable term to apply when assessing re-colonization after a disturbance since recovery implies return to faunal compositions and associated ecological pathways developed over many years (Blanchard and Feder, 2003). They suggest that "re-adjustment" rather than recovery is the appropriate terminology. The recovery rate of the species richness, (relative) abundance and diversity at different locations in the OSPAR maritime area varies from 3 months (Bolam *et al.*, 2006a) to more than 2 years (Stronkhorst *et al.* 2003; Bolam and Whomersley, 2005; Van Dalfsen and Lewis, 2006). At some locations the benthic community never recovers because sediment is disposed there more or less continuously. Repeated disturbances, such as described by Leuchs and Nehring (1996), to a benthic system results in a succession that never proceeds beyond the initial re-adjustment phase within a restricted area (dumpsite and close surroundings). Community structures, however, often fail to converge with reference sites within the monitoring period (no recovery). It should however be noted that because reference sites are not identical to the impact areas and that communities often occur in dynamic clusters, some discrepancy is to be expected (Armonies 2000).

The significance of effects of physical disturbance depends to a large extent on relocating/disposing within a high or within a low energy system.

➥*Go to full QSR assessment report on the environmental impact of dumping of wastes at sea (publication number 433/2009)*