Environmental Impact Assessment (EIA) and Appropriate Assessment (AA)

Evaluation of assessment tools and methods

Lot 2: Analysis of case studies of port development projects in European estuaries

By Royal HaskoningDHV, October 2012

Commissioned by the Antwerp Port Authority

Project part-financed by the European Union (European Regional Development Fund)

The Interreg IVB North Sea Region Programme

Disclaimer

By Royal HaskoningDHV, 12 November 2012

Commissioned by the Antwerp Port Authority

Project part-financed by the European Union (European Regional Development Fund)

Table of Contents

Project part-financed by the European Union (European Regional Development Fund)

Project part-financed by the European Union (European Regional Development Fund)

The Interreg IVB North Sea Region Programme

Project part-financed by the European Union (European Regional Development Fund)

Project part-financed by the European Union (European Regional Development Fund)

Executive summary

Background
TIDE (Tidal River Development) is an EU Interreg project (Interreg IV-B North Sea Region Programme) with Hamburg Port Authority as leading partner. In addition to Hamburg Port Authority, there are nine other partners in TIDE.

As part of TIDE, Royal Haskoning DHV was commissioned by the TIDE steering committee to carry out an investigation on how different European Member States cope with the uncertainties in Environmental Impact Assessments (EIA) and Appropriate Assessments (AA) for investigating the impact of major port development projects in the estuarine environment.

Lot 2 (the findings of which are reported in this document) comprises an analysis of environmental assessment practice through five case study examples, as follows:

- Enlargement of the navigation channel in the Eems estuary;
- Dredging of the approach channel to the Immingham Oil Terminal in the Humber estuary;
- Enlargement of the navigation channel in the Scheldt estuary;
- A series of major port development and capital dredging projects in the Stour and Orwell estuaries; and,
- Construction of container terminal 4 in the Weser estuary.

The key conclusions are summarised below for each case study estuary.

Eems
The enlargement of the navigation channel in the Eems is now subject to a new EIA and planning procedure because the zoning plan for the project was annulled on safety grounds and the permit that was granted has been withdrawn. However, there was agreement with the analysis of the ecological effects as described in the EIA accompanying the zoning plan.

There were objections to the project, mainly from the NGOs (cumulative effects, ecosystem approach, integration with other projects), but also from German mussel fishermen who are concerned that increased turbidity can harm mussels. Concern was also raised by German health resorts on the island of Borkum.

To minimise uncertainties, gaps in knowledge were filled as much as possible by performing specialised studies and using expert judgement. Also a (very) worst-case has been used to be sure that the effects are not underestimated.

The largest uncertainties lie in the hydromorphological modelling. Initially, a 2D modelling exercise was performed. An audit commission decided that a 3D modelling was necessary to ensure that the results of the 2D modelling were correct and to make sure that the best available methods were used. Ultimately, all parties agreed that the results were good enough. The low accuracy (5-50%) of some models (e.g. sediment transport and hydrodynamic models) has been accepted and, therefore, worst-case scenarios were used to ensure effects were not underestimated. One independent scientist does not agree with the methods used (3D modelling), although this type of modelling is used in all other comparable studies and projects.

According to the NGOs the uncertainty is the whole ecosystem itself. The Ems-Dollard ecosystem is in poor condition and, therefore, they believe that no activity should take place in the estuary.

Many lessons can be learned from the project. From the interviews, it was shown that the NGOs would have liked to have more participation and consultation in the process as they were only consulted at formal moments, while Rijkswaterstaat felt that they had been informing and consulting in a sufficient way for all parties. The NCA was also convinced that there was enough participation and consultation.

The enlargement of the navigation channel is only one of the many projects that are being performed in the vicinity of the Eemshaven. In the new procedure, the connection and interaction between these projects should be stressed more and effects on the ecosystem should possibly be evaluated together.

Humber

The key issue for the consultees was the uncertainty surrounding the ability to predict the future maintenance dredging commitment as a result of the deepening of the approach channel and the implications that this could have on sediment supply to designated intertidal areas. To manage this uncertainty, a Dredging and Disposal Strategy was developed, the underlying principle of which was to distribute dredged material within the estuary to supplement sediment supply to intertidal areas. Importantly, this strategy did not represent a significant change from how dredged material was already managed in the Humber estuary.

The uncertainty inherent in modelling a dynamic system was understood and accepted by consultees and regulator. The interpretation of the predictions made through the modelling by experts with a thorough understanding of the system is critical in ensuring that the significance of the potential implications of the scheme are presented in context. The above approach, together with the proposed implementation of the Dredging and Disposal Strategy, enabled the consultees and regulator to agree with the findings of the EIA process and to grant consents for the project.

Scheldt

The enlargement of the navigation channel in the Scheldt estuary formed part of a wider package of measures developed as a common long term vision for the Scheldt estuary. The three pillars of the long term vision are:

1. Conservation of the physical characteristics of the estuary (naturalness);

2. Maximum safety against flooding; and,
3. Optimal accessibility for the ports.

Initially, the inclusion of the project alongside other 'naturalness' measures helped prevent discussions about the inevitable uncertainties. However, the execution of the naturalness part of the package deal was postponed, and a different approach was needed to ensure that the project would be 'Natura 2000–proof'. For this a so-called three-stage rocket approach was adapted. The first stage of this approach consists of using the most environmental friendly alternative. The second stage consists in adding the flexible disposal strategy as a mitigating measure. The third stage is the fact that the possibility to stop the project in case unexpected negative effects do occur is embedded in the permit.

The environmental organisations (especially those in the Netherlands) were, however, not convinced that this approach would ensure that no negative effects would occur. The uncertainty was not in the methods used for the prediction of the effects, but mainly in the importance of the positive ecological effects of the new disposal strategy. This was mainly because it was a new technique that had not proven to be effective. Therefore the environmental organisations in the Netherlands did have (legal) objections against the project.

It was only when the political leaders gave a sign that they would execute the naturalness part of the package deal, that they withdrew their objections. The first step of stakeholder involvement therefore remained crucial to reduce the risks.

Whether the three-stage rocket approach would have been effective remains partially uncertain, since some important NGOs withdrew their appeals before a final court decision. The port authorities are convinced that it would persist in court, the environmental organisations are convinced that it would not without implementation of the nature development plan that was politically linked to the deepening. In any case, the Court finally concluded that (based on the remaining appeals) the Dutch minister had reasonable arguments to state that the ecological features of the Natura 2000 area will not be significantly affected.

Stour and Orwell

In the Stour and Orwell estuaries, a number of major port development projects (including capital dredging and reclamations) have been proposed since 1998. For the first major project – the deepening of the approach channel to Harwich Haven – it was predicted that rate of erosion of intertidal areas would increase as a result of the project. A mitigation strategy was developed which comprised replacement of sediment removed by maintenance dredging into the estuary system at a number of locations. Subsequent projects benefitted from this strategy as their predicted adverse effects could be mitigated through modifying this strategy.

At the time of the EIA, the main source of uncertainty was related to the ability of an artificial sediment bypassing system to efficiently replicate nature, the relevance of the placement locations, and the potential effect of sediment replacement on the benthic ecology and fish resources of the estuaries. To accommodate this uncertainty, a precautionary approach was adopted which required provision of compensatory intertidal equivalent to an area that assumed failure of the sediment replacement programme for 5 years.

A crucial aspect in achieving acceptability with the stakeholders was the development of mitigation and monitoring commitments that were enforceable, together with a Regulators Group which has the authority to make decisions regarding the refinement of the mitigation and monitoring programme. The acceptance of this mechanism for the Harwich Haven approach channel deepening established the framework through which the mitigation requirements for subsequent projects in the estuary system could be dealt with. Overall, the flexibility and consultation built into this approach ensures that a well informed decision making process exists and enables successful mitigation to be delivered.

Weser

There were a number of uncertainties associated with the construction of container terminal 4 (CTIV). Firstly, the Weddewardener Aussendeich and Nationalpark Niedersächsisches Wattenmeer SPAs and SACs were not notified to the European Commission at the time of the planning process. According to the precautionary principle the two sites were treated in the environmental studies as if they had been notified and designated already, and the legal procedures of the Habitats Directive were implemented.

The second significant area of uncertainty was the potential effect of the project (piling) on migratory fish, especially for the twaite shad as very little on the species was known in the area. An expert group was formed and a workshop was held to discuss the effects. The experts decided that the project could be performed without harming the species, and a monitoring programme was established.

The permit described several mitigation measures, and also a package of compensation measures as tidal habitats were destroyed by the construction of the CTIV. However, there were insufficient appropriate compensation areas in the small Federal State of Bremen and, therefore, collaboration with the State of Lower Saxony was necessary, which made the situation complex.

Two compensation areas were identified after a thorough analysis of other uses. One of the compensation areas was not perfect as a storm surge had to be built for safety, and conditions were not completely natural. It was, however, the best solution at that time.

The NGOs did not go to court as they were short in capacity but, more importantly, they felt they had little chance to win the case as the underlying studies had a solid base and there were little gaps in knowledge or uncertainties.

In total, the project took approximately 4 years to get a permit and to start construction. The CTIV project was completed in 2008.

Similarities and differences between the case studies

It is apparent that there are a number of similarities and differences in the way in which uncertainties were dealt with within the five case studies. These are illustrated in Table A below.

Recommendations for good practice

A number of aspects have been identified as good practice measures relevant to dealing with uncertainties that could be considered for wider application in other projects. These are summarised as follows:

- Early consultation with stakeholders and maintaining consultation at appropriate times throughout EIA and AA studies.
- Agreeing scope of works for the EIA and AA, potentially through production of an environmental scoping report as is normal practice in the UK.
- On the basis of the case studies, the main source of uncertainty relates to the understanding of physical processes and morphological evolution of the estuarine system. These issues should be investigated in detail to lead to a clear scientific view on the current situation and the baseline conditions that are to be used in assessing new plans and projects.
- Evidence regarding the effectiveness of mitigation techniques that have been applied should be fed back in order to improve scientific knowledge and refine numerical models, where appropriate.
- Conditions on permits can be used to deal with scientific uncertainty with regard to the effects of a plan or project or the related mitigation or compensatory measures. Conditions can define, for example, corrective measures that may need to be undertaken if monitoring reveals that a proposed mitigation measure has not been successful.
- A long term forum, including the developer, stakeholders and regulatory authorities, that is authorised to implement changes to a programme of mitigation or compensation measures on the basis of the results of monitoring programmes can be a valuable mechanism for managing mitigation or compensation commitments and giving comfort to stakeholders that areas of uncertainty and risk can be accommodated and managed through a process of reporting of monitoring and feedback.
- The use of legal agreements that set out mitigation, compensation and monitoring commitments (and the proposed approach to reporting and management of such commitments) can give regulators confidence that such measures are enforceable and such agreements can form part of the permit / consent for the project.

Table A Summary of similarities and differences between the five case studies

Aspect	Similarities between the case studies	Differences between the case studies
Approach to the EIA and AA studies	• The scope of issues to be included in the EIA and AA are defined by the consultant team and applicant and agreed through consulting with relevant external stakeholders.	• In the UK there is no requirement to undertake SEA for plans or programmes that include port developments. In other countries, SEA is sometimes carried out (e.g. the Schledt case study). • The process for defining the scope of studies in the UK case studies appears to be more standardised (through a scoping phase, with the production of a scoping report) than in the other case studies. • For the Eems and Scheldt case studies, a formal review body was established to assess the quality and results of the EIA. Although in the UK establishing a formal review body is not standard practice, the formal consultation undertaken by the regulator allows consultees the opportunity to comment on adequacy of the EIA.
Parties involved and overview of local NGO situation	• A wide range of parties were involved in the EIA process for each case study, as relevant depending on the nature of the project and the environmental issues relevant to the project.	• The environmental organisations involved in the Scheldt and Eems case studies formed a coalition and consultation was undertaken through this coalition. In other case studies the environmental organisations were individually represented.
Approach to the consultation process	• Informal consultation was undertaken with a wide range of stakeholders throughout the EIA process.	• In the UK, informal consultation during the EIA is often initiated and focussed through an environmental scoping exercise. This leads to the regulator issuing a scoping opinion which helps define the 'terms of reference' for the EIA.
Areas of uncertainty and risk	• The main source of uncertainty for all case studies is linked to understanding of morphological processes operating in the estuary system. In all cases, numerical modelling was used as a tool to predict impacts on estuarine habitats. The approach to modelling was discussed and agreed with consultees.	• In the Schledt case study, the environmental organisations felt that because the condition of the Scheldt was unfavourable, all negative effects associated with the project must be avoided. Any negative effect would be considered significant. • In the Eems case study, the NGOs believed that no activity should be

Aspect	Similarities between the case studies	Differences between the case studies
	• Organisations that are consulted often want predictions made by numerical modelling to be precisely quantified. This can be misleading and there is a tendency to place too much reliance on these numbers when determining what constitutes a significant effect. • More reliance should be placed on the interpretation of modelling results by an expert when considering whether or not an effect is significant. • There is no universally accepted threshold to define what constitutes a significant effect. • For the Harwich Haven Approach Channel Deepening (Stour and Orwell estuaries, UK) and the Scheldt case studies, the likely success of mitigation measures was considered to be an area of uncertainty.	allowed because the Eems-Dollard system is in poor condition. The view was that any existing issues should be understood and resolved before new activity should be allowed.
Approach to dealing with uncertainty	• Monitoring programmes were developed in all cases to verify predictions made in the EIA process and the effectiveness of mitigation and compensation measures. • Legal agreements can be used to ensure that mitigation and monitoring commitments are enforceable (e.g. Stour and Orwell estuaries and Scheldt case studies). This provides a safeguard which is important to provide certainty that commitments were deliverable and can be modified in light of results of monitoring programmes.	• A specific approach developed for the Scheldt case study was to incorporate the project into a wider package of measures. In this way it was ensured that all functions of the estuary (i.e. safety against flooding, ports accessibility and naturalness) would improve on the longer term. • For the Harwich Haven Approach Channel Deepening, precautionary compensatory habitat was required to deal with the uncertainty associated with the proposed mitigation for a predicted increase in the rate of intertidal erosion. • Compensatory habitat was required for the Bathside Bay container terminal project (Stour and Orwell estuaries) and for the Weser case study. Different approaches were applied in determining the area required; a 2:1 ratio was required for the Bathside Bay container terminal project, whereas the ratio for the Weser case study was 1:1.

List of abbreviations

AA	Appropriate Assessment
AOS	Adviserend Overleg Schelde
ASMITA	Aggregated Scale Morphological Interaction between a Tidal Basin and the Adjacent Coastline
Cefas	Centre for Fisheries and Aquaculture Science
cSAC	Candidate Special Area of Conservation
EIA	Environmental Impact Assessment
EMMP	Environmental Management and Monitoring Programme
ES	Environmental Statement
GIS	Geographical Information System
GSP	Groningen Seaports
HHA	Harwich Haven Authority
MFA	Marine and Fisheries Agency
MMO	Marine Management Organisation
NCA	Nature conservation agency
NGO	Non-Governmental Organisation
OAP	Overleg Adviserende Partijen
RWS-NN	Rijkswaterstaat Noord-Nederland
RSPB	Royal Society for the Protection of Birds
SAC	Special Area of Conservation
SEA	Strategic Environmental Assessment
SPA	Special Protection Area
SSSI	Site of Special Scientific Interest
SDC	Sunk Dredged Channel
TIDE	Tidal River Development
VMADCP	Vessel Mounted Acoustic Doppler Current Profiler
WeBS	Wetland Bird Survey
WSD	Wasser und Schiffart Direction
WV	Wadden Vereniging

1 Introduction

1.1 General

TIDE (Tidal River Development) is an EU Interreg project (Interreg IV-B North Sea Region Programme) with Hamburg Port Authority as leading partner. In addition to Hamburg Port Authority, there are nine other partners in TIDE (see Section 1.3). TIDE focuses on the estuaries of the Elbe, Weser, Scheldt and Humber; all of these estuaries show similar characteristics, as follows (www.tide-project.eu):

- They are used as shipping channel leading to large ports;
- They are characterised by a strong tidal influence;
- They transport large quantities of sediment; and,
- Most estuarine areas are designated Natura 2000 sites.

The overall objective of TIDE is to make integrated management and planning a reality in the Elbe, Weser, Scheldt and Humber estuaries. To support this objective, TIDE comprises the following project activities (www.tide-project.eu):

- Improves knowledge about estuary functioning;
- Improves the effectiveness of policy mechanisms and instruments in each region;
- Compares, assesses and plans mitigation and compensation measures (i.e. sediment traps, new dredging methods, restoration of river shores);
- Raises awareness of the issues at stake among the different target groups, ranging from EU policy makers to estuary residents;
- Brings together the best available knowledge and practices from within the TIDE regions and beyond; and,
- Experience is synthesized in a joint TIDE toolbox.

Even when using the most appropriate and state-of-the-art research tools in Environmental Impact Assessments (EIA) and Appropriate Assessments for investigating the impact of major port development projects in the estuarine environment, there will be uncertainties in the process of undertaking the studies and, therefore, when regulatory bodies are making decisions on licence applications. As part of TIDE, Royal Haskoning DHV was commissioned by the TIDE steering committee to carry out an investigation on how different European Member States cope with these uncertainties in the implementation of four relevant European Directives (Birds Directive, Habitats Directive, Environmental Impact Assessment Directive and Strategic Environmental Assessment Directive) and when assessing the possible effects of a certain project in the estuarine environment.

1.2 Objective and approach to the study

The overall study consists of two ‘Lots’. Lot 1 (Royal HaskoningDHV, 2012) investigates differences between Member States with regard to the legal and procedural aspects of obtaining a licence/permit for a project in an estuary, in order to achieve a proactive approach by all stakeholders towards innovative solutions for the legal and practical issues and bottlenecks while assessing the potential impacts of major projects, in particular concerning how to deal with uncertainties.

Lot 2 (the findings of which are reported in this document) comprises an analysis of environmental assessment practice through five case study examples (in alphabetical order of the name of the estuary; Figure 1.1 shows the relative location of each estuary):

- Enlargement of the navigation channel in the Eems estuary (Section 3);
- Dredging of the approach channel to the Immingham Oil Terminal in the Humber estuary (Section 4);
- Enlargement of the navigation channel in the Scheldt estuary (Section 5);
- A series of major port development and capital dredging projects in the Stour and Orwell estuaries (Section 6); and,
- Construction of container terminal 4 in the Weser estuary (Section 7).

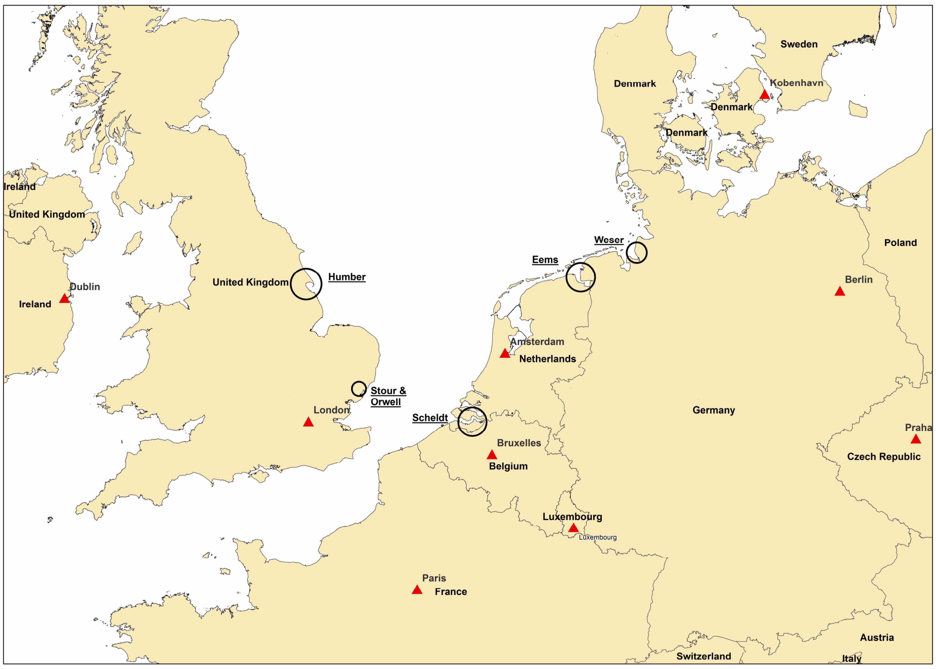


Figure 1.1 Location of the case study estuaries

Lot 2 focusses on tools and methodologies applied in EIA and Appropriate Assessments and how uncertainty and risks are dealt with and managed in practice. It should be noted that the scope of the project is limited to the subjects of flora and fauna (marine and estuarine) and soil (marine sediments) and water. In terms of fauna, the focus is on the potential effects on biological communities through direct impact of the project (e.g. reclamation), effects on water quality and effects on habitats (e.g. through changes to the hydrodynamic and sedimentary regime). Disturbance effects (e.g. construction noise) are outside the scope of this project.

1.3 TIDE partners

The partners in TIDE are:

- Hamburg Port Authority (www.hamburg-port-authority.de);
- Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency (www.nlwkn.de);
- Free Hanseatic City of Bremen (www.wuh.bremen.de);
- University of Bremen (www.uni-bremen.de);
- Rijkswaterstaat (www.rijkswaterstaat.nl);
- Flemish Authorities, Department of Mobility and Public Works, Maritime Access Division (www.maritiemetoegang.be);
- Antwerp Port Authority (www.portofantwerp.be);
- University of Antwerp (www.ua.ac.be/ecobe);
- Environment Agency (www.environment-agency.gov.uk); and,
- Institute of Estuarine & Coastal Studies, Hull (www.hull.ac.uk/iecs).

The partners in the TIDE steering committee for this project that guided the effective delivery of the study are:

- Stefaan Ides, Yves Plancke, Guy Janssens and Els Van Duyse (Antwerp Port Authority);
- Kirsten Wolfstein and Sonja Wild-Metzko (Hamburg Port Authority);
- Jochen Kress (City of Bremen);
- Susan Manson (Environment Agency); and,
- Jean-Paul Ducrotoy (Institute of Estuarine & Coastal Studies).

2 Analysis of case studies

2.1 General

An analysis of environmental assessment practice – focussing on areas of uncertainty – has been undertaken through selecting five case studies in various Member States. The selected case studies are all major interventions (port developments and capital dredging projects) in estuarine systems, as summarised below:

- Eems estuary (enlargement of the navigation channel);
- Humber estuary (Immingham Oil Terminal approach channel dredging);
- Scheldt estuary (enlargement of the navigation channel);
- Stour and Orwell estuaries (Harwich Harbour Approach Channel Deepening, Trinity III Terminal (Phase 2) Extension, Bathside Bay Container Terminal and Felixstowe South Reconfiguration); and,
- Weser estuary (construction of container terminal 4).

The study comprised undertaking a review of available literature for each case study and interviewing a number of individuals who were involved in the case studies, including representatives of the applicant, statutory consultees and decision-makers. Further details of the approach to the study are provided in the following sub-sections.

2.2 Literature review

For each case study, publically available literature was obtained and reviewed in the first instance. The literature comprised environmental assessment studies (e.g. Environmental Statements, mitigation and monitoring agreements), correspondence from consultees to the decision-maker, legal agreements made between the applicant and consultees and decision letters.

The literature review concentrated on those areas of direct relevance to the project (i.e. flora, fauna, soil (marine sediments) and water) and focussed on identifying areas of uncertainty in the environmental assessment studies.

Further details of the literature reviewed during the project are provided for each case study (see Sections 3 to 7).

2.3 Interviews

Following the literature review phase of the project, a series of interviews were held for each case study. The interviews were important as they provided the opportunity to further explore areas of uncertainty identified from the literature reviews.

Table 2.1 summarises the individuals who were interviewed for each case study.

Table 2.1 Summary of individuals interviewed for each case study and their role in the project

Individual	Organisation represented	Role
Eems (enlargement of the navigation channel)		
Paul de Graaf	Rijkswaterstaat (Waterdienst)	Overall project leader
Herman Mulder	Rijkswaterstaat (Waterdienst)	Specialist in the hydromorphology of the Ems-Dollard. Designer of disposal strategies for Rijskwaterstaat.
Victor de Jonge	Institute of Estuarine & Coastal Studies, University of Hull	Independent expert, consulted as second opinion on hydromorphological effects
Esmé Gerbens, Jouka Wouda (replacements of Ester Kuppen)	Waddenvereniging (nature conservation party)	Legal consultants preparing objections for the project.
Ben Schoon	Ministry of Economic Affairs, Agriculture and Innovation	Partly permit writer. Nature conservation law, responsible for Appropriate Assessment and mitigation.
Humber (Immingham Oil Terminal approach channel dredging)		
Tom Jeynes	ABP	Applicant
Peter Whitehead	ABPmer	EIA project director and specialist in numerical modelling
Kate Jennings	Natural England	Statutory consultee (nature conservation issues)
Scheldt (enlargement of the navigation channel)		
Yves Plancke	Antwerp Port Authority	Consultee (morphological issues, port authority)
Guy Janssens	Antwerp Port Authority	Consultee (legal issues, port authority)
Kirsten Beirinckx	Administration waterways and maritime affairs, department maritime access (Flanders)	Applicant
Peter Symens	Natuurpunt vzw	Consultee (nature conservation)
Harm Verbeek	Rijkswaterstaat, management Zealand (Netherlands)	Applicant (project manager)
Vincent Klap	Werkgroep Schelde estuarium	Consultee (nature conservation)
Stour and Orwell (series of port development projects)		
Terry Gray	Hutchison Ports (UK) Ltd	Applicant (for port development projects)

John Brien	Harwich Haven Authority	Applicant (for dredging and disposal consents and licences) and harbour authority
Chris Gibson	Natural England	Statutory consultee (nature conservation issues)
Weser (one common interview) (construction of container terminal 4)		
Martina Wernick	Senator für Umwelt, Bau und Verkehr (Nature protection Agency)	AA permission authority (including mitigation and compensation). Writer of a part of the approval document (Nature conservation law).
Martin Rode	Bund Bremen (nature conservation party)	Objecting the project
Uwe von Bargen	Bremenports GmbH & Co. KG	Organiser of approval process for the project

3 Eems

3.1 Description of the project

Three power plant companies were interested in investing and constructing in the Eemshaven. The investments are only viable if larger vessels can enter the harbour, and the navigation channel represented a constraint to safe vessel access. It was, therefore, proposed that the navigation channel would be enlarged to improve access for the larger vessels.

The main purpose of the project is the deepening and widening of the navigation channel by dredging 9.1 million m^3 of sand, clay and boulder clay in order to allow Panamax ships with a draft of maximum 14.0m and Qmax LNG-ships with a draft of 12.0m to enter the Eemshaven.

The dredged sediments largely consist of sand (8.1 million m^3) and it is proposed that the sediments will be disposed at four different locations (known as P0, P1, P3 and P4; see Figure 3.1). The locations P2A and P2 were potential disposal sites, but were not chosen for different reasons (e.g. P2A is located close to a seal resting place and effects on nature conservation issues would be too significant). P0 and P4 are existing disposal sites and will be used for the disposal of sand. P3 (also sand) was also proposed because the capacity of P4 is too small. P1 is a new location that will be used for the disposal of boulder clay.

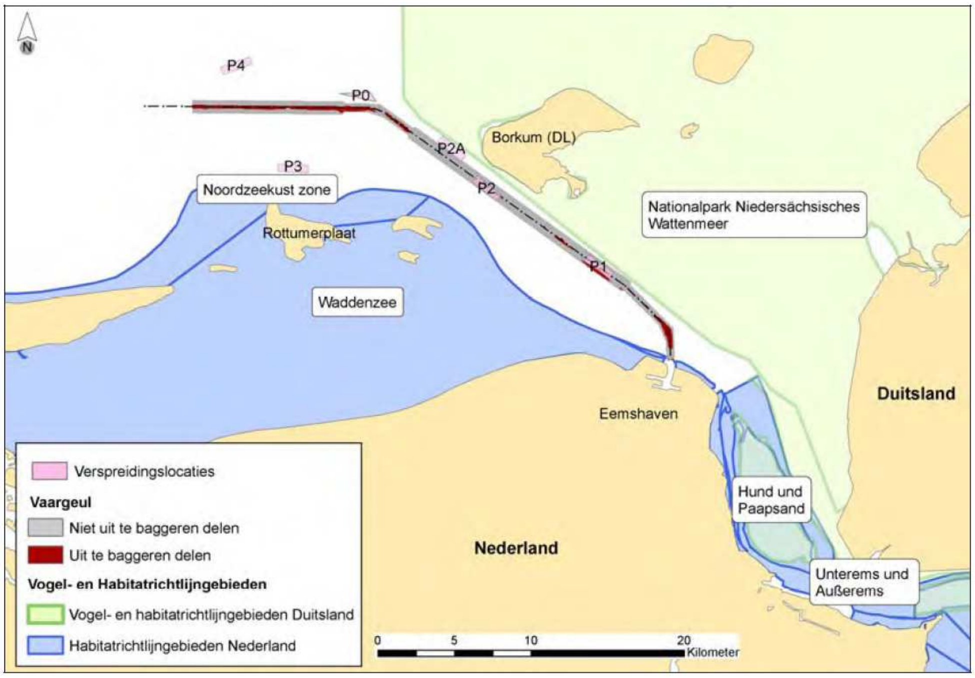


Figure 3.1 The location of the navigation channel, the disposal sites and the Natura 2000 areas (source: Haskoning (2009c))

During the operational phase of the navigation channel, additional maintenance dredging will be needed to keep the navigation channel open. It should be noted, however, that in the current situation maintenance dredging is also necessary. An estimated 1.1 million m^3 of sediment will be dredged annually and disposed at similar locations (P1 and P3) as the sediment arising from the capital dredging during the construction phase. The effects of several different dredging techniques (trailing suction hopper dredger or a cutter dredger) were examined.

The boundary of the Natura 2000 area (Waddenzee) is in the middle of the navigation channel.

The following points summarise the main components of this project:

- The local deepening and widening of the navigation channels (Eemshaven-North Sea);
- The local deepening of the entrance to the Doekegatreede for anchorage;
- The transport and disposal of the dredged material;
- Maintenance dredging during the operational phase;
- Replacement of Nordned cable;
- Removal of obstacles and wrecks.

3.2 Overview of relevant Natura 2000 sites

The following summarises the Natura 2000 sites of relevance to the project:

- Waddenzee;
- Noordzeekustzone;
- Niedersächsisches Wattenmeer;
- Nationalpark Niedersächsisches Wattenmeer;
- Niedersächsisches Wattenmeer und angrenzendes Küstenmeer (D);
- Hund und Paap (D);
- Duinen Ameland;
- Duinen Schiermonnikoog;
- Duinen Borkum.

The following paragraphs describe the specific protected features of these sites (http://www.synbiosys.alterra.nl/natura2000).

- **Waddenzee**

The Waddenzee is a complex of deep gullies and shallow water with tidal sand and mudflats. Saltmarshes are scattered along the mainland and the islands.

The Waddenzee is the largest and – in an international perspective - the most important Natura 2000 area in the Netherlands due to the very large populations of waterbirds that use the intertidal habitats for feeding and saltmarshes, beaches and dunes for breeding.

The deeper waters are important as a nursery for fish species from the North Sea. The Waddenzee also hosts the majority of the seal population in the Netherlands.

- **Noordzeekustzone**

The Noordzeekustzone is characterized by high ecological and amenity values, and the fish fauna in the coastal sea is different from that of the rest of the Dutch Continental Shelf in that it has a high diversity of species. There can also potentially be a number of fish species listed in the Habitats Directive, such as twaite shad, Allis shad, and sea lamprey.

Large numbers of common scoter (over 100,000) are often present in the Noordzeekustzone. Large groups of eider ducks are also seen regularly in this area.

In the spring and summer (the breeding season) the whole of the Noordzeekustzone is extremely important as a foraging area for lesser black-backed gulls, herring gulls, sandwich terns and common terns. In addition, in the migrating season (autumn and spring), large numbers of sea birds forage in the area.

The site is also important for red-throated divers; up to several thousand of these birds can occur in the North Sea coastal zone in the winter and spring.

The most important site over the past decade has been a large complex of *Spisula* banks between Bergen aan Zee and Callantsoog. Because of the presence of shallow water with plentiful shellfish (*Spisula* or other species), very large flocks of ducks can occur in the Dutch North Sea coastal zone.

The Noordzeekustzone off the Wadden Islands is important for the common and grey seal and harbour porpoise

- **Hund und Paap (D)**

This area is part of a dispute area between the Netherlands and Germany. According to the Dutch this is Dutch territory, but Germany also claims this area. The Dutch include the Hund und Paap as part of the Waddenzee designated area.

- **Duinen Ameland**

The landscape of Duinen Ameland is characterised by a stretch of dunes which extends over the entire length of the island. In the east and northwest corner the island is accreting (growing), while near Nes and Buren coastal erosion takes place.

The area has a high diversity of ecotopes due to the variability in environmental conditions (e.g. freshwater and saline habitats). The area also includes some small forest complexes which consist of planted coniferous and deciduous forest and naturally occurring trees.

- **Duinen Schiermonnikoog**

Schiermonnikoog is one of the smallest and most pristine islands in the Dutch Wadden Sea. The landscape of this area is characterised by a stretch of dunes that extend over a large part of the western half of the island. The dune area has a high diversity and well-developed calcareous dune slacks. In the past pine trees were planted on the western and central part of the Natura 2000 area.

- **Duinen Borkum**

The habitats present in this area are similar to those on Schiermonnikoog and the area is part of the Niedersachsische Wattenmeer. It is protected because of the pioneer vegetation, saltmarshes and dunes.

The Ems-Dollard area is protected as a part of the Wadden Sea designation for birds (under the Birds Directive). The habitats are not protected yet, although the designation of the habitats is in progress. It is proposed that the goals for one habitat type (estuary – H1130) will be added to the Wadden Sea decree (goals for the other habitat types that are in the process of designation are already part of the Wadden Sea decree). The goal for 'estuary' will probably be a conservation goal, but this is being disputed by several organisations as the quality of the habitat is not good in the Ems-Dollard.

3.3 Parties involved in the case study

The Rijkswaterstaat Noord-Nederland (RWS-NN) was the applicant (developer) for the project.

Groningen Seaports (GSP) has an interest in the deepening of the navigation channel as the power plant companies were proposing to develop on its land, and the Eemshaven can become a larger harbour with the enlargement of the navigation channel.

Nature conservation parties, represented by the Wadden Vereniging (WV), were concerned with the ecological implications of the project directly, but also indirectly because the proposals would facilitate the development of coal-based power plants and the nature conservation parties prefer sustainable energy in the area.

The Province of Groningen is responsible for the permit for the enlargement of the Eemshaven harbour, but not for the permit for the enlargement of the navigation channel. Since the two projects are closely linked, there was significant interaction between the Province of Groningen and the Ministry of Economic Affairs, Agriculture and Innovation about the permits for these projects.

The Wadden Sea Island is interested because of the tourism on the islands. The German island of Borkum is a health resort island and larger vessels were seen as undesirable for this type of tourism.

The German shrimp fishermen were concerned that shrimp populations will decrease due to the effects of the project. In the Netherlands, the shrimp fishermen are banned in the Dollard as a compensation measure for the enlargement of the Eemshaven harbour.

Wasser und Schiffart Direction (WSD) is the German counterpart of the Dutch Rijkswaterstaat and responsible for the navigation channels and the safety in and around the channels.

Table 3.1 summarises the organisations involved in the case study and their role or key interest.

Table 3.1 Summary of organisations involved in the case study

Organisation	Role (role or key interest)
Rijkswaterstaat, Noord-Nederland*	Applicant (developer)
Groningen Seaports	Harbour authority; interested party because of economic development,
State of Secretary for Transport, Public Works and Water Management (now Ministry for Infrastructure and Environment)	Responsible for decision about the zoning plan for the alignment of the navigation channel and the approval of the permits that involve the protection of ground and surface water, soil and excavations
Ministry of Agriculture, Nature and Food Quality nowadays Ministry of Economic Affairs, Agriculture and Innovation (Min EL&I)*	Responsible for the approval of the permits regarding the protection of fauna and flora; nature conservation agency
Ministry of Housing, Spatial Planning and the Environment (Netherlands)	Partly responsible for the overall decision about the occurrence of the project and the approval of the permits that involve the protection of the environment.
EIA Commission	Administration responsible for the approval of the EIA.
Provinces of Groningen	Responsible for the approval of the environmental permits in the Eemshaven
Prof. V. de Jonge*	Independent expert for the Eems-Dollard area
Waddenvereniging*	Nature conservation, consultee (NGO)
Coalitie Waddenzee natuurlijk	Group of nature conservation agencies, consultees (environmental effects)
NLWKN (Germany)	Consultee (environmental effects Germany)
Island of Borkum (Germany)	Consultee (tourism and nature)
National Park Niedersachsisches Wattenmeer	Consultee (environmental effects, German part of the Wadden Sea)
LTO	Consultee (agricultural organisation)
Fishermen (German and Dutch)	Consultees (fisheries)
Island of Schiermonikoog	Consultee (tourism and nature)
Wasser und Schiffart Direction (WSD - Germany)	Consultee (safety and shipping)
Alkyon	Hydromorphological studies
Royal Haskoning	EIA and Appropriate Assessment
Consulmij B.V.	Ecological background study
Waterschap Noorderzijlvest and Hunze en Aa's	Consultee (body of surveyors of the dikes)

* indicates that representatives from these organisations were interviewed as part of the reporting for this case study

3.4 Overview of the local NGO situation

The Waddenvereniging is the main nature conservation party (hereafter WV). Together with other parties (Staatsbosbeheer, Vogelbescherming Nederland, Landschap Noord-Holland, It Fryske Gea, Stichting Het Groninger Landschap, Stichting WAD en Vereniging Natuurmonumenten) they form the 'Coalitie Waddenzee natuurlijk' which is concerned with the conservation of the natural environment of the Wadden Sea. The NGOs were consulted and informed during formal and informal meetings.

The NGOs, represented by the WV are unconditionally against this project. Their view is that the Eems-Dollard ecosystem is currently in a poor condition (too high turbidity, too low oxygen levels, a single channel system instead of the natural multiple channel system, etc.) that any new activity should not be allowed.

The WV view is that, firstly, an understanding of ecosystem functioning is needed and, secondly, investigation is needed into what can be done to resolve any existing problems within the ecosystem. When these items are addressed, new activities can potentially be allowed.

The juridical reality, however, is different. As noted in Section 3.2, although the goal for the 'estuary' habitat type (H1130) in the Ems-Dollard is not defined yet, it will probably be a conservation goal rather than an improvement goal. This means that new activities, such as the enlargement of the navigation channel, can be executed without having significant effects on the Natura 2000 area. If the goal for H1130 would be more severe (and thus an improvement goal), similar effects could be considered significant since the goal is more stringent and no deterioration can take place. In addition, in terms of potential impacts on the designated area, effects are considered in the context of the Wadden Sea designated area as a whole and not just the local Ems-Dollard area.

3.5 Chronological overview of study process

This section describes the chronology of the EIA studies undertaken for this case study.

Guidelines for the EIA process were formulated by the EIA Commission in 2006. A notification of intent (2007) was first formulated by Rijkswaterstaat Noord-Nederland and, subsequently, the EU Directives of relevance to the project were described; these serve as a framework for the EIA. Public consultation was undertaken on these documents. The EIA Commission also gave their advice on these documents.

After this process, the outline/draft zoning plan for the trajectory of the navigation channel (with EIA and Appropriate Assessment as accompanying documents) was drafted, and a public consultation was undertaken on these documents. During 2007 specific studies were undertaken that are used as background information for the EIA and Appropriate Assessment. The two main background studies were the ecological effect study and the hydromorphological study. Several other smaller investigations were also performed. RWS RIKZ commissioned Consulmij to investigate the ecological effects due to the activities in the Eemshaven (i.e. the enlargement of the navigation channel and the deepening and enlargement of the Eemshaven harbour). Alkyon (2007 and 2008) undertook the morphological studies for these two activities.

RWS-NN instructed Royal Haskoning to undertake the EIA (completed in 2009) and Appropriate Assessment for the enlargement of the navigation channel. During this work, specific studies were carried out to fill gaps in knowledge (e.g. studies on the effects on mussel beds and shrimp).

The outcomes of the public consultation were included in the draft zoning plan, which then became the final application (with accompanying (adjusted) EIA and Appropriate Assessment) for the permit in the frame of the nature conservation law. A permit for a project could then be delivered on the basis of an approved zoning plan.

The general approach to deal with uncertainties in the EIA and Appropriate Assessment in this project was to carry out additional investigation work in the first instance and then to adopt precautionary principle (i.e. worst-case scenario) in order not to underestimate potential impacts in light of any uncertainties.

Models and methods used were then checked and reviewed by an independent expert panel. The Ministry of Economic Affairs, Agriculture and Innovation (the nature conservation agency, NCA hereafter) asked this expert panel as they needed expertise to evaluate the results was not available within the Ministry. In some cases, a second opinion was sought to verify the statements of the expert panel (e.g. hydromorphology).

To investigate the potential hydromorphological effects of the project, 2D numerical modelling was performed as part of the EIA process to predict the effects on sediment transport and turbidity (Alkyon, 2007). For the hydromorphological modelling, a review process was initiated since the expertise was not available within the NCA to assess the outputs of the modelling exercise. An expert commission was appointed by the NCA and consisted of three prominent professors who have good knowledge of the ecosystem (two hydromorphologists and one ecologist). The commission advised that a 3D version of the model should be applied to ensure that the best available techniques were used.

The results of the 3D modelling (Alkyon 2008) were comparable with the results of the 2D modelling. The outputs of the modelling provided a good prediction of the effects of the project under different conditions. The results of the 3D modelling were incorporated in the EIA and Appropriate Assessment.

The NCA and Rijkswaterstaat (RWS) agreed with the general principle on how to deal with uncertainties (decision process), as described above.

On completion of the EIA, the EIA Commission (Comissie MER, 2006) (a commission composed of independent experts who advise on the quality and results of the EIA before permit writing is initiated) reviewed the outputs. Its advice is of great value for projects since authorities follow the advice and formulate regulations in the permit according to the Commission's advice. The EIA Commission agreed with the methods and advised that the predictions made by the modelling work should be verified with monitoring, so these data can be put back into the model to verify if there are any doubts about the results of the model. This advice on monitoring was then followed up in the conditions of the permit.

The permit was given in December 2010. A concept monitoring plan was part of the permit. The permit was withdrawn after the approved zoning plan was destroyed by the Raad van Staten (Council of State) in 2011. The execution and monitoring of the project was delayed and the process was ended after the destruction of the approved zoning plan.

A complete new process with new teams started in 2012.

Figure 3.2 summarises the timescale for the EIA and consenting processes for the channel deepening project.

3.6 Overview of the consultation process

In 2007 the notification of intention was announced (public announcement) by Rijkswaterstaat Noord-Nederland and formal consultation and participation took place.

Thereafter a number of meetings were held with the stakeholders. Some meetings were organised by RWS only to discuss specific issues around the enlargement of the navigation channel. Other meetings were organised together with other parties, such as Groningen Seaports or the Province of Groningen, as the enlargement of the navigation channel was closely related to other projects that were planned in the Eemshaven, like the enlargement of the Eemshaven harbour of which Groningen Seaports is the contractor and the building of the power plant in the Eemshaven by RWE. For this latter project, the Province of Groningen is responsible for the approval of the environmental permits in the Eemshaven. During that period the specific background studies and EIA were drafted. These meetings were discussing the content, but also the process, of the project and were mostly of an informing character and not organised on a regular basis. The stakeholders were mostly informed at key milestones (e.g. to review and comment on the EIA), but formal and informal bilateral and group consultations were also organised.

At the end of 2009, the public announcement of the zoning plan and accompanying EIA was made when parties could formally object to this project. A lot of objections, especially from the NGOs, but also from German fishermen, were submitted. All objections were then answered in the "Nota van Antwoord". Based on these objections, further suggestions and adjustments were made to the EIA.

2006 Q1-Q2	2006 December	2007 Q1-Q2	2007 Q3-Q4	2008 Q1-Q2	2008 Q3-Q4	2009 Q1-Q2	2009 Q3-Q4	2010 Q1-Q2	2010 December	2011 Q1-Q2	2011 August
Scoping	Advice guidelines on EIA (Commission MER)	Notification intention	Ecological and 2D modelling studies	Audit of modelling	3D modelling	EIA	Public announcement of the zoning plan and EIA. Advice of Commission MER. Refutation of objections. Adjustments to EIA (use of dredged material and safety).	Decision making and announcement	Permit		Annullment of zoning plan and accompanying permits
		Public announceme nt (incl. Germany)	Consultation formal and informal		Informal consultation		Formal consultation (incl. Germany)			Appeal	

Figure 3.2 **Summary of the timescale for the EIA and consenting processes for the channel deepening project**

In the meantime, the NCA was preparing the permit in the frame of the nature conservation law. The NCA specifically informed the stakeholders frequently throughout the process and they could raise objections and have insights that could be included in the permit.

The permit was given in December 2010. There was opportunity to raise objections in court (Raad van Staten). The NGOs did make an appeal on environmental grounds, as did the German WSD (and other parties) who objected on the ground of nautical safety rules as there was no good agreement on this between Germany and the Netherlands.

The Raad van Staten destroyed the zoning plan in August 2011 on the basis of safety and the permit in the frame of the nature conservation law was withdrawn by the NCA. The concept monitoring plan was added within the permit, but the monitoring has never started since the permit was withdrawn.

In 2012 a new process for the enlargement of the navigation channel commenced.

3.7 Analysis of research tools and methods

3.7.1 General

Different hydrodynamic, sediment transport and morphological models have been applied in the study. The first priority was to assess the impact of the enlargement of the channel on water movement. Because relatively minor changes to the bathymetry of the area were proposed – only local capital dredging was required to meet the channel specifications – it was anticipated that the consequent changes in water movement would be minimal.

Secondly, the consequent changes in sediment transport capacity and patterns were considered. This concerns potential wide ranging morphological effects due to changes in tidal volumes. Such large scale changes may influence the stability of the system of ebb and flood channels and also cause undesired re-sedimentation within the dredged channel. However, because of the very small interference in the system, no significant morphological effects were expected.

Dredging a channel will essentially promote re-sedimentation; nature will try to restore the original balance between water levels, currents and waves and water depth. The possibility of re-sedimentation was a specific point of attention in the EIA studies.

In view of potential ecological impact, the focus was on resuspension of disposed dredged material at a number of distinct disposal locations. The dredged material - sand and silt - would be disposed at these locations and would be expected to be transported and re-distributed within the estuary due to wave and current action. The dredged material also consists of boulder clay, which would be disposed at one specific location with greater water depth. The boulder clay was largely expected to remain in this 'natural' deep pit.

Because resuspension and redistribution of disposed dredged material would cause a certain increase in turbidity, it was deemed important to estimate this increase and to evaluate the possible ecological effects. The disposal and distribution of sediments from dredging in different harbours (Eemshaven, Delfzijl, Emden) and the existing navigation channel (Emden fairway) were also taken into account due to the potential for cumulative effects to occur with these projects.

The turbidity increase due to the dredging and disposal operations itself was not considered to be a significant environmental issue because of the limited area affected and the predicted short duration of the increases in turbidity.

In the following paragraphs, the approach that was adopted to model the above potential effects is discussed.

3.7.2 Water movement

For hydrodynamics the Waqua-in-Simona model was used. This model simulates time-varying water levels (tidal motion) and flow velocities in a 2-dimensional horizontal grid. In addition, the dispersion of dissolved particles is simulated. Tidal volumes and salt/fresh water gradients can be derived from the computational results.

For simulation of waves the model SWAN was used. This model is based on the growth of short wind-driven waves in varying water depths, taking into account bottom- and current-induced refraction, bottom friction, white-capping and depth-induced wave breaking.

3.7.3 Morphology and sedimentation

Large scale morphology was analysed on the basis of historical bathymetric information. Empirical relations between tidal volume and cross-sectional area of flow-carrying channels were applied to predict the stability of tidal channels with changing tidal volumes.

Re-sedimentation of the dredged channel (parts) was computed with a model (CHANS) taking into account the decrease in sediment transport capacity in the deepened channel sections. Large scale morphological changes may contribute to channel sedimentation as well. This was analysed on the basis of historical bathymetric information. To support this analysis a 2-dimensional Delft3D morphological model was set up.

3.7.4 Silt transport

A silt-distribution model was set up to simulate the above resuspension and transportation of disposed dredged material. Firstly, a two-dimensional (horizontal) approach has been applied on the basis of Delft3D-WAQ. This model was applied for all disposal locations considered with the predicted volume of dredged sediment as model inputs.

An expert commission, appointed by the NCA, advised the use of a 3-dimensional model to be sure that the best available techniques were used.

The resulting concentration trends of the 2D and 3D models were comparable and gave a good idea of the concentrations at different conditions. Although the models are not able to produce accurate quantitative predictions of the silt distribution in time and space, the outputs can be considered reliable indications.

The 3-dimensional model was built on the basis of Delft3D, with both the WAQUA and the SEDONLINE module for simulation of sediment transports. With the WAQUA module, the sediment transport is evaluated separately on the basis of a number of cycles in the tidal water motion. The SEDONLINE module computes the sediment transport in each time step of the water motion.

The 3-dimensional computations have been carried out for two disposal locations.

3.7.5 Disposal locations

As has been outlined above, dredged sediments are disposed at specific locations to be re-distributed by currents and waves.

The volumes of sediment which can be disposed without unacceptable accumulation are limited by the spreading capacity of the disposal locations. The spreading capacity for sand was based on the transport capacity of the channel system (application of sediment transport formulae) and on the observed morphological changes.

The spreading capacity for mud was determined by calculating the net silt transport per tidal cycle by using a 1-dimensional vertical time-dependent mud transport model.

3.7.6 Water quality

Chemical and ecological water quality was examined. Effects on salinity and oxygen conditions, pollution due to disposal of dredged material, eutrophication, priority and other substances (TBT and TPT), turbidity and accidents were considered. No extra tools were used. Regular monitoring measurements undertaken by Rijkswaterstaat were used for evaluation (Monitoring Waterstaatkundige Toestand des Lands Milieumeetnet Rijkswateren or MLWTL).

3.7.7 Soil quality

Soil investigation was undertaken by Wiertsema & Partners (2007). When the quality is within the ranges of the Zoute-Bagger-Toets (ZBT) (Besluit Bodemkwaliteit), contaminant levels are considered accepted and effects are negligible.

3.7.8 Ecological modelling (flora and fauna)

Habitats

Maps of the habitat types that potentially could be impacted by the project were drafted using recent existing data on biota (phytoplankton, phytobenthos, sea grass, etc.) and abiotic parameters since they influence the quality of the habitat.

Changes to habitats due to the project were then determined by the ZES-1 (salt-ecotope-matrix) and modelling. The ZES-1 matrix is much more detailed than the habitat types described for Natura 2000, and this is the reason why this method was used. The 'ZES-code' defined zones describe the changes in hectares due to the deepening of the navigation channel on the one hand and those changes in combination with the Emder fairway on the other hand. The results of the ZES method were then assessed in the context of the changes in the area between 1855 and 2000, described by De Jong (2006). The hydromorphology of the area has been changed by human activities with higher flow velocities and tidal amplitudes. In several places poldering has also taken place. By putting together the results of these two methods (ZES and de Jong, 2006) it is clear that the surface of the estuary has been diminished by almost 30% since 1855.

Alkyon (2007), following the work of De Jong (2006), described the differences between 2010 and 2030. The results of this modelling was that the surfaces of brackish areas diminish and those of saline areas increase. Highly dynamic ecotopes increase and less dynamic ecotopes decrease. The results also show that the changes are minimal and not larger than the natural dynamics and effects due to rising sea level.

Fish
Data from research on diadromous fish in the Ems-Dollard has been conducted from 1999 to 2001. As a result of the fishing method adopted in this research, non-migratory fish have also been monitored (Kleef and Jager, 2002).

Data from the above study were compared with data from more recent studies of effects of fish from the cooling water intake of the RWE and NUON power plants (Bioconsult, 2008). No complementary inventory (survey) was undertaken. The assessment was based on the expected impact of dredging techniques and made by expert judgement.

Benthic fauna
For this project a specific inventory of the presence of benthic fauna (macrobenthos) in the navigation channel was made (van der Graaf, 2007). The assessment was based on the expected impact of dredging techniques and locations (e.g. direct loss of benthic community) and the implications of this loss was then translated to impacts on other species higher in the food web using expert judgement.

Feeding, roosting and breeding birds
Data was collected from literature and data files from institutes and authorities. No complementary inventory was made specifically for this project.

Marine mammals
Data on the presence and numbers of harbour seals from aerial surveys in the Wadden Sea in 2006 (Trilateral seal expert group, 2006) was obtained. Brasseur (2007) modelled the chance of the presence of harbour seals in the

water based on the Dutch population of harbour seals and corresponding resting areas. In the appropriate assessment for the LNG terminal (Tebodin, 2007) this model was supplemented with data from surrounding German resting areas. No extra survey studies of grey seals and harbour porpoises were made.

Primary production
The most recent data is from 1976-1980 and is restricted to the Ems estuary. The effects of turbidity on primary production are based on the fact that there is a linear relation between the relative increase of turbidity and the decrease of the primary production (in %) (Consulmij, 2008). This method was approved by scientists who were asked to give a second opinion on this report.

3.7.9 Cumulative impact

The cumulative effects with several other defined projects and plans were described in the EIA and AA. Only initiatives that are in an advanced planning stage, and that are likely to be executed, were considered. Cumulative effects occur when this project and one or more other projects have a simultaneous or successive effect on the designated species or habitats.

Therefore the following projects/plans were considered:

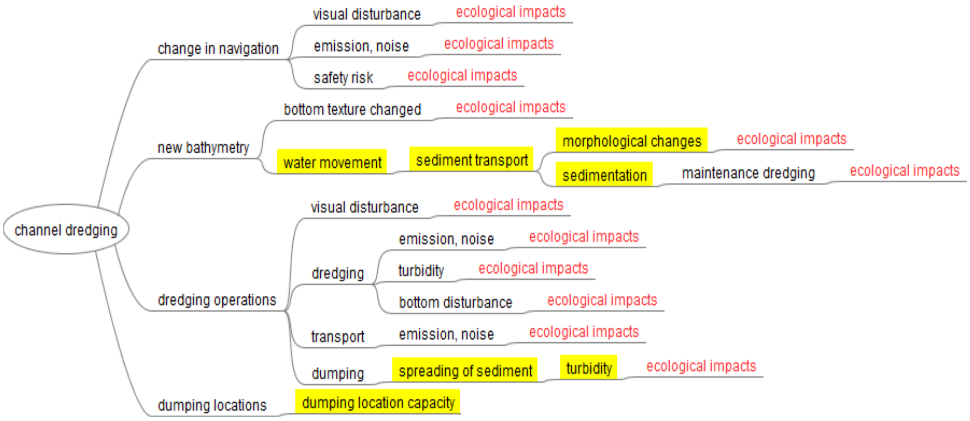
- The construction of the Nuon and RWE power plants and the LNG Terminal ELT;
- The enlargement of the Eemshaven harbour;
- The enlargements of the Emder fairway and Unterems;
- The construction of the Borkum Riffgat Windpark.

The cumulative impact assessment concluded that no significant effects would occur. It was predicted that seals could be disturbed by the increased shipping traffic, but it was not expected that the goals for the species would not be reached especially since the numbers of seals are increasing every year. Also in the frame of other projects, like the enlargement of the Eemshaven, compensation measures are taken that also have a positive effect on the seals (the Dollard has been cut off for shrimp fisheries which reduces disturbance for seals in the area).

3.8 Analysis of areas of uncertainty and risk

3.8.1 General

The ecological impact resulting from the project is, in part, due to the complex interactions between water and sediment. An indication of the position of this interaction in the cause-effect chain resulting from channel dredging is shown in the following diagram:



In the following sections, uncertainties are discussed which are related to the elements highlighted yellow in the above diagram: water movement, sediment transport, morphological changes, sedimentation, spreading of sediment/turbidity and the dumping location capacity.

3.8.2 Water movement

Water movement is represented by hydrodynamic models based on the equations for motion and continuity. A reasonable assumption is that such models are able to predict water levels with an accuracy of 0.1m with adequate grid resolution, boundary data and initial data. For impact assessment it is, however, more important to consider changes in water movement, induced by projects. Experience with this kind of model shows that the relative outputs of such models have an accuracy of 5 to 10% (based on expert judgement). This accuracy is taken into account when considering the environmental effects. In the calculations of the water movement a worst case was included. The effects on water movenemt were calculated in a scenario where no material or sediment was put back into the system (at the disposal location) (only material was removed from the system).

3.8.3 Sediment transport

Water-sediment interaction and the consequent quantities and patterns of sediment transport are modelled with much larger inaccuracy than described for water movement above. The main sources of uncertainty are the entrainment functions (friction on sediment particles due to water flow) and the sediment composition and properties. Depending on the type of sediment transport (bottom, suspended) the accuracy of transport computations is generally not more than 50%. This estimation is made by experts experienced in using this type of model. This accuracy is recognised and accepted and therefore a worst case is being calculated in order to avoid underestimating the environmental effects. An example of such a worst case scenario was the situation in which sediment is not settling and turbidity levels are, therefore, overestimated. These extreme scenarios are not used to calculate the effects on primary production, only to estimate the severity of hydromorphological effects on the environment. The model was also validated with data from the deepening of the river Ems (an already completed project) (see Section 3.8.8). Also the worst case scenario as described for the calculation on water movements was included in this model.

3.8.4 Morphological changes

Large scale trends and changes in the bottom topography or bathymetry ("morphological changes") are generally predicted on the basis of historical bathymetric maps. Such analysis is - when appropriate - supported by empirical relations, for example of tidal volume versus channel cross-sectional area, and numerical morphological models of initial changes of the bathymetry (due to a project). It is still impossible to produce long-term morphological predictions with satisfactory accuracy on the basis of numerical morphological models alone.

Therefore, it is also impossible to express the accuracy of morphological models in terms of a percentage. Such models are suitable to analyse trends in bottom development rather than to predict shoaling or deepening in specific locations with a certain percentage of accuracy. Morphological models are, therefore, suitable to provide qualitative information when predicting long-term morphological changes.

3.8.5 Sedimentation

As has been outlined previously, channel sedimentation was analysed on the basis of reduced sediment transport capacity inside the deepened channel on the one hand, and on the basis of consideration of large scale morphological changes on the other hand.

The CHANS model was applied to predict the reduction of sediment transport capacity and resulting sedimentation in the channel. The accuracy of the transport formula included in this model is estimated at 50% (in the EIA report). However, it is clear that the quality of such predictions depends to a large extent to the quality of the boundary conditions: the tidal water movement, waves and sediment properties. For that reason the inaccuracy might by much higher and definitively exceed 100%.

The accuracy of the prediction of sedimentation due to large scale morphological changes is impossible to assess quantitatively, for the same reason as given above in Section 3.8.4.

3.8.6 Dispersion of silt/ turbidity

The Delft3D model to simulate the dispersion of deposited dredged sediment should also be considered as a tool to predict trends qualitatively and orders of magnitude of resulting increases in turbidity.

In addition there is a great deal of uncertainty about the properties of the boulder clay. Whereas the silt and mud from dredging harbours and the Emder fairway is likely to be of a rather loose composition of fine material, the composition of the boulder clay, and the fraction of it that will be transported away from the disposal locations as suspended sediment, is highly uncertain.

As far as the result is concerned, the computations reveal a rather large area of dispersion in a seaward direction and at the same time a relatively quick reduction of concentrations in time. Without claiming that the resulting concentrations match reality, it is expected that the resulting trend is correct. The resulting temporary increases in turbidity of 10 ppm (order of magnitude) were considered insignificant.

3.8.7 Capacity of disposal locations

The accuracy of the capacity for sand is basically the same as the accuracy of the prediction of sedimentation in the channel. The applied sediment transport formulae have an inaccuracy of no less than 50%. The influence of morphological changes on the spreading capacity for sand can only be estimated qualitatively.

The accuracy of the disposal capacity for silt and mud depends on the applied one-dimensional vertical model of mud transport. Here a comparison can be made with the accuracy of the 3-dimensional Delft3D distribution model. One of the sources of uncertainty is the entrainment properties of the mud/silt bottom, and this holds for the 1-dimensional vertical model as well. Therefore the accuracy of the resulting disposal capacity is most probably rather low and should be considered an order of magnitude only.

3.8.8 Effects on habitats

To describe the effects on habitats, initially a matrix of all possible effects on the habitats was made. Possible effects were divided in different categories, such as hydromorphological effects (increased turbidity, changes in water movements and tides, etc.), effects on quality (water, air and soil) and other effects (calamity, loss of habitats and cumulation). Effects on the protected habitats were described and then assessed for each habitat type. The ecological background study (Consulmij, 2008) was used for the assessment and the effects were calculated if possible (e.g. for primary production) or the assessment was made by expert judgement. Worst case scenarios were used to calculate the hydromorphological effects which also affect habitats. Effects on a specific habitat were related to the total area of that habitat in the Natura 2000 area.

3.8.9 Consultation on hydromorphological modelling

The NCA defined some gaps in knowledge. These were filled by doing research during the EIA and Appropriate Assessment process. For the effects on hydromorphology, 2D modelling was performed to describe the effects of sediment transport and turbidity (Alkyon 2007). This research was done to be able to define the risks of the project. This investigation was pure modelling with worst case scenarios for sediment transport and turbidity. An example of such a scenario was the situation in which silt is not settling and turbidity levels are, therefore, overestimated. This was calculated to examine if this situation leads to severe effects in the environment (upper level of the range of effects). This scenario was not, however, used to calculate effects on primary production. To calculate effects on primary production, overestimations of turbidity and sediment transport were used, but not an extreme situation where no settling of the sediment took place. Due to this research, the gaps in knowledge were filled according to the authorities.

As noted earlier, to validate this model an independent audit commission was consulted. The audit commission was not completely sure of the results of the 2D model and advised the use of a 3D model to be sure that the best available techniques were being used. They recommended specifically to express the accuracy of the calculated values for water levels, velocities and salinity levels in a score. The researchers followed this advice and chose for a mean and standard deviation from difference series of observation-calculations and used 3D modelling. These results are included in the Alkyon reports (2008a, b).

Another recommendation of the Commission was to calculate the harmonic components of the water levels and velocities with the 3D flow model and to compare that with the observations in the field. For this comparison the same score is used as described above. Further 3D flow model GIS is used to describe the effects of the enlargement of the river Ems. To validate the model, data on the vertical tide from another project performed in the same ecosystem (Ems estuary, but not in the same place in the estuary) were put into the model. These results were compared to observations in the field (monitoring undertaken as a part of the German permit for this already implemented project). The outcomes of the model were comparable with the results in the field, which strengthened the usefulness of the model. Based on the scores of the sequences and the harmonic components as well as the results of the calculations of the deepening of the channel, the Commission accepted the results of the 3D modelling.

The 3D modelling was thus performed (Alkyon 2008B) to be sure that the best techniques were used. Although effects were minimal, and 2D modelling was probably sufficient, the 3D modelling was performed mainly to ensure that the studies were fully defendable in court.

The effects of dispersion of the dredged material were described combining two big projects (enlargement of the Eemshaven and the widening of the navigation channel) by using a 2D model and, following the recommendations of the audit commission, also a 3D model. This was considered to be a good approach and the questions were answered and gaps in knowledge were filled. The best available techniques were used, and this convinced the NCA that the best was done to predict effects. The results of this research were then used to make predictions on the potential ecological effects.

Following this process, the EIA Commission provided advice on the documents and they approved the 3D modelling, stating:

"The comparison between trends in the results of the different simulations (2D and 3D) give a good idea of the differences at different conditions. The models can't give exact predictions of the distribution of the silt but can give reliable indications".

The advice of the EIA Commission was to verify the modelling predictions with monitoring and adjust the models if needed. This is also taken up as regulations in the permit (regulation 18-23).

The accuracy of the silt distribution model Delft3d-Waq is low. By using sensitivity analysis, the accuracy is being enhanced and the worst-case approach is being used in order not to underestimate turbidity effects.

The T0 situation is the present, in other words the time before the project. In estuaries it is generally difficult to determine the hydormorphological T0 situation in a dynamic area where a lot of activity is going on. In order to compensate for the inaccuracy of the T0 situation, worst case scenarios are used.

As a conclusion for hydromorphological effects, it can be stated that the best available techniques are being used, the use of models was verified by expert panels and then by the EIA Commission. In addition, a monitoring programme was designed to verify the predictions of the model

3.8.10 Primary production

The worst case calculated by the 3D model is translated to ecological effects on primary production. The translation of the effects of turbidity to effect on primary production was done in a simple way assuming that there is a direct linear relation between the relative increase in turbidity and the decrease of primary production (in %). A worst case scenario was used since positive feedback mechanisms were not included (chain models Eems Deltares) and background values of turbidity were kept very low. This simple method was approved by scientists and the NCA that asked for a monitoring plan for primary production to check if the predicted effects are also seen in reality. In the permit for the nature conservation law there is always the possibility for the authority to withdraw the permit if monitoring (or other means) show that effects are not as predicted and/or significant. Before withdrawing the permit, additional mitigation measure can be prescribed. This is a “step-wise” permit.

3.8.11 Marine mammals

To deal with the uncertainties with regard to the potential effects on marine mammals, RWS had to design a monitoring programme given that this is in the regulation of the permit. Monitoring is needed for seals, especially their presence in the area, how they use the area and what their reaction is on disturbing activities (i.e. the turbidity as a consequence of disposing dredged material and the change in location of gullies and mudflats as a consequence of the widening of the navigation channel). For the monitoring of marine mammals, a zero measurement is needed for the presence of the animals and their use of the area. The monitoring has as a goal to verify the effects of the activity and the mitigation measures. The monitoring plan should also be used as an early warning system so that changes in the behaviour of marine mammals and changed use of the area can be identified.

For marine mammals, the step-wise way of writing the permit was applied by the NCA. To fill the gap in knowledge, an investigation was made by experts from Imares. The research was partly fundamental research and partly focussed on the project.

The result of this research is that risks for the marine mammals could not be excluded. Imares advised that this could only be done by having an extensive monitoring programme. The NCA could not ask one proposer of a project to do this; this would be disproportionally large and fundamental research. Consequently, the NCA made a consideration together with their internal experts and people in the field (surveillance boats) and the findings of the Appropriate Assessment that the risk was acceptable. It was only a temporary disturbance; there would be effects but only of small magnitude and not at the population level. Monitoring was prescribed to verify the above conclusions.

3.8.12 Significance

There are no general rules for significance. An effect is considered significant if it endangers the goal of the protected habitat or species. Consideration as to whether or not an effect is significant is made on a case by case basis. This also applies for cumulative effects.

If there is an improvement goal for a habitat or species, any effect can be considered as significant. If the goal is conservation any activity that does not affect achieving this goal is considered not significant. In the Netherlands, a framework for the assessment of effects in Natura 2000 areas has been developed by Bureau Waardenburg (2008). This framework is frequently used for determining the significance of effects and is generally accepted by the Dutch authorities responsible for the permit. Deterioration (in amount, surface or quality) of less than 1% is not significant unless the decline of the amount or the surface is lowering the value as set in the goal. A decline of greater than 1%, but less than 5%, should be assessed per case to determine whether the effect is significant. If, as a result of the change, the amount or surface is reduced beyond the value named in the goal, the effect is considered to be significant. If the trend of a species is declining, a decline of greater than 1% but less than 5% can be significant, while this is not always the case when there is a positive trend (Bureau Waardenburg, 2008).

3.8.13 Permit decision making process

The EIA Commission advised that the modelling predictions should be verified with monitoring and adjustments made to the models, if necessary (see Section 3.8.9). Monitoring is included in the permit (regulation 18-23). The purpose of the monitoring is to monitor the effects in the field (reality check) and to check if they are corresponding with the predicted results.

The regulations in the permit (18-23) state that within 3 months of the publication of the permit a monitoring plan has to be delivered to the authorities. This plan will describe in detail what (biotic and abiotic factors), how (methods), when (during and after the activities), frequency and how long the specific items will be monitored to be sure there are no significant effects.

The monitoring plan needs to guarantee that conclusions concerning the violation of Natura 2000 goals and mitigation measures can be drawn. The plan needs to be approved by the director of the authority before activities can start.

For the enlargement of the navigation channel, monitoring is necessary for marine mammals, turbidity as a consequence of disposing dredged material and effects on primary production and the change in location of gullies and mudflats as a consequence of the widening of the navigation channel. The monitoring plan should be such that it can function as an early warning system and that negative effects, which are not predicted from the studies, can be traced in an early stage.

If, on the basis of the monitoring, it is clear that the proposed mitigation measures are not sufficient (e.g. if negative effects are larger than predicted) the authority can prescribe additional mitigation or compensation measures to minimise the adverse effect. These measures are not described specifically yet and will be formulated if the situation occurs. If those are not effective, the permit can be withdrawn and the activity can be put on hold so the system can recover from the negative impact.

Also the permit authority (NCA) can demand changes in the monitoring plan at any time, if necessary.

3.9 Overview of output of the interviews

3.9.1 Quality of the estuary

RWSs expert on hydromorphology stated that the uncertainty on the morphological changes (and the question whether the system would flip to an alternative stable state due to this enlargement project) is actually not so uncertain since there are little effects (temporary and local) due to this project if you consider the whole dynamic Wadden Sea. There are uncertainties concerning modelling and cumulative effects, but they are small and certainly not significant putting them into the framework of the whole Wadden Sea.

The NGOs did not, however, agree with the above. They believe that all effects are trivialised without thinking of the precautionary principle. Any chance that an effect will take place is significant for a system that is in bad condition (i.e. too turbid and possibly turned into an alternative stable state). The NGOs state that the biggest uncertainty is nature itself; the ecosystem is not fully understood yet and this is why the precautionary principle needs to be applied. This is not fully done according to the WV.

The overall attitude of the nature conservation parties was negative towards the entire project. They are against the enlargement of the navigation channel itself, but also against the building of coal-based power plants.

3.9.2 Cumulative effect

Taking into account cumulative effects is a problem according to the WV. According to the WV not all relevant deepenings of channels and dredgings should be taken into account, meaning that the planned deepening of Emder fairway should be included in the cumulative assessment. This was at that time not necessary since the plan was not yet official. Cumulative uncertainties will become extremely large on system level. This point of view is not shared by RWS nor the NCA. All cumulative effects have been thoroughly described in the EIA and Appropriate Assessment.

3.9.3 Research on marine mammals

According to RWS, the largest uncertainty is the behaviour of marine mammals. The research that has been performed the last few years in the context of the piling for the enlargement of the Eemshaven harbour has been very controversial since the research is done on an individual level (tagging separate seals), results are difficult to interpret and scientist do not want to draw clear conclusions. Due to increasing scientific and specific knowledge, uncertainties have also increased since research is done on individuals and it is difficult to extrapolate these results to population levels. RWS believes that the wrong type of research has been performed in the context of the enlargement of the Eemshaven and too detailed scientific research is performed instead of research concentrating on the project. RWS is concerned that they will be forced to do this expensive kind of research in connection with of the enlargement of the navigation channel.

3.9.4 Availability of primary production data

One uncertainty is that primary production has not been measured since the 1980s and without a current baseline understanding it is not possible to make accurate predictions. The best available data has been used and RWS has started to develop a monitoring programme for primary production for future projects.

3.10 Conclusions

The project has not yet been accomplished as the zoning plan has been destroyed by court and the permit in the frame of the nature conservation law has been withdrawn. The destruction of the zoning plan was done on safety grounds, since Rijkswaterstaat removed a part of the dredging activities for the creation of a safe anchorage area from the EIA at the last moment. The court, therefore, decided that the safety for the public was not secured. They did agree with the analysis of the ecological effects as described in the EIA accompanying the zoning plan. Many other objections on the project were formulated, mainly from the NGOs (cumulative effects, ecosystem approach, integration with other projects), but also from German fishermen (mussels) who are concerned that increased turbidity can harm mussels. Concern was also raised by German health resorts on the island of Borkum.

A whole new procedure has just been started (mid-2012) to enlarge the navigation channel from the Eemshaven to the North Sea.

Many lessons can be learned from the project. From the interviews, it was shown that the NGOs would have preferred more participation and consultation in the process as they were only consulted at formal moments, while Rijkswaterstaat felt that they had been informing and consulting in a sufficient way for all parties. The NCA was also convinced that there was enough participation and consultation.

The enlargement of the navigation channel is only one of the many projects that are being performed in the vicinity of the Eemshaven. In the new procedure, the connection and interaction between these projects should be stressed more and effects on the ecosystem should possibly be evaluated together.

To minimise uncertainties, gaps in knowledge were filled as much as possible by performing specialised studies and using expert judgement. Also a (very) worst-case has been used to be sure that the effects are not underestimated.

The largest uncertainties lie in the hydromorphological modelling. Initially, a 2D modelling exercise was performed. An audit commission decided that a 3D modelling was necessary to ensure that the results of the 2D modelling were correct and to make sure that the best available methods were used. Ultimately, all parties agreed that the results were good enough. The low accuracy of some models has been accepted and, therefore, very worst-case scenarios were used to ensure effects were not underestimated. One independent scientist does not agree with the methods used (3D modelling), although this type of modelling is used in all other comparable studies and projects.

Rijskwaterstaat criticised the way the monitoring of marine mammals was done for the enlargement of the Eemshaven and is concerned that these detailed results will increase the uncertainty of effects on seals.

According to the NGOs the uncertainty is the whole ecosystem itself. The Ems-Dollard ecosystem is in poor condition and, therefore, they believe that no activity should take place in the estuary.

In the Netherlands the amount of specialists is limited. To find independent scientists that are not involved in the project is difficult, not only for NGOs but also for the NCA. This is a real problem and experts from abroad possibly have to be consulted in future projects.

4 Humber

4.1 Description of the project

The Immingham Oil Terminal approach channel deepening project involves dredging in five areas (see Figure 4.1), as follows:

(1) Edges of the proposed Stallingborough emergency turning area to the west of the Sunk Dredged Channel (SDC);
(2) The existing SDC;
(3) The Hawke Channel inside the mouth of the estuary;
(4) The Chequer Shoal Bar to the east of Spurn Head;
(5) An area to the east of Chequer Shoal, which is referred to here as the Eastern Approaches.

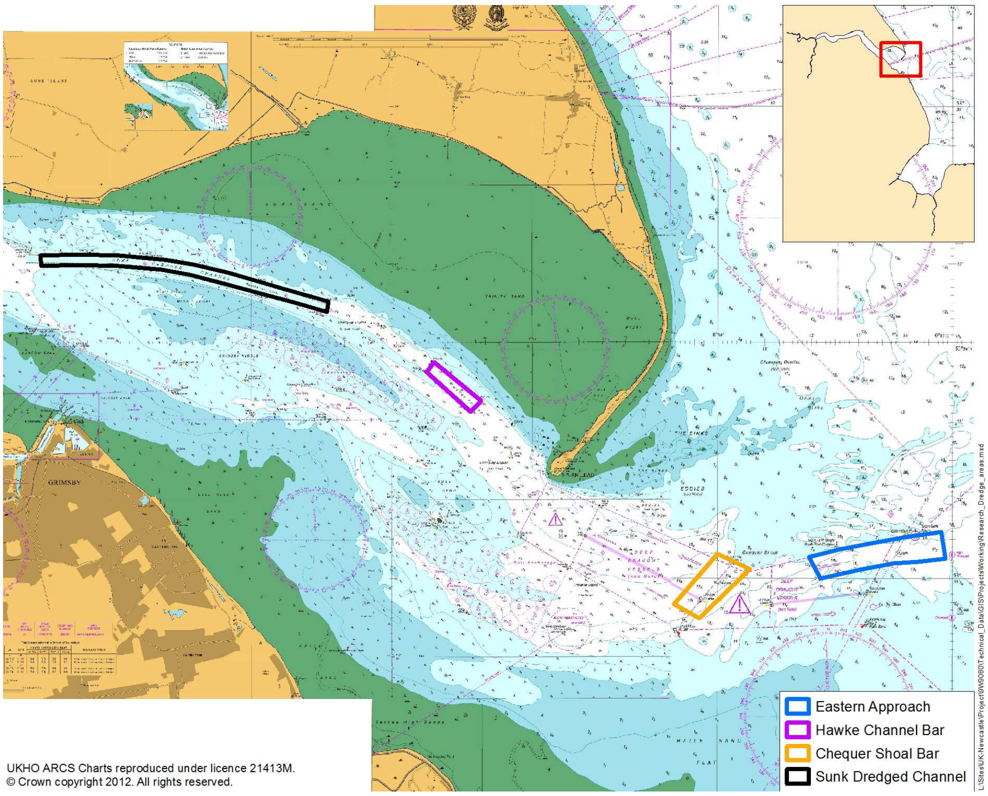


Figure 4.1 Proposed dredging locations for the Immingham Oil Terminal Approach Channel Deepening project (source: ABPmer, 2009)

The dredging would cover approximately 427ha of seabed, 312ha of which is located within the boundaries of the Humber Estuary European Marine site. The total dredge volume is estimated at 3,905,000m^3 of glacial clay, silts and sands to allow access for a design vessel draught of 15m. Without the proposed dredging, the draught of vessels using the terminal is limited to about 13.2m (without tidal restriction).

The dredged material would be disposed at a number of different disposal sites located within the Humber depending on, for example, the type of material and the volume being dredged and disposed.

4.2 Overview of relevant Natura 2000 sites

The relevant Natura 2000 sites are the Humber Estuary Special Protection Area (SPA) and Humber Estuary candidate Special Area of Conservation (cSAC). The following information summarising the designated interest features of the European site is taken from the ES (ABPmer, 2009).

4.2.1 Humber Estuary SPA

At the time of the EIA, the qualifying features of the Humber Estuary SPA were as follows:

- Annex I bird species that comprise regularly more than 1% of the Great Britain population in any season:
  - Breeding - bittern, marsh harrier, avocet and little tern;
  - Wintering - avocet, golden plover, bar tailed godwit, bittern and hen harrier;
  - Passage – ruff.

- The site is used by greater than 1% of the biogeographical populations of migratory species in any season (not listed in Article 4.1):
  - Passage - knot, dunlin, black tailed godwit and redshank;
  - Wintering - knot, redshank, dunlin, shelduck and black tailed godwit.

The site as a whole also qualifies for being used by over 20,000 waterfowl in any season. In the non breeding season, the area regularly supports 153,934 waterbirds including dark bellied brent goose, shelduck, wigeon, teal, mallard, pochard, scaup, goldeneye, oystercatcher, avocet, ringed plover, golden plover, grey plover, lapwing, knot, sanderling, dunlin, ruff, black tailed godwit, bar-tailed godwit, whimbrel, curlew, redshank, greenshank and turnstone.

4.2.2 Humber Estuary cSAC

The habitats and species of European priority interest for which the Humber Estuary cSAC area has been recommended are:

- Coastal lagoons; and,
- Fixed dunes with herbaceous vegetation (grey dunes).

In addition to these habitats/species there are European interest features for which this area has been recommended as a cSAC and they are:

- Atlantic salt meadows (*Glauco-Puccinellietalia maritimae*);
- Embryonic shifting dunes;
- Dunes with *Hippophae rhamnoides*;

- Estuaries;
- Grey seal *Halichoerus grypus*;
- River Lamprey (*Lampetra fluviatilis*);
- Mudflats and sandflats not covered by seawater at low tide;
- Sea lamprey (*Petromyzon marinus*);
- Glasswort (*Salicornia*) and other annuals colonising mud and sand;
- Sandbanks which are slightly covered by sea water at all times and
- Shifting dunes along the shoreline with marram (*Ammophila arenaria*).

4.3 Parties involved in the case study

During the EIA and consenting process a number of organisations were involved and consulted on the proposals. A summary of the organisations involved and their role in the process is provided in Table 4.1. It should be noted that for consultees, only those organisations that provided a response to consultation during the EIA are included (i.e. others were consulted, but did not respond).

Table 4.1 Summary of organisations involved in the case study

Organisation	Role (role or key interest)
Associated British Ports (Grimsby and Immingham) *	Applicant (developer)
ABPmer *	EIA consultant (including numerical modelling work and interpretation)
Marine and Fisheries Agency (Marine Environment team) (became the Marine Management Organisation (MMO) during the course of the application process)	Regulator (decision-maker)
Marine and Fisheries Agency (Fisheries Inspectorate)	Consultee; advisor to Marine and Fisheries Agency (Marine Environment team) with regard to fisheries issues
Associated British Ports Hull	Consultee; Harbour Authority (port and navigation issues)
Natural England *	Consultee; statutory advisor to the regulator on nature conservation issues (ecological impact, Habitats Regulations issues)
Royal Society for the Protection of Birds (RSPB) *	Consultee (ecological impact)
Simon Ports	Consultee (ports and navigation)
Trinity House	Consultee (ports and navigation)
English Heritage	Consultee (archaeology and heritage)
North Lincolnshire Council	Consultee (general interest in EIA)
Lincolnshire Wildlife Trust	Consultee (ecological and environmental impact)
Centre for Fisheries and Aquaculture Science (Cefas)	Consultee (environmental impact; scientific advisor to the Marine and Fisheries Agency/MMO)
East Midlands Regional Assembly	Consultee (general EIA issues)
Yorkshire and Humber Assembly	Consultee (general EIA issues)

* indicates that representatives from these organisations were interviewed as part of the reporting for this case study

In terms of defining the approach to the EIA for the project, including the approach/methodology for the surveys, numerical modelling studies, impact assessment, etc., the Marine and Fisheries Agency (MFA) (which became the Marine Management Organisation (MMO) through the course of the project) is the key organisation because the MFA issues the formal scoping opinion that addresses such issues.

The information to enable the regulator to reach a scoping opinion was provided by the applicant (through the production of an Environmental Scoping Report produced by the consultant team working on behalf of the applicant). This included the scope of issues to be addressed for each environmental parameter (e.g. potential impacts of the scheme) and a description of the studies, including methodology, that are proposed to be used to inform the impact assessment. This information was developed through discussion and agreement with key consultees. Of particular relevance to the scope of this study, the opinions of Natural England, the RSPB, Cefas and the Lincolnshire Wildlife Trust are of significance in informing the EIA process. Further information on the consultation process is provided in Section 4.6.

Issues such as what constitutes a significant effect or how to deal with uncertainties (e.g. in making predictions through numerical modelling) are not typically addressed at the scoping stage as there is usually not sufficient information available at that stage to make such judgements. For this case study, such issues were discussed as the EIA process progressed by undertaking regular consultation with the key consultees, such as Natural England and the RSPB. Section 4.7 and 4.8 describe how the significance of effects was assessed and areas of uncertainty managed as the EIA studies progressed.

4.4 Overview of the local NGO situation

The involvement of the NGOs with projects in the estuary is essentially on a project by project basis, and the organisations are consulted through the EIA process. In terms of the subjects within the EIA process that are of relevance to this study, and the Appropriate Assessment, the key organisation is Natural England as it is the advisor to the decision-maker on the nature conservation implications of the project and, therefore, should (as a matter of good practice) be consulted during the process of undertaking a Habitats Regulations Assessment.

Other key organisations include the RSPB. Although not a statutory consultee, the RSPB is an important organisation to consult as it has significant expertise. In addition to being a consultee on the EIA and Habitats Regulations Assessment, the RSPB manages two reserves in the Humber at Read's island and Blacktoft Sands.

For this case study, the NGOs were consulted throughout the EIA process. The NGOs were not organised into a single group, but were consulted, and provided input to the process, on an individual basis. Whilst it is important that all organisations with an interest in the project were consulted at the local level, it is particularly important that those organisations that have an advisory role to the regulator (e.g. Natural England and the Environment Agency) are consulted during the EIA process). The fact that there are many bodies involved in the consultation process was not problematic for the EIA process (in terms of conflicting opinions) as many of the key issues to be addressed in the EIA were common to each organisation.

4.5 Chronological overview of the study process

The Immingham approach channel dredging project was a stand-alone scheme required to improve marine access for vessels into the Humber, and was not part of a wider strategic study. As such, the EIA was the first environmental study undertaken specifically for this project.

The EIA commenced with a scoping study, the output of which was a scoping report that was submitted to the MFA. The MFA subsequently responded with a formal scoping opinion, which incorporated the findings of the scoping study and included further issues raised by consultees during the MFA's consultation on the scoping report.

Consultations were undertaken throughout the EIA with statutory and non-statutory consultees (i.e. during the feasibility, scoping and assessment phases) (see Section 4.6).

A baseline review was undertaken using available literature, field surveys and desk-based analysis followed by the impact assessment and identification of mitigation.

Figure 4.2 summarises the timescale for the EIA and consenting processes for the Immingham Oil Terminal approach channel deepening project.

It can be seen that the overall timescale for the project from the beginning of the EIA process until consents were granted was approximately 3.5 years. It is understood from the interviews that part of the reason for the extended timescale between application and receiving consent was due to the creation of the Marine Management Organisation during this period, which replaced the Marine and Fisheries Agency as the regulator.

2007				2008				2009				2010		
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3
EIA								Application	Supplementary environmental information					Consent (February)
Informal consultation throughout EIA process								Statutory consultation (by regulator)						

Figure 4.2 Summary of the timescale for the EIA and consenting processes for the channel deepening project

4.6 Overview of the consultation process

During the EIA process (i.e. until the point of submission of the application to the regulator (decision-maker), there is no obligation (legally) to undertake consultation. However, it is standard best practice to consult with those organisations who are likely to have an interest in the project to ensure that any issues of relevance to these organisations are addressed through the EIA process (i.e. in the case of the projects addressed in this section, those organisations listed in Table 4.1). Any consultation carried out during the EIA process is often termed 'informal consultation'.

During the consultation undertaken for the EIA, a number of issues and concerns were raised by consultees regarding the potential effect of the project which needed to be addressed in the EIA studies. The RSPB and Natural England in particular made comments regarding the potential effects of the proposed channel deepening on the estuary system. Comments that are of relevance to this study (i.e. where any comment relates to an area of uncertainty) are summarised below:

- Modelling is to be based on worse-case scenario in terms of maximum channel depth required for the scheme (i.e. assuming maximum under keel clearance);
- Predicted morphological changes and effects on designated sites;
- Modelling to take account of sea level rise and climate change predictions;
- Beneficial use of dredged sediment and retention of sediment within the estuary;
- Operation of deepened channels, including maintenance dredging and vessel traffic;
- Impact on the Spurn peninsula, particularly changes to hydrodynamics and sediment supply;
- Balance sheet from modelling to allow an assessment of erosion versus accretion
- Presentation of the volumes and frequencies of dredging, dredge volumes based on full range of natural variation in bathymetry and maximum under keel clearance.

The approach that was adopted as part of the EIA process was to openly discuss the studies being undertaken and their results. An initial feasibility modelling exercise (hydrodynamic modelling) was undertaken at an early stage in the EIA process to assess whether the project would have any particularly significant effects on hydrodynamics and, therefore, potentially on designated habitats within the estuary. This modelling indicated that the project would have small, relatively localised effects and, therefore, a detailed scoping document was prepared by ABPmer as part of the next stage in the EIA process to identify pathways by which the project could impact on designated habitats.

Following submission of the application to the regulator, the regulator consults with its statutory consultees on the application and takes any responses received into account in making a decision on the project (often termed statutory, or formal, consultation). It is for this reason that it is advisable to consult with these organisations (and others) informally during the EIA phase, as described above, to minimise the risk of issues being raised during the statutory consultation phase that have not been addressed within the EIA process.
The MFA consulted on the application and environmental information and a number of comments were raised by consultees, largely requiring further clarification on certain issues. In response to this, Supplementary Note 1 (ABPmer, July 2009) was produced. Some of the comments related to the results of the numerical modelling and the predictions of likely maintenance dredging requirement and long term estuary functioning. For these issues, further explanation of the findings of the ES was provided (this is encompassed within Sections 4.7 and 4.8 of this report).

Supplementary Note 2 (ABPmer, 2009b) sets out the Dredging and Disposal Strategy, which is a key document as it describes the approach to mitigate the potential effect of the predicted increase on the maintenance dredging requirement on estuarine morphology (and designated habitats). This document is discussed further in Sections 4.8.2 and 4.8.4.

Supplementary Note 3 (ABPmer, 2009c) describes a monitoring plan. This s referred to in Section 4.8.4.

The documents referred to above enabled the regulator and consultees to be satisfied that the environmental impacts of the proposed project could be effectively managed and that a mechanism was in place to deal with the uncertainty in predicting maintenance dredging requirements and implications for designated sites. Consequently, the licence was granted for the project and, because there were no outstanding objections to the project, no public inquiry was required.

4.7 Analysis of research tools and methods

4.7.1 Numerical modelling

Introduction

The EIA process used numerical modelling to predict and, where possible, quantify the effects of the channel deepening project on coastal and estuarine processes. The model that was used was the Delft 3D, which includes modules for investigating the hydrodynamic and sediment regime of the estuary. The model grid extended from a seaward boundary 30km offshore from Spurn, to an upstream boundary at the tidal limits of the major tributaries of the Humber estuary. With regard to sediment transport, the modelling was undertaken for silt (25µm) and sand (150µm) fractions as these fractions are representative of the muddy intertidal sediments and those found throughout the subtidal sections of the estuary.

The model also includes a morphological modelling function. ABPmer (2009) acknowledges that this function represents a high degree of over simplification compared with reality; however it is a useful tool to help predict the impact of the project providing that careful expert interpretation is used to take account of the simplifying assumptions in the model.

The approach to the modelling involved undertaking an initial assessment, with a relatively coarse grid, to assess whether the proposed dredging was feasible (i.e. to provide an initial indication of its likely effect on the hydrodynamics (i.e. water levels and flow regime) of the estuary). This initial result was used to infer likely implications for the sedimentary regime. During this process, various sensitivity runs were undertaken to investigate the sensitivity of the results to the various assumptions that have to be made within the modelling process to determine optimum modelling parameters for subsequent, more detailed, assessment. The sensitivity tests involved varying the different parameters in the model and it was concluded that the most realistic results would be achieved by:

- Setting up the model with 8 layers, representing the vertical profile of the water column;
- Running the sediment module with both silt and sand (as separate simulations);
- Imposing average wave conditions on the model.

The tests indicated that the most important factor affecting prediction of the future maintenance dredging commitment, assessment of future estuary stability and quantitative impacts on intertidal areas was the distribution of the layer thickness of the material over the bed of the model. The sensitivity analysis suggested that this layer thickness needs to be variable over the model domain and was set using available data and expert judgment of knowledge of real changes within the estuary.

The results indicated that a 3D approach would be most likely to give the best results, but that when the model grid was modified to give the required detail to correctly resolve the dredge dimensions, the model run time and storage capacity would be excessive. It was concluded that a 2D approach would be able to give sufficient detail of the effects of the project and that the 2D model was capable of providing adequate representation of the estuary processes within a morphological model of the Humber estuary.

Hydrodynamic modelling

The Delft 3D model was used to investigate the short-term changes to the hydrodynamic regime (water levels and flow regime) due to the implementation of the proposed project. Modifications to tidal range as a result of the project would affect tidal propagation and tidal prism and this would have the potential for a long-term impact on the estuarine morphology and designated sites. Changes to flow velocity influence erosion and deposition patterns and, consequently, the potential maintenance dredging requirement. The predicted effects from the hydrodynamic modelling formed the basis for the sediment transport and morphological modelling.

The dredge volume results in a 0.036% increase to the overall low water volume of the estuary. The change in the subtidal morphology was predicted to change water levels, tidal currents and sediment transport.

Changes to mean high and low water levels were predicted. Generally, high water levels were predicted to increase or decrease by the order of 1mm or less throughout the estuary. Low water was predicted to be marginally lowered by the order of 1mm. The net effect of the changes was predicted to be a marginal net increase in water spring tidal range of about 2mm; the overall tidal prism was predicted to be increased by about 460,000m^3 (0.033%). The ES concluded that the predicted changes were so small that they would not be identified from background variability and were assessed as negligible.

Sediment modelling

Sediment transport modelling of silt and sand fractions was undertaken to represent sediment transport and to predict how this could be affected by the proposed project.

The modelling concluded that suspended sediment concentrations for silt would not change by more than 1% at any location. In terms of erosion and accretion patterns, the main changes were predicted to occur around the Sunk Dredged Channel extending to the edge of Spurn Bight where a small increased potential for the accretion of silt was predicted. In the Read's Island reach and over the remaining intertidal from Hull to Spurn accretion rates were predicted to be marginally reduced. The EIA predicted that the net result of the indirect effect on flows (and consequently sediment transport) and water levels would be a very marginal increase in the intertidal area of the estuary (less than 0.2ha/year); these changes were considered to be well within the accuracy of the model calibration. The EIA concluded that the effect was of negligible significance.

For sand, the maximum effect of the proposed dredging was predicted to be a change in background conditions of +/- 10mg/l in the vicinity of the dredging works (2-10% of the background concentrations).

The overall conclusion was that the project would make very little difference to estuary-wide erosion and accretion patterns and the effect on intertidal and subtidal habitats would be negligible.

Maintenance dredging commitment

The Humber estuary is very dynamic. Regular bathymetric surveys of the area adjacent to the Sunk Dredged Channel have shown cyclic patterns of 12-15 years with shorter periods superimposed. The rate of sedimentation in the Sunk Dredged Channel as well as in the lower estuary as a whole is, therefore, highly variable.

The above variability means that any modelling is only representative of conditions for a short period of time and makes predictions of medium and long term morphological change difficult to model. The model can be calibrated against water levels and flows, but these can change over short timescales in an unpredictable manner, which has implications for the calibration of the model and, therefore, how closely the model will be able to predict reality. As bed material type, thickness of material on the bed and water column sediment concentrations also vary then a sensitivity analysis is required to determine the level of certainty of any model results.

The model was calibrated against observed suspended sediment concentrations and sedimentation rates within the estuary; these can vary considerably over seasonal and annual timescales. The Sunk Dredged Channel area was specifically considered during the calibration exercise. This area requires regular maintenance dredging, but this is variable in nature with a general 12-13 year cyclic pattern (within which there is an existing long-term maintenance dredging requirement of an average of 1.7-2.4Mm^3 depending on the chosen start and end date of the cycle).

Within this channel, the model predicted a sedimentation rate (silt and sand combined) of 182,000m^3/month (equating to an annual volume of 2.18Mm^3). Maintenance dredging records for the period 1994 to 2005 suggest a mean annual dredging commitment of 1.83Mm^3, with values ranging from 0.79Mm^3 to 3.92Mm^3 over the 12 year period. The model, therefore, represents an above average value and predictions of sedimentation are likely to slightly over-estimate long-term mean conditions.

ABPmer (2009) note that due to natural viability in the Humber estuary on different cyclic timescales, it is not realistic to expect a short-term simulation with just two characteristic sediment types (silt and sand fractions) to be able to absolutely determine the exact rates of sedimentation and erosion at all locations. To assess volumetric (sediment) change, local relationships were derived between baseline sediment modelling data and dredge records to calibrate the model for prediction of maintenance dredging requirement.

Measured sediment accumulation rates in areas where maintenance dredging is already undertaken were compared with long term average maintenance dredging data. This comparison allowed a calibration of the model used to predict the effects of the scheme on maintenance dredging and ensured that results (predictions of the amount of sediment dredged in the absence of the proposed scheme) reflect measured values. The effect of the proposed scheme was then modelled against these baseline conditions to indicate the effect of the scheme on sedimentation and maintenance dredging commitment. The results from the above process were then assessed, taking into account the assumptions and simplifications that are inherent in the modelling and its calibration.

The EIA predicted changes in the pattern of erosion-accretion for fine sediment (silt) and coarse sediment (sand). With respect to silt, a calibration of predicted change against average accumulation that had been observed over the period

2005-2007 in the intertidal zone around the Immingham development complex, Humber Sea Terminals and around Hawkins Point indicated that the model is over-representing accretion rates by an average of about 2.7 times. ABPmer (2009) notes that to provide the closest prediction of the change in reality, the model results of the accretion patterns associated with fine sediment moving with the estuary as suspended load should be reduced by this factor (as an absolute value).

The EIA predicted that the project would result in an attraction of flow towards and through the channels which would draw in sediment and contribute to the maintenance dredging commitment. As described above, estimates of volume change were derived using sediment modelling data linked to, and calibrated against, historical dredging records. For the Sunk Dredged Channel, the EIA predicted that there would be an increase in sedimentation, or a reduction in erosion potential, of the order of 750,000m^3 per annum for the area that currently requires maintenance dredging. This constitutes an increase of 29-82% based on the known long-term average variability over an established 13 year cycle.

Long-term morphological modelling

Prediction of the long-term effects of the project (over the next 50 years) on estuarine morphology was informed by using ASMITA (Aggregated Scale Morphological Interaction between a Tidal Basin and the Adjacent Coastline).

Three ASMITA models, using different conditions, were compared with observed historical changes in intertidal area for the period 1946-2000 for different zones of the estuary. Model 3 gave the best fit to observed data; in the outer and middle inner reaches of the estuary, ASMITA predicted area losses but observed data suggests small increases in intertidal area. In all other areas of the estuary, the predicted changes are in the same direction as the observed changes, but tend to under predict the observed changes. It is noted that observed change in intertidal areas for 1946 and 1950 appear to have been uncharacteristically low in the outer estuary and this could explain the differences between the observed and predicted changes in this zone of the estuary. Overall, it was concluded that ASMITA was generally able to predict the observed trends in intertidal area changes.

Under the baseline case (i.e. without inclusion of the proposed dredging), ASMITA predictions indicated that intertidal area will be lost from the Humber estuary over the next 50 years. This loss was predicted to increase with increasing rates of sea level rise and was generally greatest in the outer estuary.

The inclusion of the proposed dredging in the model was predicted to cause a small increase in the rate of intertidal loss of between 0.02 and 0.03ha/year, with nearly all of this change occurring in the outer estuary. This translates into intertidal loss rate due to the project of between 1 and 1.5ha over the next 50 years. This is much smaller than the losses predicted due to increased rates of sea level rise over this period (between 0.25% and 4% of the change due to sea level rise). This loss does not account for the slight annual increase in intertidal area that is predicted to occur resulting from changes in tidal processes (described above under 'Hydrodynamic modelling').

4.7.2 Ecology

The main habitat that was predicted to be directly affected by the project was the subtidal seabed and, therefore, the EIA focussed on assessing the potential impacts on this habitat. The project had the potential for an indirect impact on the intertidal areas of the estuary through effects on the hydrodynamic and sedimentary regime, although this effect was considered likely to be smaller scale than the subtidal impact.

For the above reason, the ecology of the intertidal habitats were described at a generic level using existing sources of information. However, for the subtidal areas within and adjacent to the dredging and disposal sites, benthic surveys were undertaken to inform the project.

The subtidal benthic survey comprised sampling at a total of 46 stations within and around the proposed dredging and disposal locations. A significant amount of previous sampling had been undertaken in the Humber in connection with other projects and this information was used when designing a sampling programme for the project to avoid duplication of effort. The results of the benthic survey were used to describe the community types present within and adjacent to the proposed dredging and disposal areas to inform the baseline for the EIA.

Natural England and the RSPB had a specific concern about the effect of dredging on sandeel populations outside the Humber. A trawl survey (at 10 sampling locations) was therefore undertaken of the Chequer Shoal and Eastern Approaches to understand the importance of these areas for these species.

4.7.3 Cumulative effects

For this case study, the ES identified that there were two key pathways for cumulative and/or in-combination effects, as follows:

- Interactions with other plans or projects that could alter the hydrodynamic conditions of the Humber Estuary;
- Direct effects on the subtidal habitats of the estuary.

The potential cumulative and in-combination hydrodynamic effects were subject to examination using additional hydrodynamic modelling. An additional set of model runs were undertaken to assess the effects of the channel deepening in-combination with a group of other proposed and completed developments.

The cumulative assessment excluded completed infrastructure projects, the effects of which are already incorporated into the modelling undertaken for the EIA and, therefore, have been taken account of in the relevant sections of the EIA. Other developments, which are of such a small-scale that any effects of these projects would be insignificant and, therefore, have no potential for in-combination effects, were also excluded. The projects included were, therefore, those that have yet to be implemented and for which there was sufficient publically available information on which to base the assessment of cumulative impact.

4.8 Analysis of areas of uncertainty and risk

4.8.1 Numerical modelling

The key area of uncertainty for the project was predicting the future maintenance commitment for the deepened channel. There was a high level of uncertainty in the predictions for the following reasons:

- The cyclical nature of the bank and channel conditions in the lower Humber, which is the main contributory factor in determining the long-term variability in the maintenance dredging requirement of the existing channel.
- There is uncertainty in the calibration of the model; the model was not able to be accurately calibrated for the specific maintenance dredge requirement in the channel with the 2006 bathymetry used in the model (because at that time erosion was occurring in the channel), but the model did give a good general pattern of erosion and accretion over the whole estuary and the lower Humber in particular. The actual quantitative calibration for the channel was a good representation of the average long-term maintenance dredging commitment. This was taken into account in the interpretation of the modelling results for the longer term assessment.
- Historical evidence shows that the particle size distribution of the material that deposited in the channel can change over time form fine silts to fine to medium sand. This will give rise to variable modelling results due to both differences in settling velocities and changing hydrodynamics, as the configuration of the lower estuary changes.
- The modelling does not account for the episodic effects, such as storm activity.

The interviews process undertaken for this project provided further insight into sources of uncertainty and how these were managed through the EIA and the decision-making and consenting process.

The hydrodynamic model used for the EIA predicted very small magnitude of change (of the order of millimetres) in water levels as a result of the channel dredging. This magnitude of change is well within the margin of error in the modelling and, therefore, in this sense it is meaningless to quantify the effect as the tools that are used to measure the effect are not sufficiently accurate. In addition, the background change (tidal range) is in the order of metres, and the tidal range itself changes by approximately 0.5m over an 18 year cycle. The model is, therefore, predicting very small changes as a result of the scheme in the context of large natural changes; any effects of the scheme would be indecipherable from monitoring.

It is apparent from the above that there can be a high probability of uncertainty inherent in undertaking modelling and, therefore, modelling should be considered as one tool in the EIA process. The most important aspect is the need for experts who fully understand the system being studied and its background behaviour - a model can provide part of the answer, with the usefulness of a model highly depending on the understanding of the system.

The EIA process often requires (at the request of consultees) for all predicted effects to be precisely quantified and, as described above, this quantification can have little meaning in that it is not necessarily a precise description of the potential effect of a project. This is particularly the case where the predicted effects are very small. One consequence of providing quantification in these instances is that there can be a requirement to provide mitigation and compensation that can be disproportionately large compared with the significance of the predicted impact and such mitigation and compensation interventions could have more significant effects than the proposed scheme itself. Consideration of significance often assumes that any change is significant, even if the change is minimal, and this leads to a requirement to mitigate or compensate.

For the EIA, the uncertainty inherent in the modelling and in making predictions of sedimentation and, therefore maintenance dredging requirement, was dealt with by calibrating the model to the long-term average conditions for sedimentation in the channel rather than to the short term conditions, which would suggest negligible sedimentation. This approach resulted in the upper estimate of an increase in sedimentation, or a reduction in erosion potential, of the order of 750,000m^3 per annum for the area that currently requires maintenance dredging (as described in Section 4.3).

4.8.2 Mitigation requirements

The consultees accepted the findings of the EIA (in terms of nature and magnitude of predicted effects as described in Section 4.3.1) and, therefore, there was no challenge to the findings on these grounds. The studies addressed the various issues raised by consultees during the scoping phase of the EIA.

The predicted increase in maintenance dredging commitment as a consequence of the channel deepening project (see Section 4.3.1), and the potential implications of this for sediment supply to designated habitats, was one of the main issues of concern to consultees. The EIA concluded that the project would have a moderate effect on maintenance dredging requirement and therefore could potentially affect sediment transport to designated habitats. As a result, mitigation was proposed and this was embodied within a Dredging and Disposal Strategy. This strategy was included as an appendix to the ES (ABPmer, 2009) and further developed in a Supplementary Note to the ES (ABPmer, 2009b) to be submitted to the RSPB and Natural England for agreement.

The Dredging and Disposal Strategy aims at distributing material throughout the estuary to supplement the sediment supply (i.e. increase the sediment available for deposition in the estuary) without changing the bathymetric configuration of bed sediment type, with minimal impact on benthic communities and designated features, whilst being operationally practical (ABPmer, 2009). Four sites were proposed for disposal of dredged material, namely:

- Middle Shoal Main Deposit Ground;
- Sunk Dredged Channel 'windows';
- Bull Sand Fort Deposit area;
- Holme Channel Deep.

With the exception of Holme Channel Deep, the above disposal sites had already been used for the disposal of dredged material.

For each of the proposed dredging areas, the recommended disposal location was based on the type of material being dredged and other considerations such as the proximity/suitability of potential disposal grounds. The strategy was developed to allow for dredged material that is disposed to be distributed throughout the estuary to supplement the sediment supply.

4.8.3 Consultation during the EIA process

The way in which the EIA team interacted with the consultees during the EIA process was important in managing uncertainty inherent in the modelling studies and in the functioning of a complex estuary system. As noted above, it is particularly important that the results of any modelling are subject to expert interpretation. To convey the findings of the modelling, at certain points in the project meetings were held with the consultees to present the findings of the studies and this allowed the opportunity to describe the findings of the modelling work in context of the background changes that occur within the Humber estuary. It is felt that this approach cuts out some of the uncertainty as it allows consultees to make their interpretation of the modelling results with a full understanding of how they relate to the functioning of the system.

4.8.4 Managing uncertainty during the decision-making and consenting process

Following submission of the application, the regulator (the Marine and Fisheries Agency (MFA) at the time) consulted with its consultees on the application. The RSPB response stated that it was satisfied that the concerns raised during the scoping phase of the EIA had been adequately addressed in the Environmental Statement. The RSPB confirmed that the proposals were likely to have a significant effect on the Humber Estuary European marine site and, therefore, that the MFA should undertake an Appropriate Assessment.

A key component of the EIA was the inclusion of the Dredging and Disposal Strategy (see Section 4.4.2) which would mitigate the potential effect of the increased maintenance dredging commitment on designated habitats by aiming to distribute material throughout the estuary to supplement sediment supply.

The Dredging and Disposal Strategy (ABPmer, 2009b) was accepted by both Natural England and the RSPB. The strategy developed a practical approach to managing dredged material that satisfied consultee concerns regarding the effect of the project on designated sites. The strategy did not represent a significant change to how dredged material is currently managed in the Humber estuary. An important part of gaining acceptance of the strategy was that historic field monitoring of the effects of disposal was used to predict how deposited dredged material would behave. This gave consultees and the regulator comfort that the strategy could be implemented and overcame any uncertainties that a workable mitigation strategy could be implemented.

The licence that was granted for the project included a condition that the dredging and disposal operation must be carried out in accordance with the agreed Dredging and Disposal Strategy.

A further important aspect was the recommendation of a monitoring programme, which includes bathymetric surveys for the purposes of navigational safety and to establish maintenance dredging requirements. The monitoring requirements for the project were encompassed within an existing Environmental Management and Monitoring Programme (EMMP) which was developed for previous developments in the Humber. This EMMP approach had been provided to be an effective mechanism for involving stakeholders in the monitoring process and to ensure that all aspects (e.g. survey methods, reporting and mitigation measures) are agreed between all interested parties. This formed one of the conditions of the licence for the project.

4.9 Overview of output of the interviews

Although there are sources of error in all models (in terms of the extent to which they can represent real conditions), the error within hydrodynamic models (e.g. water level and flow conditions) are usually less significant than those within sediment transport models, which are likely to be less accurate in predicting effects. Any errors in hydrodynamic models feed into sediment transport models, which have their own (larger) range of uncertainties. For example, sources of uncertainty in sediment transport models include representing sediment size, cohesiveness, flocculation (in the case of clay particles), critical shear stress for erosion and deposition, erosion rate, deposition rate and suspended sediment concentration (i.e. potential supply of material). In addition, it is not possible to model a mixture of sediment types (e.g. silt and sand fractions) at the same time and in reality there is likely to be a range of sediment grain sizes in motion. It is, therefore, necessary to generalise based on knowledge of the predominant sediment type that is present (i.e. model as non cohesive sediment if sand is predominant or cohesive sediment if mud is predominant).

A key consideration is that predicted effects need to be put in perspective through expert interpretation and, therefore, there is a need for the decision-making process to accept more expert opinion to be used alongside any modelled results. This is important when determining whether or not a predicted effect is really significant in the context of the system being studied.

4.10 Conclusions

The key issue for the consultees was the uncertainty surrounding the ability to predict (from numerical modelling) the future maintenance dredging commitment as a result of the deepening of the approach channel and the implications that this could have on sediment supply to designated intertidal areas. To manage this uncertainty, the Dredging and Disposal Strategy was developed, the underlying principle of which was to distribute dredged material within the estuary to supplement sediment supply to intertidal areas. Importantly, this strategy did not represent a significant change from how dredged material was already managed in the Humber estuary.

The uncertainty inherent in modelling a dynamic system was understood and accepted by consultees and regulator. The interpretation of the predictions made through the modelling by experts with a thorough understanding of the system is critical in ensuring that the significance of the potential implications of the scheme are presented in context. The above approach, together with the proposed implementation of the Dredging and Disposal Strategy, enabled the consultees and regulator to agree with the findings of the EIA process and to grant consents for the project.

5 Scheldt

5.1 Description of the project

The project comprised the deepening and widening of the navigation channel by dredging 14 million m^3 of sand and silt in order to allow ships with a draft of 13.1m to enter the Port of Antwerp independant of the tide and to create a turning basin. It was proposed that the dredged material will be disposed on sand bars in the Western Scheldt, on land and in the 'Schaar van Ouden Doel' tidal channel. During the operational phase of the navigation channel, maintenance dredging will be needed and it was estimated that between 15.5 and 16.2 million m^3 of sediment will be dredged annually. Maintenance dredging material will be disposed at similar locations as the sediment from the construction phase, but also in deeper parts of navigation channel and secondary channels

5.2 Overview of relevant Natura 2000 sites

The following Natura 2000 sites are relevant to this case study:

- Westerschelde;
- Westerschelde and Saeftinghe;
- Schelde- en Durmeëstuarium;
- Durme en middenloop van de Schelde;
- Schorren en polders van de Beneden Schelde; and,
- De Kuifeend en Blokkersdijk.

5.2.1 WesterSchelde and WesterSchelde and Saeftinghe (SAC and SPA, NL9803061 + NL9802026/NL1000019)

The Westerschelde is the name of the Dutch part of the estuary of the Scheldt river. Due to the tidal dynamics and the transition from fresh to salt water, a variety of ecosystems with a rich variety of plants and animals is found here. The estuary is important for large numbers of resting and foraging waders, and coastal birds breeding in saltmarshes or bare sandbars which are rich in Crustaceae. The 'Verdronken land van Saeftinghe' area lies within this site. Verdronken land van Saeftinghe is the largest saltmarsh in the Netherlands. Some coastal dunes and low polder areas also lie within the boundary of the Natura 2000 site.

5.2.2 Schelde- en Durmeëstuarium van de Nederlandse grens tot Gent (SAC, BE230006), Schorren en polders van de Benedenschelde (SPA, BE2301336)

The waterway of the Scheldt, the mudflats and saltmarshes have a very high ecological value. The high natural productivity of the ecosystem leads to a high number of species, often in large numbers.

An important feature is the transition from saline to brackish-sweet water in the intertidal zone. The occurrence of freshwater tidal marshes is unique in Flanders; elsewhere in Europe, this habitat is extremely rare.

Notable species comprise avocet, spined loach, river lamprey, crested newt, marsh marigold, fragrant agrimony, chaffweed, bee orchid, round-leaved wintergreen, venus' looking-glass. It is an important area for staging and wintering species such as golden plover, ruff, bean goose, white-fronted goose, greylag goose, shelduck, gadwall and shoveler.

5.2.3 Durme en middenloop van Schelde (SPA, BE2301235)

The Durme is a watercourse which, since it was cut off from its upper stream (Moervaart), mainly receives fresh water at high tide. At the river side of the dike, extremely valuable freshwater mudflats and marshes are found. At the landside of the dike, some very valuable wetlands are found.

Notable breeding birds are black-necked grebe, garganey, black headed gull, reed bunting, spotted crake, little grebe, water rail and shelduck.

5.2.4 De Kuifeend en Blokkersdijk (SPA, BE2300222)

De Kuifeend is a wetland with open water, swampy areas, polder grasslands and man-made environments in various stages of development. This is a relic of the historic polder on the right bank of the Scheldt river near Antwerp. The pond of De Kuifeend is an old polder that was inundated due to the elevation of surrounding land. It is a very important breeding, migratory, feeding and wintering area for birds. Notable breeding birds are bittern, marsh harrier, bluethroat, avocet and black-necked grebe. It is an important resting place for gadwall and shoveler.

5.3 Parties involved in the case study

During the EIA and consenting process a number of organisations were involved and consulted on the proposals. A summary of the organisations involved and their role in the process is provided in Table 5.1. All parties that were involved in the Overleg Adviserende Partijen (OAP, an advisory group consisting of NGO's, the municipalities and other stakeholders) have been included as they played an important role early in the process.

Table 5.1 Summary of organisations involved in the case study

Organisation	Role (role or key interest)
Rijkswaterstaat, management Zealand (Netherlands)*	Applicant (developer)
Administration waterways and maritime affairs, department maritime access (Flanders)*	Applicant (developer)
ProSes	Applicant (project management for the preparation of the development plan and the SEA)
State secretary for Transport, Public Works and Water Management (Netherlands)	Responsible for decision about the zoning plan for the alignment of the channel and the approval of the permits that involve the protection of ground and surface water, soil and excavations
Ministry of Agriculture, Nature and Food	Responsible for the approval of the

Quality (Netherlands)	permits regarding the protection of fauna and flora
Ministry of Housing, Spatial Planning and the Environment (Netherlands)	Partly responsible for decision about the zoning plan for the alignment of the channel and the approval of the permits that involve the protection of the environment
Ministry of transport and public works: Department environment, nature and energy– office EIA (Flanders)	Administration responsible for the approval of the EIA
Regional planning officials (Flanders)	Responsible for the approval of the planning permissions
Provinces of Antwerp and Eastern Flanders	Responsible for the approval of the environmental permits
Scheldt EIA commission	Specially assembled Dutch-Flemish commission that provides advice regarding the content of the EIA report to the authorities in the Netherlands and Flanders
Havenbedrijf Antwerpen*	Consultee; Harbour Authority (port and navigation issues)
Vlaamse Havenvereniging	Consultee; Harbour Authority (port and navigation issues)
Zeeland Seaports	Consultee; Harbour Authority (port and navigation issues)
Werkgroep Schelde estuarium*	Consultee (ecological impact): combined structure of Dutch and Flemish environmental organisations
Bond beter leefmilieu (Flanders)	Consultee
Zeeuwse economie & Zuidelijke Land- en Tuinbouw Organisatie	Consultee (agricultural organisation)
Boerenbond (Flanders)	Consultee (agricultural organisation)
Algemeen boerensyndicaat (Flanders	Consultee (agricultural organisation)
Brabants Zeeuwse Werkgeversvereniging	Consultee (employers organisation)
Waterschap Zeeuws-Vlaanderen	Consultee (Body of surveyors of the dikes)

* indicates that representatives from these organisations were interviewed as part of the reporting for this case study

For the preparation of the development plan and the SEA the project management was performed by ProSes.

In addition to the organisation listed in Table 5.1, there have been other parties that had objections to the project and made either comments on the EIA or appeals in court or both. These parties were mostly not involved in the consulting stage of the project. These organisations comprise local citizens, local factories that wanted a compensation and environmental organisations that did not agree with the ‘werkgroep Schelde estuarium’.

As part of the EIA process, only governmental organisations have to be consulted. NGOs have the opportunity to comment during the consultation phase, as part of the general public. The applicant, however, chose to consult with the most important NGOs beforehand to avoid discussion on concerns at later phases of the process.

The outline of the research programme for the EIA is defined by the contractor together with the developers. It was, however, checked scientifically by guiding groups and by a group of independent experts from different universities (Schelde MER commission). In this way, it was ensured that the best available methods would be used during the EIA. Governmental organisations and by the public also had the opportunity to comment on the research program during the consultation process.

5.4 Overview of the local NGO situation

For this project, the main environmental organisations in the Netherlands and Flanders (Natuurmonumenten and Natuurpunt) joined forces in one organisation (werkgroep Schelde estuarium). Some smaller environmental groups (e.g. Vogelbescherming Nederland) did not form part of this group.

The werkgroep Schelde estuarium was involved in the consultation process before the SEA (see Section 5.5). Although they were critical during this process, they did not object to the fact that there could be a new deepening of the navigation channel as long as there were other measures that would improve the ecological quality of the estuary. The environmental organisations that did not join this group were more radical in their rejection of the project.

Several of the environmental organisations involved (in the Netherlands as well as in Flanders) manage nature reserves in the estuary and are, therefore, very involved in any project that could influence the quality of the estuary.

The NGOs have good knowledge of the legislation and do not hesitate to file a complaint with the European authorities.

5.5 Chronological overview of the study process

The Scheldt estuary has an important ecological function for many species whilst the Western Scheldt is also the gateway to the port of Antwerp, one of the largest ports in Western Europe. In addition, many people in the Netherlands and Flanders live and work on the edges of the estuary, making safety against flooding an important issue.

Given the many different functions that the Scheldt support, and the diversity of interests in the area, the authorities in the Netherlands and Flanders decided to design a common long term vision for the Scheldt estuary; this was established in 2001. The three pillars of the long term vision are:

1. Conservation of the physical characteristics of the estuary (naturalness);

2. Maximum safety against flooding; and,
3. Optimal accessibility for the ports.

This is referred to further in the text as the 'package deal'. The deepening of the navigation channel is part of the accessibility section of this package deal.

Based on this long term vision, a development plan 2010 for the Scheldt estuary was designed and a SEA and a social cost-benefit analysis were undertaken in 2004. The SEA described the effects of all the projects within the package deal. The SEA concluded that the whole package of projects would not have negative effects if an improved disposal strategy was implemented and if the creation of sustainable estuarine habitat were included in the package.

In 2007, the EIA for this project was finished. The EIA describes the effects of the deepening of the navigation channel in combination with different sediment disposal strategies. The conclusion was that if the sediment was to be disposed on the shoal edges, no negative effects are expected associated with the deepening of the navigation channel in the Western Scheldt. Minor negative effects were predicted in the Sea Scheldt area, which had to be compensated. After the EIA had been undertaken, additional analysis was performed to investigate some of the issues in further detail (e.g. prediction of erosion processes).

The licences for the project were granted in 2007 for the Flemish part, and in 2009 for the Dutch part. In the Netherlands the licence was subsequently suspended due to an appeal from two environmental organisations. The suspension of the licence was based on the uncertainties regarding the effectiveness of the disposal strategy to compensate for possible negative effects of the project. In 2010 the suspension of the licence was lifted. At this point, the environmental organisations had withdrawn their appeals.

Figure 5.1 summarises the timescales for the process from development of the long term vision for the Scheldt to completion of the permitting process (top) and for the EIA and permitting process for the deepening of the navigation channel project (bottom).

2001		2004	2005	2007	2007	2009	2009	2010
Long term vision for the Scheldt estuary	Development plan Scheldt 2010	SEA and social cost benefit analysis	Treaty	EIA	Permits (Flanders)	Permits (Netherlands)	Suspension of the permits in the Netherlands	Suspension lifted
Consultation with OAP and AOS		Scheldt MER commission, guiding groups		Scheldt MER commission, guiding groups	Formal consultation public and governmental organisations	Formal consultation public and governmental organisations		
		Formal consultation public and governmental organisations		Formal consultation public and governmental organisations				

2006 (February)		2006 (May)	2006 (October)	2007 (April)	2007 (October)	2007 (November-December)	2008 (February)	2008 (July)
Scoping		Guidelines for EIA (Flanders)	Guidelines for EIA (Netherlands)	Additional guideline (Flanders) regarding the turning basin	EIA		Decision	
	Formal consultation public and governmental organisations					Formal consultation public and governmental organisations		Reply to remarks

Figure 5.1 Summary of the timescales for the process from development of the long term vision for the Scheldt to completion of the permitting process (top) and for the EIA and permitting process for the deepening of the navigation channel project (bottom)

5.6 Overview of the consultation process

In the process of designing the development plan 2010 for the Scheldt estuary, two advisory groups were consulted. One consisted of different official representatives from the applicants (Adviserend Overleg Schelde, AOS). This was a technical advisory group. The other consisted of NGOs, the municipalities and other stakeholders (Overleg Adviserende Partijen, OAP).

For the SEA and the EIA, the scientific value of the analysis was checked by the Schelde MER commission, a group of independent experts. This group consisted of experts appointed by the EIA offices of Flanders and the Netherlands. The group was formed voluntarily by the EIA offices. Subsequently, there were working groups for morphology and ecology, consisting of governmental organisations, scientific institutes and stakeholders.

In addition to the consultation undertaken during the EIA process itself, formal consultation also took place on the licence application.

5.7 Description of research tools and methods

5.7.1 Morphological modelling

The EIA for the project involved the use of numerical models to inform prediction of the potential effects of the project on the estuary system. For modelling the morphological effect over the short term (i.e. a five year timescale from 2010-2015), the Delft3D software was adopted. This model has been used several times in other projects. For this project, the dredging and deposition module was used. The model was calibrated during the previous studies, including the SEA. The model was, however, improved between the SEA and EIA.

It was found that the total dredged volumes as predicted by the modelling were similar to the actual observed dredged volumes. However, for a single dredging polygon, the predicted dredging volume could differ by a factor of two from the actual dredging volume. The similarity between predicted and observed dredging volumes could be improved by assuming an extra dredged 'overdepth' of 0.7m.

Estmorf was used for informing prediction of morphological effect over the longer term (2010-2030). This model has also been used many times in other studies and is well validated and calibrated. Expert judgement and interpretation of the results of the modelling, based on an analysis of the system, was applied.

From the comparison of the predictions made in the modelling and the observed values, it was concluded that a maximum uncertainty of 50% could be assumed.

The results indicate that due to ongoing background processes, the morphological diversity of the system would deteriorate on the long term. The project could enhance these negative effects. When using the new disposal strategy, the difference between the effect of the project and the predicted evolution of the system in the absence of the project would be minimal.

In the Western Scheldt part of the estuary, no significant effects are predicted. In the Sea Scheldt part of the estuary, a small loss of intertidal area is predicted as a result of the deepening and widening of the navigation channel. Near the turning basin some intertidal area will also be lost due to erosion processes.

5.7.2 Silt transport modelling

For the silt transport modelling, the Slib3D model was used, which is based on the Delft3D model. The model has been used in various other studies. There is a lack of long-term validated measurements of the suspended sediment concentration in the proximity of the project area. Expert judgement and experience from other models was used to define the pre-conditions for the model Slib3D.

The model has been calibrated when used in other studies. However, the range of the model was increased to include the western part of the Western Scheldt. Therefore, a limited calibration was performed.

No effects are expected based on the results from the modelling.

5.7.3 Hydrodynamic modelling

Kustzuid-model version 3, with an additional schematization of the NeVla-model, was used. The model was calibrated using the distinction between high/low dynamic areas and the distinction between saline and brackish areas. Both predictions are compared to the distribution of ecotopes in the estuary.

The hydrodynamic model was not a source of further uncertainty in the overall modelling predictions.

No effects are expected based on the results from the modelling.

5.7.4 Ecological modelling

The prediction of the area of intertidal habitats is based on the results from the morphological and the hydrodynamic modelling. The hydrodynamic model is also used to predict whether the areas are low dynamic or high dynamic. Based on both elements, the distribution of the ecotopes is predicted. The uncertainty in the results from the morphological modelling therefore persists in the results from the ecological modelling. This was partially resolved by correcting the results from the modelling by using expert judgement. The long term effects of the new deposition strategy were too uncertain to assess the impact and, therefore,monitoring was included to assess the effects of this.

The potential effects of the project near the high water line are not well predicted and this had consequences for the prediction of effects on saltmarsh habitats. The results of the modelling were, therefore, adapted based on expert judgement.

The influence of tidal action and waves generated by ship movements was not included in the models. These effects were, therefore, predicted based on expert judgement.

The long term effects of the deposition of sediment on the edges of the shoals are not well predicted by the models. Monitoring is used to identify possible negative effects.

The impact on benthic fauna was assessed by calculation of the area of seabed that is removed by dredging. The area and the quality of the intertidal habitats is used to predict the distribution of waders in the estuary.

In the Sea Scheldt part of the estuary, 4 hectares of intertidal area was predicted to be lost because of the project. Because of the unfavourable conservation status of the estuary, this is considered to be a significant effect; it was proposed that this would be compensated by creating new habitat.

No significant effects are expected for the Western Scheldt part of the estuary.

5.7.5 Cumulative effects

To take into account the effects of other projects, the predicted development of the estuary in the absence of the project was taken into account. In predicting what this development would be all projects that were certain to be executed within the timeframe of the research for the navigation channel deepening were taken into account. This included those projects from the other parts of the 'package deal'. In addition to these projects, other process were also taken into account, the most important being the effects of climate change.

5.8 Analysis of areas of uncertainty and risk

5.8.1 Overview of key consultee issues and concerns

- Despite the fact that state of the art models were used, there are still important uncertainties that remain. This is largely because the morphological processes are still not entirely understood (e.g. erosion in the intertidal areas).
- Due to uncertainties, the exact effect of the disposal strategy could not be calculated. However, a range was given based on the results of the modelling, taking into account expert judgement to determine a margin on this numbers.
- Because of the unfavourable conservation status of the Scheldt estuary, all possible negative effects had to be avoided, since they would be considered as significant negative effects.

5.8.2 OAP and the package deal

Stakeholder involvement was an important issue in this project. The most important aspect of this was the so called 'overleg adviserende partijen' or OAP. The result of the planning stage was a large 'package deal' concerning the future development of the Scheldt estuary. Besides the proposed dredging to improve accessibility (this project), safety and naturalness were equally important aspects in this package. The fact that the enlargement of the navigation channel was thus counterbalanced by the improvement of the ecological quality of the estuary ensured that (initially) there was broad support for the project and adverse reactions were scarce at the start of the process.

Later in the process, the postponing of the implementation of the naturalness part of the package by the Dutch government caused an imbalance in the agreement. As a consequence of this the environmental organisations had to use the EIA and the permissions for this project to force the implementation of the naturalness part of the package.

The issues referred to above were more important than the presence of uncertainties in the methods used in the EIA studies. The port authorities tried to ensure that the project became legally independent from the implementation of the measures that were planned within the naturalness part of the package. The only way to do this was to ensure that no negative effects would occur as a result of the dredging of the navigation channel. For this reason, the new strategy of disposing the sediments on the edges of the shoals was included within the project in order to create enough positive effects to counteract all possible negative effects of the project, even in worst-case scenarios.

5.8.3 The use of state of the art research tools

The morphological models that were used for the SEA already existed and had been calibrated before the start of the SEA. Additionally they were updated and recalibrated for the EIA for the project. The models were therefore well calibrated and 'state of the art', and this was confirmed in all interviews undertaken in connection with this case study. Because of the discussion between experts regarding key issues of the system, important uncertainties in the results could, however, not be avoided.

The representatives from the port authorities state that there is always a certain amount of uncertainty in undertaking modelling studies and there are choices to be made when designing the model. These choices have all been discussed in expert teams. The uncertainty of 50% was not calculated, rather it was based on expert judgement. As there was still discussion about whether the error could be even greater, the strategy of disposing sediment at the edges of the shoals was added to counteract possible negative effects.

The key issue for the project was that the multichannel system of the estuary had to stay intact. Results from modelling had indicated that there could be a risk that the project would lead to a simplification of the system to a single channel system. For different reasons, including implications for ecological value, this had to be prevented. The effect on the persistence of the multichannel system was tested by analysing the effect on different parameters which could be predicted by the models. The parameters were the ratio between the average depth of the large ebb and flow tidal channels (the tilt index) and the occurrence of short-cut channels.

The second important criterium was the amount of intertidal area in the system. The predicted reduction in intertidal area due to the deepening of the channel had to be counteracted by the increase due to the disposal of sediment on the shoal edges, taking into account the uncertainty of 50% on the results from the modelling.

On the scale of the whole system this could be predicted relatively accurately. On a smaller scale this was more difficult to predict. Delft 3D was the model that was most suitable to assess the impact on the intertidal areas. This model had the disadvantage that it could only give reliable results for a limited time scale (2-3 year). For longer periods, the error on the results becomes too large.

During the morphology working group it became clear that there was a lot of discussion among the experts about what is the dominant process for how sediment is transported in the system: bed load or suspension transport. This issue is very important for the outcome of the analysis but is still not well understood. The models were state of the art, but this was not enough to entirely understand the system due to lack of knowledge of physical processes.

The steepening of the intertidal shoals due to erosion was particularly difficult to assess. This was the most important uncertainty that persisted and which could not be reduced with the currently existing models. Therefore, intensive monitoring of the flow velocity (which has an important impact on erosion) is included in the protocol. The prediction of the erosion processes was also the focus in the additional analysis which was conducted after the EIA (see below).

Apart from the uncertainties that are connected to the choice of the model and of the parameter settings used, the experts agreed that the predicted results were in accordance with their expectations on how the system would react morphologically.

The uncertainties are most important for those predictions that are ecologically relevant (short time, small scale and in the intertidal areas). The use of state of the art models could not, therefore, avoid uncertainties about the effects remaining to be of great importance.

After the completion of the EIA, an additional analysis was performed to look in more detail at certain issues. The presumed positive effects of the proposed new disposal strategy were only modelled on a global scale. An additional analysis was conducted to assess the impact on a more local scale in order to get a better view on the size of the positive effects. For this analysis, a model was used with a finer grid. The results from these analyses have been translated into ecological effects to see whether the Appropriate Assessment was still valid. These additional analyses took away some of the remaining uncertainties.

For the hydrodynamic model, everyone agreed that the predictions were very accurate. The model had been calibrated and tested many times before the EIA and the predictions made using this model were not questioned.

The ecological modelling also had its uncertainties. It was, however, generally accepted that the morphological effects could be translated to ecological effects. Although this translation was crucial for the assessment, it was not an important issue in the debate concerning the uncertainties.

5.8.4 Significance of effects

The thresholds for significance of effects were determined by expert judgement but were not questioned or challenged through the EIA process. This may partly be due to the fact that there were no negative effects predicted (at least not in the Netherlands) and, therefore, the thresholds were less important.

An extra difficulty was that conservation goals had not yet been defined at the time of the Appropriate Assessment. Therefore, there were some discussions as to which reference should be used to evaluate the effects (present status or historical trends). In the EIA. the present status was used.

5.8.5 Three-stage rocket approach

The project uncertainties were dealt with using a three-stage rocket approach. The first stage of this approach consists of using the most environmental friendly alternative as determined through the SEA. The second stage consists of including the flexible disposal strategy as a mitigating measure. This strategy includes regular monitoring of the impact of the project in order to avoid adverse effects by changing the location and the way the sediments are deposited in the estuary. As a third stage, there is the possibility to stop the project. However, if negative effects are observed, the initial option is to undertake necessary measures to counteract the negative effects, rather than to stop the project.

By using this three-stage rocket approach, it is assumed that the project cannot have negative effects, regardless of the amount of uncertainty that is present when assessing the impact in the EIA.

The environmental organisations do not agree with this point of view. In their view, the uncertainties remain too important, mainly regarding the positive ecological effects of the disposal strategy. In view of the unfavourable conservation status of the Scheldt estuary, they state that more mitigation measures are needed. The unfavourable conservation status is not due to the project; however, they used the project in order to put pressure on the Dutch government to execute the naturalness part of the package deal. Therefore, the execution of the naturalness part of the package deal should be added as an obligation to go along with the deepening of the navigation channel.

As at the time when the permissions had to be granted it seemed uncertain that the nature development measures that were decided upon within the same Dutch-Flemish political agreement regarding the development of the river Scheldt would be executed, the environmental organisations submitted appeals before the Dutch Council of State against the Dutch decisions regarding the deepening of the Westerscheldt. However, they claimed to be objecting to the non-execution of the nature development measures embedded within the same political agreement, not the specifically the deepening of the navigation channel. After a provisional suspension ruling and a political reconfirmation of the engagement to implement the nature development plan, some NGOs withdrew their complaints. In the final ruling, the court (Council of State) concluded (based on the remaining appeals) that the Dutch minister had reasonable arguments to state that the ecological features of the Natura 2000 areas will not be significantly affected. The remaining appeals were, therefore, rejected.

5.8.6 Mitigation measures and monitoring

In the most environmentally friendly alternative that was chosen for this project, a new disposal strategy for sediments was included. It was predicted that this new strategy would lead to an increase in intertidal area, thus mitigating the possible negative effects of the project. This measure would be enough to compensate for the worst case scenario, taking into account the 50% uncertainty in the modelling.

Although the environmental organisations were positive about the proposed disposal strategy, the uncertainties regarding the positive ecological effects were in their view too important to use this as the only mitigation for possible negative effects. There was no doubt that the new disposal strategy was better, seen from a morphological point of view. The method was, however, still new and the long term effects on the ecology of the system were uncertain. The test on the Walsoorden shoal demonstrated that the morphological effects were positive, but up to this date the beneficial effects for the ecology have not been demonstrated. It is expected that these effects will become visible in the near future (e.g. within 2 years), since the disposal along the sandbars is still going on.

Another objection was that the negative effects (loss of intertidal habitat in the Sea Scheldt) of the project would occur immediately, while the creation of new compensatory intertidal habitat was only planned (as part of the long term vision for the Scheldt) for 2025. Consequently, the environmental organisations suggested that one of the habitat creation projects should be advanced to ensure adequate compensation was provided for this project.

There was one negative effect which only became clear after the SEA. From their own observations following the construction of Deurganckdok, the environmental organisations knew that in areas high numbers of ship movements there could be increased erosion of the intertidal areas. This was in the end compensated by the creation of an intertidal area as part of this project.

Finally there were some additional negative effects due to changes to the original plan (e.g. the additional broadening for a turning basin). These added to the uncertainties in the end result of the whole project. The environmental organisations would, therefore, have preferred that the naturalness measures would have been added to the project, as was foreseen in the SEA. In the EIA these were, however, no longer included in the project because - with the implementation of the new disposal strategy - the project was assumed to have no negative effects.

5.9 Overview of output of interviews

Most of the conclusions from the interviews are included in the description of the areas of uncertainties in the preceding sections. However, some additional remarks are provided below.

One of the representatives of the environmental organisations stated that a very important uncertainty is to be found in the execution of decisions by the government. In this case, all the agreements reached were ignored when other parties came into power. A solution for this problem could be that stakeholders who were involved in developing an agreement should have the opportunity to take legal measures when agreements are not executed.

Another uncertainty (according to the NGOs) concerns whether or not the mitigation measures included within this project were enough to counteract all possible negative effects, and the ‘naturalness’ part of the package deal had to be completed to mitigate for the effects. As the claims were never brought to trial, they state that it remains unclear which view would be found to be correct. The environmental organisations are convinced that the three-stage-rocket approach would not be enough to take away all uncertainties regarding the possible negative effects. Based on the complaints that were not withdrawn, the court decided that the Dutch minister had reasonable arguments to state that the ecological features of the Natura 2000 site will not be significantly affected. The NGOs still feel that this result would not have been the same if their arguments would have been taken into account.

5.10 Conclusions

Including the project in a larger deal can be helpful to prevent discussions about the inevitable uncertainties. The main issue for the environmental organisations was the postponement of nature projects in the Western Scheldt in combination with the bad state of the estuary (which would be counteracted by the nature projects).

At the start, ecological effects of the project were taken into account by using the package deal approach. At this point in the process, there was an agreement amongst the stakeholders and the risk for legal claims was limited.

As the execution of the naturalness part of the package deal was postponed, a different approach was needed to ensure that the project would be ‘Natura 2000 –proof’. For this the three-stage rocket approach was adapted. The first stage of this approach consists of using the most environmental friendly alternative. The second stage consists in adding the flexible disposal strategy as a mitigating measure. The third stage is the fact that the possibility to stop the project in case unexpected negative effects do occur is embedded in the permit.

The environmental organisations (especially those in the Netherlands) were, however, not convinced that this approach would ensure that no negative effects would occur. The uncertainty was not in the methods used for the prediction of the effects, but mainly in the importance of the positive ecological effects of the new disposal strategy. This was mainly because it was a new technique that had not proven to be effective. Therefore the environmental organisations in the Netherlands did have (legal) objections against the project.

It was only when the political leaders gave a sign that they would indeed execute the naturalness part of the package deal, that they withdrew their objections. The first step of stakeholder involvement therefore remained crucial to reduce the risks.

Whether the three-stage rocket approach would have been effective remains partially uncertain, since some important NGOs withdrew their appeals before a final court decision. The port authorities are convinced that it would persist in court, the environmental organisations are convinced that it would not without implementation of the nature development plan that was politically linked to the deepening. In any case, the Court finally concluded that (based on the remaining appeals) the Dutch minister had reasonable arguments to state that the ecological features of the Natura 2000 area will not be significantly affected.

6 Stour and Orwell

6.1 Description of the project

This case study comprises of a series of projects in the Stour and Orwell estuarine system that have been implemented and proposed since 2000. Figure 6.1 shows a location plan of the estuarine system.

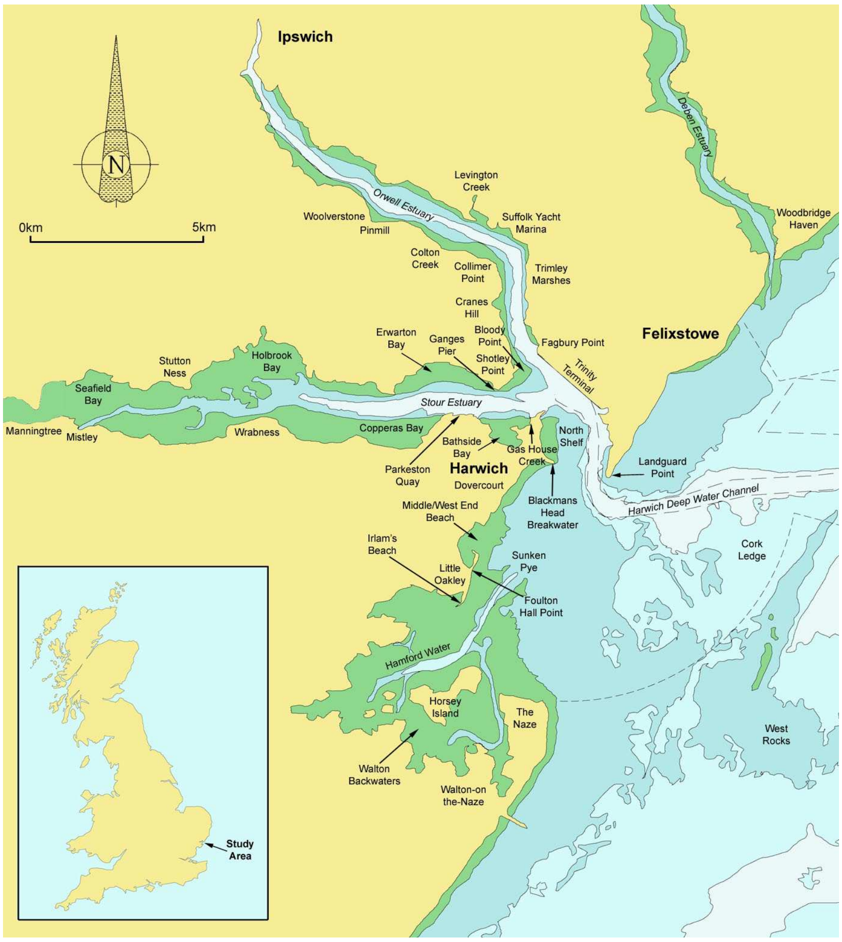


Figure 6.1 The Stour and Orwell estuarine system

The projects included in this case study comprise:

- Deepening of the approach channel to Harwich Haven (1998-2000);
- Trinity III Terminal (Phase 2) Extension (2003-2004);
- Bathside Bay Container Terminal (consented in 2005; construction has not commenced); and,
- Felixstowe South Configuration (Phase 1 completed).

The following sub-sections provide an overview of the main components of these projects. A summary of the main predicted environmental impacts associated with these projects (of relevance to the present study) is provided in Section 6.1.5.

6.1.1 Deepening of the approach channel to Harwich Haven

The Harwich Haven approach channel deepening comprised dredging of approximately 18Mm^3 of material to deepen the approach channel from -12.5m CD to -14.5m CD. The dredged material was disposed of at an existing offshore disposal ground in the North Sea (Inner Gabbard). The project was completed in 2000. The location of the deep water approach channel is indicated on Figure 6.1.

6.1.2 Trinity III Terminal (Phase 2) Extension

This project comprised a 270m extension at the northern end of the Trinity Terminal (see Figure 6.1) and the northern end of the Port of Felixstowe. Capital dredging was undertaken to deepen the adjacent channel to -14.5m CD and berth to -15m CD. The total volume of dredged material was approximately 1Mm^3. The project was completed in 2004.

6.1.3 Bathside Bay Container Terminal

The Bathside Bay container terminal project comprises the reclamation of approximately 65ha of intertidal area and construction of a quay wall (approximately 1400m in length) to create the terminal. The location of Bathside Bay is shown on Figure 6.1. In addition, the project comprised dredging of an area of approximately 4ha of intertidal area to create a small boat harbour to accommodate moorings that would be displaced by the construction of the container terminal.

The project included the capital dredging of the approaches to the terminal to a depth of -14.5m CD. It was proposed that some of the dredged material (capital silt) would be disposed at the existing Inner Gabbard offshore disposal ground. It was necessary to designate a new disposal site for the stiff clay arising from the channel dredging (termed Inner Gabbard East).
This project has yet to be implemented.

6.1.4 Felixstowe South Configuration

The Felixstowe South Reconfiguration project involves the reconfiguration of the Landguard Terminal at the southern end of the Port of Felixstowe. The project comprises the reclamation of approximately 28.5ha, the majority of which is in the subtidal zone. Capital dredging would be required to deepen and widen the approach channel to -14.5m CD, with a berthing pocket at -16m CD. The total volume of the dredging would be approximately 3.9Mm^3. The dredged clay and rock would be disposed of at the Inner Gabbard East disposal site, with dredged mud being disposed at the Inner Gabbard disposal site.

Phase 1 (Berths 8 and 9) of the project has been completed.

6.1.5 Summary of predicted effects of the projects

Extensive environmental impact assessment was undertaken for each of the projects described in Sections 6.1.1 to 6.1.4. A summary of the key predicted effects of the projects discussed in Sections 6.1.1 to 6.1.4 on the habitats of the Stour and Orwell estuary system is provided in Table 6.1.

Table 6.1 Summary of key predicted impacts of major consented and proposed port developments in the Stour and Orwell estuaries (without mitigation)

Scheme name	Intertidal reclamation (ha)	Tidal propagation effect on intertidal area (ha)	Effect on estuary-wide intertidal erosion rate (ha/annum)[c]	Localised erosion
Approach Channel Deepening to Harwich Haven	None	-4	-2.5	Lower Stour estuary
Trinity III Terminal Extension[a]	2.93	-0.4 to -0.6	-0.2	Lower Orwell estuary
Bathside Bay Container Terminal[b]	65 (plus 4ha loss of intertidal area due to dredging to create a small boat harbour)	-2.7	-2.6 to -2.8	Lower Stour estuary
Felixstowe South Reconfiguration[b]	1.7	-0.7	+0.5	Lower Stour and Orwell estuaries

6.2 Overview of relevant Natura 2000 sites

The majority of the Stour and Orwell estuarine system is designated as a SSSI under the Wildlife and Countryside Act 1981, SPA under the EC Wild Birds Directive and a Ramsar site under the 1972 Ramsar Convention.

At the time of the EIA studies for the Approach Channel Deepening, Trinity III Terminal Extension and Bathside Bay Container Terminal, the Stour and Orwell Estuaries qualified as an SPA due to:

- Populations of internationally / nationally important overwintering birds, based on:
  a) Notable numbers of golden plover (under Article 4.1); and,
  b) Important populations of dunlin; shelduck; dark-bellied geese; redshank; grey plover; black-tailed godwit; turnstone; ringed plover; wigeon; knot; curlew; pintail; mute swans; goldeneye and scaup (under Article 4.2).

At the time of the EIA for the Bathside Bay Container Terminal project, Bathside Bay itself was outside the boundary of the SPA, although it had been proposed for designation as a SSSI and for inclusion within the Stour and Orwell Estuaries SPA (and, therefore, had the status of proposed SPA).

Since qualification in 2003, the boundaries of the constituent SSSIs (i.e. the Stour Estuary SSSI and the Orwell Estuary SSSI) have been extended. Bathside Bay was included in the Stour Estuary SSSI during this process. In May 2005, the SPA boundary was extended to include an additional 360 hectares. The SPA boundary extensions coincide with areas incorporated within enlarged boundaries of the constituent SSSIs, as well as the whole of Cattawade Marshes SSSI.

Following the renotification of the SSSIs in 2003 and the SPA in 2005, the SPA now also qualifies under Article 4.1 of the Wild Birds Directive (79/409/EEC) by supporting 1% or more of the Great Britain population of avocet *Recurvirostra avosetta*. Over the period 1996 to 2000 the SPA supported 21 breeding pairs. It also qualifies under Article 4.2 of the Directive as it is used regularly by 1% or more of the biogeographical populations of a number of migratory species. It should be noted that the site no longer qualifies under Article 4.1 for golden plover.

The site further qualifies under Article 4.2 as it is used regularly by over 20,000 waterbirds in any season. In the non-breeding season, the site regularly supports around 63,000 individual waterbirds (based on the 5 year peak mean recorded between 1993/94 and 1997/98).

6.3 Parties involved in the case study

During the EIA and consenting processes for the various projects described in Section 6.1, many organisations have been involved and consulted on the proposals. A summary of the organisations that have been involved and their role in the process is provided in Table 6.1. It should be noted that for consultees, only those organisations that provided a response to consultation during the EIA are included (i.e. others were consulted, but did not respond). In addition, for the local planning authorities, borough councils and parish councils only those organisations that were relevant given the geographical location of the project were consulted.

Table 6.1 Summary of organisations involved in the case study

Organisation	Role (role or key interest)
Harwich Haven Authority *	Applicant (for Approach Channel Deepening and dredged material disposal licences for other projects, and harbour conservancy)
Hutchison Ports (UK) Ltd *	Applicant (developer)
Marine and Fisheries Agency (and predecessors)	Regulator (decision-maker) for construction works and dredged material disposal licences
Department for Transport (Ports Division) (and predecessors)	Regulator (decision-maker)
Suffolk Coastal District Council	Consultee (general EIA issues) and local planning authority for the Felixstowe South Reconfiguration
Tendring District Council	Consultee (general EIA issues) and local planning authority for the Bathside Bay Container Terminal project
Natural England *	Consultee; statutory advisor to the regulator on nature conservation issues (ecological impact, Habitats Regulations

	issues)
Environment Agency	Consultee (general EIA issues)
Shotley Marina	Consultee (business (local marina owner and operator))
Felixstowe Town Council	Consultee (general EIA issues)
Centre for Fisheries and Aquaculture Science (Cefas)	Consultee (environmental impact; scientific advisor to the Marine and Fisheries Agency/MMO)
ABP Ipswich	Consultee (port operator in the Orwell estuary and harbour authority for the Orwell)
Eastern Sea Fisheries Joint Committee	Consultee (fisheries issues)
Ipswich Borough Council	Consultee (general EIA issues)
Suffolk County Council	Consultee (general EIA issues)
Anglian Water Services Ltd	Consultee (water quality)
Trinity House	Consultee (navigation)
Trimley Parish Councils	Consultee (general EIA issues)
Royal Society for the Protection of Birds (RSPB)	Consultee (ecological impact)
Suffolk Wildlife Trust	Consultee (ecological issues)
Harwich Fishermen's Association	Consultee (fisheries issues)
Suffolk Coast and Heaths Project	Consultee (general EIA issues)
Babergh District Council	Consultee (general EIA issues)
Essex County Council	Consultee (general EIA issues)
Kent and Essex Sea Fisheries Committee	Consultee (fisheries issues)
Highways Agency	Consultee (transport issues)
Royal Commission for Historic Monuments England (RCHME)	Consultee (historic environment issues)
Royal Yachting Association	Consultee (navigation issues)

* indicates that representatives from these organisations were interviewed as part of the reporting for this case study

In terms of defining the approach to the EIA for the project, including the approach/methodology for the surveys, numerical modelling studies, impact assessment, etc, the Marine and Fisheries Agency (MFA) (now the Marine Management Organisation (MMO)) is one of the key organisations because the MFA issues the formal scoping opinion that addresses such issues. In addition, for projects that required planning permission, the relevant local planning authority was also a key consultee.

The information to enable the regulator to reach a scoping opinion was provided by the applicant (through the production of an Environmental Scoping Report produced by the consultant team working on behalf of the applicant). This included the scope of issues to be addressed for each environmental parameter (e.g. potential impacts of the scheme) and a description of the studies, including methodology, that are proposed to be used to inform the impact assessment. This information was developed through discussion and agreement with key consultees. Further information on the consultation process is provided in Section 6.6.

In reaching a scoping opinion, the regulator seeks the opinions of the various consultees (in terms of their main concerns) to ensure that these are taken into account in the scoping opinion. Of particular relevance to the scope of this study, the opinions of Natural England, the RSPB, Cefas and the Suffolk Wildlife Trust are of particular significance in informing the EIA process.

Issues such as what constitutes a significant effect or how to deal with uncertainties (e.g. in making predictions through numerical modelling) are not typically addressed at the scoping stage as there is usually not sufficient information available at that stage to make such judgements. For this case study, such issues were discussed as the EIA process progressed by undertaking regular consultation with the key consultees, such as Natural England and the RSPB. Section 6.7 and 6.8 describe how the significance of effects was assessed and areas of uncertainty managed as the EIA studies progressed.

6.4 Overview of the local NGO situation

The involvement of the NGOs with projects in the estuary is essentially on a project by project basis. However, due to the series of large infrastructure projects that have been proposed and/or implemented within the estuarine system, there is a very strong knowledge base within the consultee organisations. This understanding is of benefit to the projects because the likely issues of significance to be addressed through the EIA and Habitats Regulations Assessment can be readily identified and agreed with consultees from the outset.

In addition to consulting on a project by project basis, the mechanism that has been developed for ongoing consultation with regulators, NGOs and other organisations (see Section 6.8.6) is seen as essential (by applicants and consultees) in the environmental management of the estuary system and, in particular, in managing uncertainty and risk.

For the projects addressed in this case study, the NGOs were consulted throughout the EIA process for each of the projects. The NGOs were not organised into a single group, but were consulted, and provided input to the process, on an individual basis. Whilst it is important that all organisations with an interest in the project were consulted at the local level, it is particularly important that those organisations that have an advisory role to the regulator (e.g. Natural England and the Environment Agency) are consulted during the EIA process). The fact that there are many bodies involved in the consultation process was not problematic for the EIA process (in terms of conflicting opinions) as many of the key issues to be addressed in the EIA were common to each organisation.

6.5 Chronological overview of the study process

The projects discussed within this case study were a series of stand-alone schemes required to improve marine access for vessels into Harwich Harbour and to increase container handling capacity.

The EIAs for each project commenced with a scoping study, the output of which was a scoping report that was submitted to the MFA (and its predecessors) and the local planning authority (where relevant). The MFA and local planning authorities subsequently responded with a formal scoping opinion, which incorporated the findings of the scoping study and included further issues raised by consultees during the MFAs and local planning authorities consultation on the scoping report.

Consultations were undertaken throughout the EIA with statutory and non-statutory consultees (i.e. scoping and assessment phases) (see Section 6.6).

A baseline review was undertaken using available literature, field surveys and desk-based analysis followed by the impact assessment and identification of mitigation. All of the EIA studies adopted the same approach, which involved close cooperation with the team undertaking the numerical modelling work and the EIA team as the predictions of the modelling are fundamental to the EIA and, in particular, the Habitats Regulations Assessment.

The Trinity III Terminal (Phase 2) Extension, Bathside Bay Container Terminal and Felixstowe South Reconfiguration projects were subject of public inquiries. For all of these public inquiries, the nature conservation implications of the projects were one of the main topics, in particular the potential for effect on the designated status of the Stour and Orwell estuaries. The public inquiries involve the preparation of a 'proof of evidence' for various subjects that are of relevance to the inquiry. For example, a proof of evidence was prepared that dealt with implications for the hydrodynamic and sedimentary regime and nature conservation. This sets out the approach taken to the EIA and Appropriate Assessment studies, the findings of the assessments, details of mitigation and/or compensatory habitats requirements and any legal agreements made with third parties (such as Natural England) to enforce mitigation and compensation requirements, and any associated monitoring (these aspects are discussed throughout the reporting for this case study). The proof of evidence is then presented at the inquiry and is taken into account by the inspector which is appointed to oversee the inquiry. The inspector produces a report and makes a recommendation to the decision-maker as to whether or not the project should be granted consent.

All of the projects discussed in this case study were granted consent following the public inquiries.

Figure 6.2 summarises the timescale for the EIA and consenting processes for the Bathside Bay Container Terminal and Felixstowe South Reconfiguration projects, these projects being the two most recent and significant (in terms of scale of development). It can be seen that the overall timescale for the Bathside Bay and Felixstowe South Reconfiguration projects from the beginning of the EIA process until consents were granted was approximately 5 years and 4 years respectively.

2001				2002				2003				2004				2005				2006
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
EIA									Application				Public inquiry							Consent (March)
Informal consultation throughout EIA process									Statutory consultation (by regulator)		Developing Statements of Common Ground			Decision-making period						

			2003				2004				2005				2006
Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1
EIA						Application				Public inquiry (October)					Consent (February)
Informal consultation throughout EIA process						Statutory consultation (by regulator)		Developing Statements of Common Ground			Decision-making period				

Figure 6.2 Summary of the timescale for the EIA and consenting processes for the Bathside Bay Container Terminal (top) and Felixstowe South Reconfiguration projects (bottom)

6.6 Overview of the consultation process

Although this case study comprises a number of projects, the process of consulting through the EIA and Habitats Regulations Assessment process is similar for each project.

During the EIA process (i.e. until the point of submission of the application to the regulator (decision-maker), there is no obligation (legally) to undertake consultation. However, it is standard best practice to consult with those organisations who are likely to have an interest in the project to ensure that any issues of relevance to these organisations are addressed through the EIA process (i.e. in the case of the projects addressed in this section, those organisations listed in Table 6.1). Any consultation carried out during the EIA process is often termed 'informal consultation'.

The first main point of contact with consultees is during the scoping stage when the key issues requiring consideration through the EIA process are identified and the approach to the assessment of these issues is assessed. Subsequent to this, consultation is maintained on an individual or group basis throughout the process as required. For example, consultation is undertaken to agree the detailed approach to particular studies (e.g. numerical modelling), survey methodologies, initial findings of the impact assessment and mitigation requirements.

Following submission of the application to the regulator, the regulator consults with its statutory consultees on the application and takes any responses received into account in making a decision on the project (often termed statutory, or formal, consultation). It is for this reason that it is advisable to consult with these organisations (and others) informally during the EIA phase, as described above, to minimise the risk of issues being raised during the statutory consultation phase that have not been addressed within the EIA process.

For the projects described in this case study, a crucial part of the consultation process was in advance of the public inquiries that were held (see Section 6.5). For each inquiry, agreements were made with various organisations to establish an agreed position ('Statements of Common Ground') which were submitted to the public inquiry. The intention of the Statements of Common Ground is to record areas where there is an agreed position between the applicant and consultees, such as Natural England, the Environment Agency and the RSPB. For example, agreed positions were reached on the approach undertaken for the EIA, findings of the studies, mitigation and compensation requirements. The Statements of Common Ground can also record areas of disagreement. This process can minimise the areas that require discussion at the inquiry and, in the case of the Bathside Bay public inquiry, avoided the need for Natural England to give verbal evidence (i.e. Natural England was satisfied that it needed to submit written evidence only).

6.7 Analysis of research tools and methods

6.7.1 Numerical modelling

History of the development of modelling approach in the estuarine system

As a consequence of the series of major projects that have been proposed within the Stour and Orwell estuaries, a significant amount of research has been undertaken into the functioning of the estuary system as part of the various EIA studies that have been undertaken. As a result, the estuary system is one of the most intensively studied systems in the UK.

Between 1994 and 1997, HR Wallingford carried out a number of investigations for the Harwich Haven Authority which led to the development of a methodology for impact assessment in the Stour and Orwell estuary system. At the time, the methodology was comprehensive, integrating analysis of field data and the results of computational modelling. This approach was used for the EIA studies for the 1998/2000 Approach Channel Deepening project. It was acknowledged, however, that there were some gaps in the scientific understanding of the system that needed to be addressed following further measurement, long-term monitoring and re-application of modelling techniques.

Given the above, a well-established methodology for investigating the physical impacts associated with port development in the Harwich Haven has evolved as a result of the hydraulic studies for the 1998/2000 Approach Channel Deepening.

Since the EIA undertaken for the 1998/2000 Approach Channel Deepening, new data resulting from a long-term monitoring programme (developed as part of the consent for the deepening) provided a basis for an improved understanding of the estuary system. This raised the issue as to whether it was necessary to adjust the established methodology to incorporate further data collection and new processes and parameter values for the EIA studies for the proposed Bathside Bay Container Terminal project.

For considering the impact of the Bathside Bay development on tidal flows the same methodology as adopted for the 1998/2000 Approach Channel Deepening was applied, but was extended to include investigating the significance of 3D aspects of the flow for the Bathside Bay Container Terminal project.

In order to fully assess the significance of the morphological impact of the proposed Bathside Bay development, a series of studies were undertaken with the overall aim of improving the level of confidence in the prediction of the impact of constructing and operating the development on the Stour and Orwell Estuaries SPA.

Summary of hydraulic studies undertaken

The following summarises the studies that have been undertaken either as part of ongoing strategic research by the Harwich Haven Authority or directly to inform the EIA for the Bathside Bay Container Terminal project (Royal Haskoning and HR Wallingford, 2003).

Data collection and analysis

i) Deployment of instrumented bed frames on intertidal areas at Holbrook Bay, Erwarton Bay and Bathside Bay over the winter period 2000/2001. The bed frames were instrumented to record changes in bed level elevation, wave activity, tidal currents, suspended sediment concentrations and temperature and salinity. The bed frames were deployed during a period when sediment reintroduction occurred.

ii) Obtaining and analysing sediment cores from positions within the Stour Estuary where comparison of bathymetric data shows that historically accretion had occurred.

iii) Collection of a new set of tidal current and suspended sediment concentrations and fluxes throughout the Harbour area using state-of-the-art VMADCP techniques (Vessel Mounted Acoustic Doppler Current Profiler). The data was collected over periods of three consecutive days on successive spring tide periods. The first deployment was over a period of high spring tides (tidal range up to 4.5m) and the second deployment was over a period of lower spring tides (tidal range of 3.1 to 3.5m). This provided high quality and high resolution data with which to further improve the validation of the TELEMAC-2D flow model and also to provide a basis for the development of a 3D local model of the harbour with which to investigate the significance of 3D effects.

iv) Since 1998, continuous measurements of suspended sediment concentration have been made at seven sites within the Stour and Orwell estuary and at one offshore location. The measurements have been made from floating platforms with instrumentation suspended at a fixed distance below the buoys. The data from the instruments has been analysed to investigate whether there is any evidence of increased suspended solids concentrations from dredging (capital, maintenance and sediment reintroduction) and also to establish the natural variability in suspended sediment concentrations throughout the system.

v) Since 1995, the HHA have undertaken detailed survey measurements before, during and after dredging campaigns, allowing monitoring of both the siltation rates within the Harbour and the effectiveness of dredging operations.

vi) Bathymetric surveys of the Stour and Orwell estuaries are now routinely undertaken as part of a five year rolling programme by HHA. All available data (including the second complete survey of the Orwell) have been analysed.

Hydrodynamic modelling

vii) The new measurements of tidal currents in the Harbour area (see item iii) provided the basis for further comparison of the existing TELEMAC-2D flow model (Figure 6.2 shows the spatial scale of the assessment for the 2D model) used in previous studies and as the basis for the Bathside Bay initial studies. Additionally a three-dimensional flow model (Figure 6.2), TELEMAC-3D, was set up to explore the significance of 3D currents within the Harbour area. The results of the flow modelling, in combination with the field measurements of suspended sediment concentrations, were used to refine the methodology for the sediment transport and morphology studies.

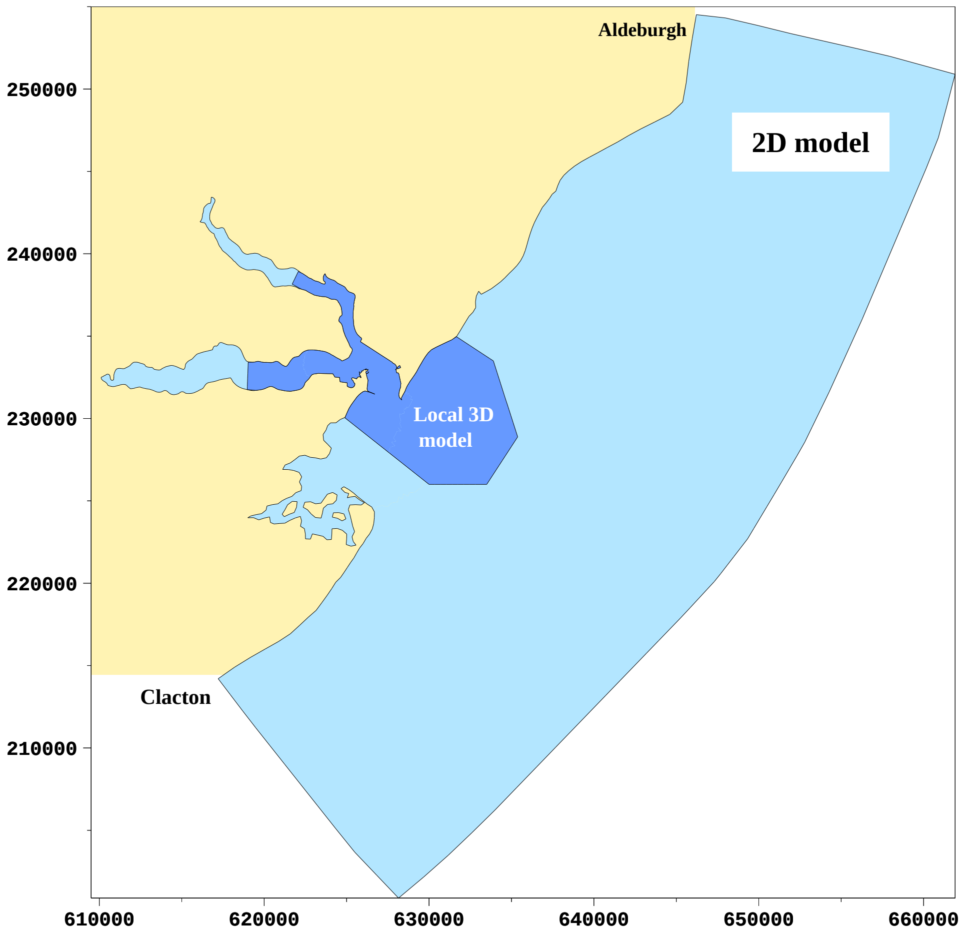


Figure 6.2 Area covered by 2D and 3D model (source: HR Wallingford)

viii) Wave processes in intertidal areas play an important role in the evolution of the morphology of those areas. The SWAN wave model was been set up for the Stour estuary, Harbour area and lower Orwell estuary. This model was applied to examine the impact of the proposed Bathside Bay development on wave conditions throughout the Stour estuary and Harbour area. Additionally, the model was used to examine the significance of previous developments in the Harbour area, the effects of evolution of the estuary morphology on wave conditions and the effects of sea level rise on the predicted impact of Bathside Bay.

Sediment transport and morphological studies

ix) The observed changes in morphology based on historic bathymetric surveys were interpreted.

x) Building on previous experience of sediment transport modelling and the prediction of longer-term morphological change, refinements to the previous methodology adopted were made. The refined approach incorporated the results of the recent measurements of suspended sediment concentrations within the Harbour area and the Stour estuary, the results of the new analysis of historic bathymetric change and the effect of the maintenance dredging regime on the estuary system.

xi) It was proposed that clays and heavy silts arising from the capital dredging will be placed at the Inner Gabbard offshore disposal site. This site is presently licensed for disposal (via dispersion methods) of silts arising from maintenance dredging with the Harbour. The SEDPLUME-RW model was applied to demonstrate how the placement of capital dredged material would affect the future dispersion of maintenance dredged material. The influence of the placement of higher volumes of maintenance dredged material was also considered.

Water quality modelling

xii) As part of the studies to support the EIA for the 1998/2000 Channel Deepening it was necessary to use the modelling system set up for Anglian Water to assess the influence of any potential changes in water quality on local sensitive areas (e.g. bathing beaches). This was repeated for the proposed Bathside Bay development.

6.7.2 Calibration/validation of the 2D and 3D flow models

The calibration for the TELEMAC-2D flow model is illustrated in Figure 6.3 which shows the measured and predicted discharges across the mouths of the Stour, Orwell and harbour. It can be seen that the discharges are reproduced well by the 2D model. In fact this figure represents *validation* of the model as no additional revision was made to the model for the Bathside Bay Container Terminal studies.

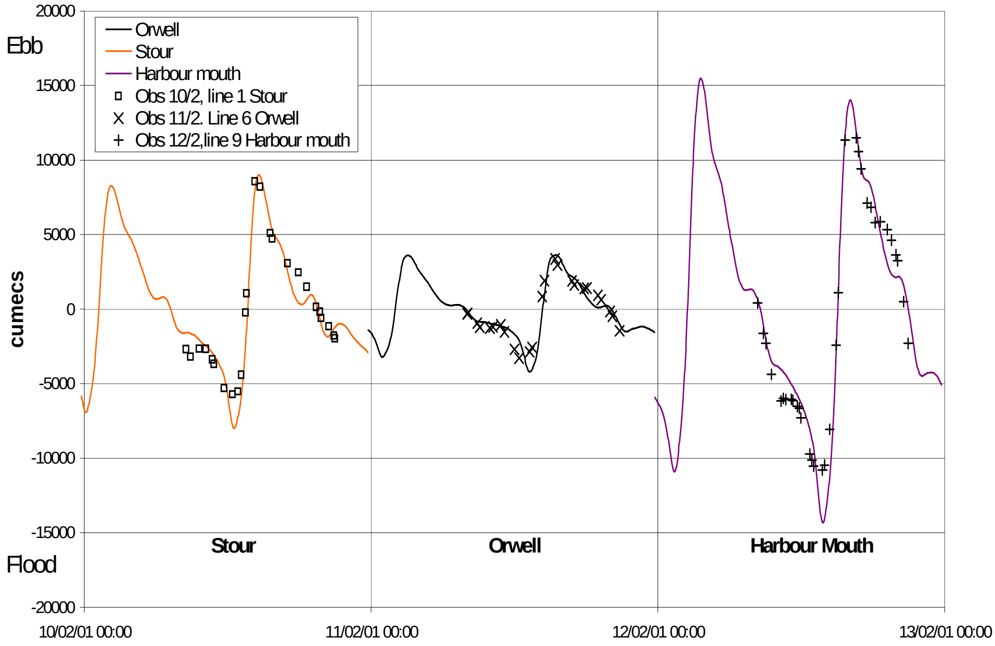


Figure 6.3 Calibration of 2D model (source: HR Wallingford)

The calibration procedure for the local TELEMAC-3D model was more extensive and took into account the surge effects occurring during field measurements and density gradient effects resulting from the relatively high fluvial flows that occurred prior to the measurement campaign.

The boundary conditions for the local 3D model were provided by a hierarchy of models ranging in size from a model of the Southern North Sea down to the local model. Calibration was undertaken on the basis of the ADCP data with further processing of the observations allowing near bed, mid-depth and surface speed and direction comparisons to be made. The model was able to reproduce the main features of flow – in particular the magnitudes of peak current speeds on flood and ebb, the peakiness of the ebb tide and the increase in near bed flood speed on the early flood caused by density effects under conditions of unusually high and prolonged freshwater flow. The 3D model could, therefore, be confidently applied in investigating the impacts of flows from the proposed development.

6.7.3 Benthic invertebrate communities

The two large-scale surveys of the estuary system were undertaken in 1997 (June-August) and 2003 (July, with biotope mapping) to assess the distribution and extent of intertidal and subtidal biotopes. The surveys sampled 152 intertidal and subtidal stations throughout the Stour and Orwell estuaries using a Shipek grab (0.04m2). These surveys provide a valuable overview of the benthic community structure throughout the estuarine system.

As a result of the 1998/2000 Approach Channel Dredging project, there is an ongoing commitment to monitor the benthic invertebrate communities throughout the estuary system. The first of the monitoring surveys was undertaken in 2008 and subsequent surveys have been undertaken annually in July (2009 to 2012).

In addition the estuary-wide surveys described above, project-specific surveys are undertaken to describe the nature of the benthic communities within the areas potentially directly and indirectly affected by the project. The estuary-wide surveys provide contextual information on benthic communities and represent a long-term data set.

Given the estuary-wide surveys that are undertaken, and the site-specific surveys undertaken for particular development proposals, there is a low level of uncertainty on the characteristics of the benthic communities of the estuary system and how these have changed over time.

6.7.4 Waterbird populations

High water counts are gathered as part of the Wetland Bird Survey (WeBS)[1]; the scheme has a long-running data set. Low water counts are also undertaken as part of the WeBS scheme, but only at larger estuaries and on an infrequent basis, approximately one winter every six years.

Low water count surveys of the overwintering bird populations on the Stour and Orwell estuaries are undertaken by the Suffolk Wildlife Trust (SWT) as part of the monitoring programme initiated after the 1998/2000 Approach Channel Deepening project. These counts are undertaken annually over the winter period (November, December, January and February) throughout the whole estuary system.

The results of both the high water (WeBS) and low water (SWT) counts provide a good basis for describing waterbird populations of the Stour and Orwell estuaries. There is therefore a good long term data set for the waterbird populations of the estuary. This information is used to inform the EIA and Habitats Regulations Assessment studies for the projects referred to as part of this case study. This significantly reduces the uncertainty regarding the status of the overwintering bird populations of the estuarine system and, consequently, the assessment of potential impacts on these populations.

6.7.5 Cumulative impact

For each of the projects described in this case study, an assessment of the potential for cumulative impact to occur was undertaken. In order to undertake this assessment, the temporal and spatial boundaries of the potentially affected resources were defined. For the parameters of relevance to this study, the

[1] WeBS is a scheme run by the British Trust for Ornithology, The Wildfowl & Wetlands Trust, the Royal Society for the Protection of Birds and the Joint Nature Conservation Committee

spatial boundary covered the Stour and Orwell estuarine system, and extended to the mouth of the estuaries.

The temporal boundary includes past projects where the impacts are still occurring or where mitigation measures are still operating, present plans or projects and reasonably foreseeable future plans or projects (for which information is available). For the cumulative impact assessment for the Bathside Bay container terminal project, the temporal boundary of the assessment was taken as being 5 years. This time period was selected because the Environmental Statement for the Harwich Haven approach channel deepening identified 5 years as the appropriate period to develop an optimum method of sediment replacement to mitigate for the loss of intertidal estimated to result from the deepening.

The assessment then involved identifying those parameters of relevance to the cumulative impact assessment. In the case of the Stour and Orwell Estuaries SPA this relates to the designated features, namely populations of waders and wildfowl and the habitat and resources which are required to support them.

The cumulative assessment comprised identifying the potential effect of the various projects that were included in the assessment on the relevant parameters identified above; this was undertaken through reviewing the available literature. The key aspects to assess were the direct loss of habitat within the footprint of the project, effect on hydrodynamics (e.g. tidal range) and predicted effects on sediment transport.

The cumulative effects assessment identified two categories of effect on the environmental parameters included in the assessment. The first category is those effects which are additive (i.e. the effects of the projects do not interact to produce a greater or lesser impact than the effect of the project in isolation). The second category is where there is the potential for effects of different projects to interact and, therefore, potentially result in a non-additive effect (i.e. the cumulative impact of the schemes could be different to the sum of the parts).

For the first category of effect, the impacts were simply summed to produce an estimate of the cumulative impact. However, for the second category of effect, numerical modelling was undertaken which included all of the projects that could give rise to interactive effects (typically larger projects with the potential for significant impacts on the hydrodynamic and sedimentary regime of the estuary system).

6.8 Analysis of areas of uncertainty and risk

6.8.1 Development of appropriate mitigation for the Harwich Haven Approach Channel Deepening: the sediment replacement programme

Description of the sediment replacement programme

In order to mitigate the predicted increase in the rate of intertidal erosion of approximately 2.5ha per annum (see Table 6.1), a number of different approaches were explored (collectively termed 'sediment replacement'), to assess which techniques were most effective and appropriate in mitigating the predicted effect of the project whilst also taking account of the potential environmental impact of the technique itself (e.g. potential for smothering of the seabed, impact on fisheries resource).

The mechanism for the predicted impact on the rate of intertidal erosion and potentially on the habitats of the estuarine system is based on the principle that more sediment depositing in the enlarged operational areas of the ports (encompassing the approaches), and subsequently being placed offshore through maintenance dredging, would further deplete the eroding system by reducing the supply of sediment to the estuaries. The basic principle of the sediment replacement programme, therefore, is to return a proportion of the extra sediment depositing in the Haven berths and Harbour approaches to the wider estuarine system, via targeted and monitored water column recharge and subtidal placement, such that natural processes are then able to redistribute the material; leading to retention of some of the returned sediment.

The different approaches to sediment replacement that were explored are summarised as follows:

- Subtidal placement of fine material

Fine sediments that are dredged during the maintenance dredging campaigns are placed on the seabed and act as a feed of material into the estuary system.

- Water column recharge

Maintenance dredgings are discharged from the dredger at certain defined placement locations within the estuary system adjacent to intertidal areas (see Photograph 6.1). Placements are made under specific tidal conditions that encourage material to disperse over intertidal areas. This represents a novel approach that has been proven to be successful.

Photograph 6.1 Water column recharge in the Stour and Orwell estuaries

- Increased overflow during maintenance dredging

During maintenance dredging, overflow can be increased above the normal rate, which represents as a further method of returning fine material within the estuary system.

Over time, and based on the results of trial placements of sediment and monitoring, the overall mitigation strategy has evolved into an approach that is considered to be the most effective (relying substantially on water column recharge). This mitigation strategy has evolved over time (in terms of placement locations and volume of sediment placed at each location on an annual basis), and the locations that are currently licensed for the placement of maintenance dredgings are shown in Figure 6.4.

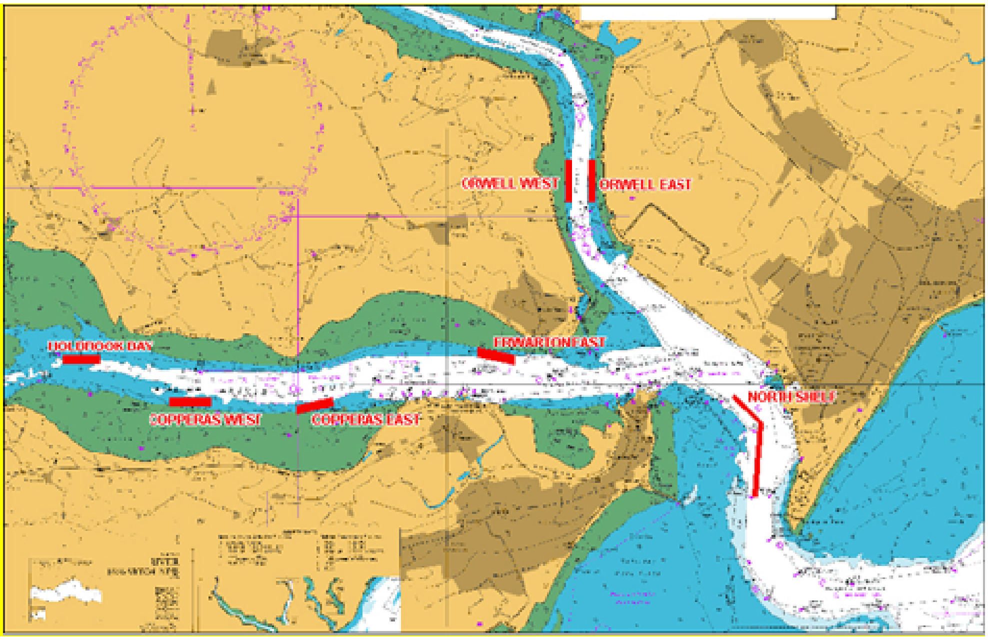


Figure 6.4 Sites licensed for the placement of maintenance dredged material

In addition to the proposed mitigation for the system-wide impact discussed above, it was proposed that the localised impact in the lower Stour estuary could be mitigated by the sediment replacement programme targeting Erwarton Bay in the lower Stour estuary for local recharge. That is, up to 25,000 dry tonnes/year would need to be recharged at this location.

In addition to the mitigation of the predicted increase in the rate of erosion of the intertidals in the estuary system described above, it was also necessary to take measures to address the effect of the proposed capital dredging on tidal propagation (effect on tidal range). The approach to compensate for the 4ha of unmitigable 'loss' of intertidal area due to the effect on tidal range was, therefore, to create additional intertidal area within the estuary system. This was achieved through the managed realignment of a seawall on the eastern shore of the Orwell estuary near Trimley (see Photograph 6.2).

Photograph 6.2 Aerial view of the 16.5ha Trimley managed realignment scheme on the eastern shore of the Orwell estuary, looking north-west (source: HHA)

Uncertainty in success of sediment replacement

When the sediment replacement programme was first developed, the techniques being proposed were untested and, therefore, the nature conservation bodies considered that there was sufficient uncertainty in whether or not the techniques would be successful to warrant adopting a precautionary approach.

The precautionary assumption that was adopted by Natural England was to assume that the sediment replacement programme would not be fully effective within 5 years of implementation of the programme. In light of this assumption it was necessary for the HHA to create intertidal area as compensatory habitat that allowed for the possible failure of the mitigation measures described above for a period of 5 years (i.e. enhanced erosion of intertidal area at 2.5ha per annum, or a total area of 12.5ha). This area of compensatory habitat was provided at the Trimley managed realignment scheme described above. The area of intertidal created at Trimley through managed realignment was, therefore 16.5ha (i.e. 4ha due to the effect on tidal range, plus 12.5ha).

In addition to the above, a further agreement was made that gave Natural England further confidence in light of the uncertainty associated with the success of the sediment replacement programme. The applicant (Harwich Haven Authority) committed to put in place any measures necessary to maintain the integrity of the designated site if monitoring showed that the mitigation and compensation was not effective in meeting its objectives.

A crucial aspect of the compensation and mitigation proposals was the monitoring, reporting and feedback mechanism to the regulators and consultees that was established; this is described in Section 6.8.6.

6.8.2 Direct intertidal placement of dredged material

Intertidal placement of dredged material as part of the Trinity III Terminal (Phase 2) Extension

The Trinity III Terminal (Phase 2) extension was predicted to have a number of effects on the estuarine environment, as summarised in Table 6.1. These effects are described in further detail below.

During the construction phase, the following impacts were predicted to occur (of relevance to this study):

- Direct loss of 2.93ha of undesignated intertidal area (i.e. the measurable loss due to footprint of the terminal construction);
- Reduced exposure of up to 0.6ha of intertidal area within the Stour and Orwell Estuaries SPA due to the predicted effect on tidal propagation.

During the operational phase, the following impact was predicted to occur:

- Enhanced erosion of up to 0.2ha/year of intertidal area within the SPA due to a reduction in sediment supply.

It was proposed that the direct impact of the development on undesignated intertidal habitat and the effect on tidal propagation (i.e. the construction phase effects listed above) would be mitigated through habitat enhancement schemes on the Shotley and Trimley foreshores in the lower Orwell estuary. These habitat enhancement schemes also acted as mitigation for the predicted increase in localised erosion over the intertidal areas in the lower estuary.

The habitat enhancement schemes are shown in Photograph 6.3 (Trimley foreshore) and Photograph 6.4 (Shotley foreshore). The schemes comprised the placement of dredged clay and gravel at around the mean low water mark to form bunds (as shown on Photographs 6.3 and 6.4) which were backfilled with mud. The total area of the habitat enhancement schemes was 26ha, 23ha of which would be productive intertidal (the remainder would be clay placed to create the bunds).

In addition to providing intertidal habitat of higher ecological value (e.g. a mixture of mudflat and, over time, saltmarsh) than that which was formerly present, the schemes also increased the stability of existing flood defences in the lower Orwell estuary. In addition, they represent the beneficial use of dredged material from the Trinity III Terminal project.

Photograph 6.3 The habitat enhancement scheme on the Trimley foreshore in the lower Orwell estuary, looking north (source: HHA)

Photograph 6.4 The habitat enhancement scheme on the Shotley foreshore in the lower Orwell estuary, looking south (source: HHA)

The erosion of intertidal area was predicted to be mitigated through adjustment of the sediment replacement programme that was established following the 1998-2000 approach channel deepening (see Section 6.8.1). There were no uncertainties raised in the EIA process regarding the scale of the predicted enhanced rate of intertidal erosion. This project therefore benefitted from the mitigation approach that was developed from the channel deepening project because a body of evidence had been built up regarding the effectiveness of the scheme and the environmental impact of the sediment replacement through the ongoing monitoring programme. This gave regulators and Natural England confidence that the sediment replacement programme could be successfully adjusted in light of the predicted effect of the Trinity III Terminal (Phase 2) Extension.

Uncertainty in future management

During the consultation that was undertaken during the development of the proposals for the habitat enhancement schemes, taking account of future uncertainty was an important consideration. This uncertainty was not in relation to the EIA studies or likely success of the schemes, but was concerned with uncertainty in the future management options for flood defences and habitats in the lower Orwell estuary.

The areas of land behind the seawalls at Shotley and Trimley are designated as Sites of Special Scientific Interest (SSSI) for freshwater and the regulators recognised that, in the longer term, it may not be sustainable to maintain seawalls and, therefore, maintain the freshwater habitats. As a consequence, there is uncertainty regarding what the future policy may be for the management of flood defences and habitats in the longer term.

In light of the above, the regulators stated that it was important that the habitat creation schemes should not be considered to be permanent structures and that they should be designed to evolve and erode over time. This was considered desirable as the habitat enhancement schemes would not constrain future options for the sustainable management of flood defences and habitats in the estuarine system.

Uncertainty in techniques adopted for intertidal placement of dredged material

The directly placement of dredged material on the intertidal areas were seen as experimental trials as there was uncertainty as to what the best technique for the construction of the schemes was and how the placements would evolve in the future.

At the northern end of the placements on the Shotley foreshore, a series of low clay bunds were constructed which were backfilled with maintenance dredged silts (see centre to lower section of Photograph 6.3). Further south, a longer gravel bund was constructed which was backfilled with silt.

On the Trimley foreshore, bunds were constructed using clay towards the southern end of the foreshore and gravel to the northern end. These bunds were then backfilled with silt.

6.8.3 Evolution of the sediment replacement strategy as mitigation for the proposed Bathside Bay container terminal:

Following the completion of the approach channel dredging project in 2000, an extensive programme of monitoring was implemented by the Harwich Haven Authority to monitor the impact of the project and the effect of the sediment replacement programme. The monitoring programme encompassed monitoring of waterbird populations, benthic invertebrate communities (biotope distribution and extent), saltmarsh extent, bathymetry, intertidal area and fish populations. The findings of the monitoring programme are reported annually and presented at an annual meeting of regulators and consultees (further information on this process is provided in Section 6.8.6).

The results of the monitoring programme, annual reporting and consultation process gave increasing confidence to regulators and stakeholders as to how sediment behaves in the system, that the sediment replacement programme was not causing significant adverse effects and the rationale behind the sediment replacement programme was sound. Through this process, uncertainty in the process was reduced and this was important in providing confidence that the sediment replacement programme represented effective mitigation and could be adapted to mitigate for the predicted effects of the Bathside Bay container terminal project.

At the time of the EIA studies for the Bathside Bay container terminal project, the licences for the sediment replacement programme allowed for the placement of up to 250,000 dry tonnes of sediment within the estuary system and Harwich Haven area. Of this total, 140,000 dry tonnes were licensed for placement at six locations within the Stour and Orwell estuaries via water column recharge and a further 110,000 dry tonnes are licensed for subtidal placement at the North Shelf (see Figure 6.1). At that time, the sediment replacement programme resulted in the placement of approximately 10% of the sediment accumulating in Harwich Harbour within the estuary system. In addition, sediment disturbance during maintenance dredging and agitation by vessels also represents a significant release of sediment into the Harbour.

The Bathside Bay container terminal project was predicted to cause an increase in the estuary-wide background rate of intertidal erosion of approximately 24,500 dry tonnes per year, equating to an increase in the rate of intertidal erosion of up to 2.8ha per year.

Following the approach to mitigation that was developed for the Harwich Haven Approach Channel Deepening project, it was proposed that the amount of sediment returned to the system via the sediment replacement programme be increased from 250,000 dry tonnes/year to 500,000 dry tonnes/year. Although this increase appears large in relation to the predicted effect associated with Bathside Bay container terminal, the return of such quantities is necessary because the natural system is inefficient at retaining material on the intertidals. That is, only a small percentage of the material entering the estuary system naturally on the flood tide will deposit on the intertidals, with the majority moving back and forth in the subtidal channels before being exported from the system. As part of the process of applying to increase the volume of material used in the sediment replacement programme it was necessary to predict the impact on benthic ecology at the placement sites and the potential impact of smothering. However, there were no concerns regarding increased turbidity in the water column associated with sediment replacement.

6.8.4 Compensation for the Bathside Bay container terminal project: uncertainty in delivery of compensatory habitat

The most significant ecological impact on the Bathside Bay container terminal was predicted to be the direct loss of 65ha of intertidal habitat due to the reclamation, plus the loss of a further 4ha due to dredging that was proposed to create the small boat harbour (see Table 6.1). At the time of undertaking the EIA studies, these habitats were proposed for designation as part of the Stour and Orwell Estuaries Special Protection Area (SPA) and Ramsar site.

Given the above predicted effects, the Appropriate Assessment concluded that the project would result in an adverse effect on the integrity of the designated site and, therefore, compensatory measures would need to be provided. Due to the nature of the habitat that would be impacted as a consequence of Bathside Bay container terminal project, and the magnitude of this loss, the environmental studies concluded that the most appropriate approach to compensate for this impact was through the creation of new intertidal habitat.

Furthermore, the best method to create intertidal habitat at the scale required to provide sufficient compensation was considered to be the managed realignment of coastal flood defences.

Following a scoping and site selection exercise, a suitable site (with an area of approximately 138ha) for undertaking managed realignment on the northern shore of Hamford Water near the village of Little Oakley, Essex (see Figure 6.1) was identified. The Walton Backwaters are designated as the Hamford Water SPA and Ramsar site and the proposed managed realignment site is immediately adjacent to this designated site. An EIA and Appropriate Assessment were undertaken for the managed realignment project.

As with most compensatory habitat schemes, there is an element of uncertainty with regards to the quality of habitat that will be created and, therefore, whether or not the scheme would deliver sufficient compensatory measures. Given this uncertainty, a risk-based approach was adopted and a compensatory habitat ratio of approximately 2:1 was required in light of the predicted impact due to the Bathside Bay container terminal project.

A detailed programme of monitoring for the proposed compensatory habitat was developed. This programme has two components, namely monitoring the managed realignment site itself and monitoring of the effects of the scheme on the wider Hamford Water SPA. For the realignment site, the programme includes monitoring habitat extent, usage by feeding and roosting waterbirds, benthic invertebrate colonisation, particle size distribution and the development of saltmarsh communities. For the SPA, monitoring focuses on potential effects on coastal processes and, specifically, on the crest level, position and extent of the beaches outside the realignment site.

An important feature of the monitoring programme is the development of habitat and species-based targets for the realignment site. For example, based on the measured level of usage of Bathside Bay by feeding and roosting waterbirds, targets for the managed realignment site were developed. These targets relate to the desired usage of the site by a particular assemblage of waterbirds (and key species) and also numerical targets for those waterbird populations for which Bathside Bay is of particular importance (i.e. 1,500 feeding and 2,200 roosting waterbirds).

The development of an appropriate monitoring programme, together with an enforceable commitment to remediation measures should monitoring reveal a cause for concern with respect to impact on the Stour and Orwell Estuaries SPA, the Hamford Water SPA or the ecological functioning of the realignment site, provides the Regulators with confidence that appropriate compensation can be delivered and that risk of failure has been minimise and can be managed.

6.8.5 Felixstowe South Reconfiguration

The Felixstowe South Reconfiguration project was predicted to have the potential to impact on the hydrodynamic and sedimentary regime of the Stour and Orwell estuary system through an effect on tidal range and sediment supply. However, the effect on tidal range was not predicted to adversely affect the integrity of the designated site because no significant effect on waterbird feeding was predicted to occur.

During the operational phase, it was predicted that the project would cause an overall reduction in the rate of intertidal erosion throughout the estuary system. Consequently, no mitigation measures were required.

The EIA did, however, predict a small increase in the rate of intertidal erosion in localised areas (in the eastern parts of Erwarton Bay and over the Shotley foreshore) under certain wind conditions. The mitigation proposed for the localised effect in Erwarton Bay was to increase the amount of sediment placed at this location through the sediment replacement programme (i.e. water column recharge). For the Shotley foreshore, the biological effect was predicted to be negligible, but direct placement of clay was proposed to provide additional protection to the seawall which was already experiencing erosion which was threatening the stability of the access road to Shotley Marina that runs along the seawall.

As for the Bathside Bay project (see Section 6.8.3), it was possible to identify an acceptable mitigation measure for the localised effect in Erwarton Bay due to the already established sediment replacement programme that had been ongoing for a number of years and the associated monitoring programme.

6.8.6 Translation of predicted effects on estuarine habitat to ecological effect

During the EIA process there were no discussions surrounding the predictions made regarding the impact of the project on the intertidal erosion rate and, therefore, no concern regarding uncertainties in this prediction. There were, however, uncertainties regarding the likely success of mitigation that was proposed to address this predicted impact; this is discussed in Section 6.8.1.

It was established through consultation with Natural England, the RSPB and others that the important features to consider when predicting the implications of projects on the nature conservation interest of the estuary are the habitats that support the designated interest features (i.e. the waterbird populations). The rationale behind this approach is that if it can be demonstrated that the predicted effects on habitats are insignificant or can be mitigated, then it can be inferred that the project would not result in an impact on the waterbird populations that the habitats support.

It is for this reason that the EIA studies focus on the effects on estuarine habitats, and on developing mechanisms to deal with uncertainty in the prediction of these effects (as reported throughout this section). In terms of predicting the ecological impact, the usage of the habitats potentially affected by the project by waterbirds is assessed using data (e.g. waterbird counts) and the significance of potential impact is assessed using expert judgement. Any safeguard built into mitigation or compensation measures to deal with uncertainty in predicting impacts on habitat change is, by virtue of the fact that the waterbird populations depend on them, dealing with potential impact of the proposed scheme on waterbirds.

6.8.7 Management of the mitigation and monitoring commitments

Establishment of a Regulators Group

The compensation, mitigation and monitoring commitments referred to above for the various projects were embodied in legal agreements (between the applicant and other bodies, such as Natural England, the RSPB and the Environment Agency) which were referred to within consents and licences for the projects. In this way, the commitments made are enforceable.

The management of the mitigation and monitoring programme established as a consequence of the Approach Channel Deepening, and which has evolved and been refined in response to the findings of monitoring and the requirement to consider the implications of subsequent proposed schemes, has a number of key features. From the outset, a 'Regulators Group', with the authority to make decisions regarding the refinement of the mitigation and monitoring programme, was established. This Group represents the forum through which the programme is delivered. The Group comprises a number of bodies including English Nature, DEFRA, the Environment Agency and non-statutory organisations including the Wildlife Trusts (Essex and Suffolk) and the RSPB.

A by-product of this collaborative approach that has partly arisen as a result of the Harwich Haven Autohrity inviting other operators in the estuaries to also attend the meetings, has been an attempt to co-ordinate all mitigation and monitoring activities in the estuary system. This has derived from the open exchange of information and the establishment of a consultative forum. A culture of shared responsibility, between operators, regulators and NGOs, has consequently arisen.

Compliance monitoring and annual reporting

In order to assess the Harwich Haven Authority's compliance with the large number of mitigation and monitoring commitments linked to the Approach Channel Deepening project, a process of 'compliance monitoring' was established. This process involves documenting those actions and commitments that were to be undertaken during capital works and those to be undertaken following completion of the works. An annual compliance report is produced which describes work that has been undertaken with respect to each of the commitments and records when a commitment has been fulfilled. The process is overseen by the Regulators Group and the annual compliance reports are circulated to this Group.

In addition to compliance monitoring, an annual report is produced which details the findings of the research and monitoring that has been undertaken during the previous year and considers the ongoing consequences, if any, of development for the health, state and integrity of the estuarine system. This report is presented at an annual meeting that is attended by the Regulators

Group to ensure that there is an open exchange of information between the HHA and the Regulators Group. This is an important process as the findings of the annual report and the discussions held at the annual meeting inform any changes to the programme of monitoring that may be required. Managing the process in this manner is the most effective approach to obtaining agreement from the various Regulators as to the way forward with respect to the mitigation and monitoring.

The process of monitoring, reporting and feedback to the Regulators Group described above is seen as a critical element by the nature conservation bodies and the regulators because it provides a mechanism to adjust the mitigation and compensation requirements in light of the findings of monitoring.

6.9 Overview of output of the interviews

During the interviews for this case study, Natural England stated that there were no significant concerns regarding the predictions made during the EIA process and, to a large extent, this was due to their confidence in the EIA team working on the project.

A crucial aspect from Natural England's point of view was the development of the mitigation and monitoring commitments that were enforceable through legal agreements which are embodied within the licences for the various projects, together with a Regulators Group which has the authority to make decisions regarding the refinement of the mitigation and monitoring programme. The acceptance of this mechanism for the Harwich Haven Approach Channel Deepening established the framework through which the mitigation requirements for subsequent projects could be dealt with.

Through the mitigation and monitoring commitments, Natural England was able to ensure that 'safeguards' were built into the mitigation and compensation proposals and this was crucial is providing certainty that the commitments were deliverable. For example, the mitigation could be adjusted (scaled up or down) if necessary depending on the results of the monitoring.

One issue raised in the interviews by the applicant was that whilst it was recognised and accepted that the monitoring programme was required initially, over time it was felt that some components of the programme could have been scaled down sooner when the results were demonstrating that there were no significant adverse effects.

6.10 Conclusions

In managing such a dynamic environment the requirement to accept some degree of 'measured' risk is unavoidable. It is vital to recognise that there will be an element of uncertainty associated with predicting both the functioning of a natural system and the extent of any perturbations likely to arise as a result of development.

In the case of the Stour and Orwell estuaries this uncertainty (albeit limited) relates particularly to the ability of an artificial sediment bypassing system to efficiently replicate nature, the relevance of the placement locations, and the potential effect of sediment replacement on the benthic ecology and fish resources of the estuaries. These issues, however, can be informed through monitoring and an informed review of monitoring data. It is for this reason that the adoption of an iterative, flexible approach to mitigation, informed by good data, appropriate monitoring and an open exchange of information with stakeholders, is essential.

This is achieved in the Harwich Haven through a system of monitoring, reporting and response with a single point of responsibility. In addition, the mitigation is conditioned (and thereby any risk is reduced) through four steps, where a procedure is in place for each step to be taken sequentially should the previous step prove to be inadequate. That is:

1. A broad, estuary-wide sediment replacement programme, as described above;
2. Sediment replacement specifically targeted towards areas of ‘need’;
3. Direct placement onto the intertidals (with appropriate consent); and (if all else fails)
4. Compensation.

Overall, the flexibility and consultation built into this approach ensures that a well informed decision making process exists and enables successful mitigation to be delivered.

7 Weser

7.1 Description of the project

Bremenports were instructed to expand the container terminal from the Federal state of Bremen by constructing a new terminal (CTIV)

The proposed scheme comprised the following main components:

1. Construction of the container terminal section, including a quay 1700m in length;
2. Diversion of the Weddewarder Tiefs (river);
3. Constructing a new dike around the site;
4. Dredging (mainly clay). The dredged material (0.6 Mm^3) has been disposed at two maintenance disposal sites of the Wasser und Schifffahrtsamt (WSA) (K1 and K3);
5. Importing 10 Mm^3 of sand for the construction. The sand has been extracted by maintenance dredging of the navigation channels in the Weser (74.5-90km) or in the Jade.
6. During the operational phase, maintenance dredging in the berths and the access to the navigation channel will be possible if necessary. .

The location of the project is on one of the compensation grounds for the previous project (CTIII). The reason for this is that CTIV is an extension of an existing container terminal. The location had to be on the territory of the Federal State of Bremen, , and no further north than the current location because the boundary between the Federal State of Bremen and Lower Saxony is located here and the National Park of the Wadden Sea begins on the Lower Saxony side of the boundary. There was no other space to develop the harbour and, therefore, the government decided to locate the project in this location. All CTIII compensation grounds are monitored very well, so there is a good knowledge of this area as well.

In the initial phase of the project, the surrounding Weddewardener Aussendeich was not yet designated as a Natura 2000 site. The discussions about designation (as SAC) were controversial and not complete. To gain legal security for CTIV, the involved authorities of Bremen agreed to implement a full Appropriate Assessment for this site during the plan approval procedure, although there was little experience with this instrument. As a result, the Weddewardener Aussendeich was treated as a designated area in the approval procedure.

For this project several environmental studies have been produced; three different Appropriate Assessments (Küfog (2002 a, b, c)) and an EIA (Bremenports, 2002). The following summarises the potential impacts that were identified in the EIA:

- Effect on feeding habitat for seabirds and migratory birds of the Weser Estuary and the Weddenwarder Aussendeich;

- Loss of breeding area for birds at the outer dike of Weddewarden (compensation);
- Predicted (hydro)morphological changes by removal, loss and replacement of sediment;
- Hydrological effects;
- Effects of (maintenance) dredging and impact of disposal of dredged material on benthos and consequently on flatfish, shellfish and nursery areas;
- Loss of habitat in estuary supra-, eu- and sublittoral (compensation) in the Wadden Sea and Weddewarden;
- Effect on fish stocks, especially designated migratory fish (river lamprey, twaite shad) and other red listed species, particularly given the importance as a nursery area;
- Effects on migratory fish due to changes of the Weddewarder Tiefs.

The most significant potential impact associated with the project was habitat loss due to the construction of the container terminal and piling (approximately 91.5 ha of subtidal and intertidal habitat), and the implications of this for benthic fauna, fish and (breeding) birds. These effects would impact on the Weddewardener Aussendeich; this was treated as if it was a designated area in the environmental studies (see Section 7.2.1).

In addition, approximately 59ha of brackish water tidal flats (including reedbed and saltmarsh) would be lost and a further 12ha of estuarine habitat would be changed due to diversion of the river. These effects would impact on the Weddewardener Aussendeich designated site (see Section 7.2.2).

These significant effects described above are compensated in two areas: der Grosse Luneplate and der Wurster Küste (Figure 7.1).

With regards mitigation, the following measures were taken:

- Pile driving by means of vibration as much as possible;
- Low intensity piling at the beginning of the pile driving process enabling fish to flee without injuries;
- Driving one pile per day during the migratory period;
- Installation of a bubble curtain to lower the impact of noise emissions from the pile driving;
- Additional research to get more information about the migrating period of fish;
- Protected reed and saltmarshes plants which grew on the construction site were relocated;
- Stones and cobbles of the sublitoral areas within the construction site were relocated in the river Weser to create a stony habitat.

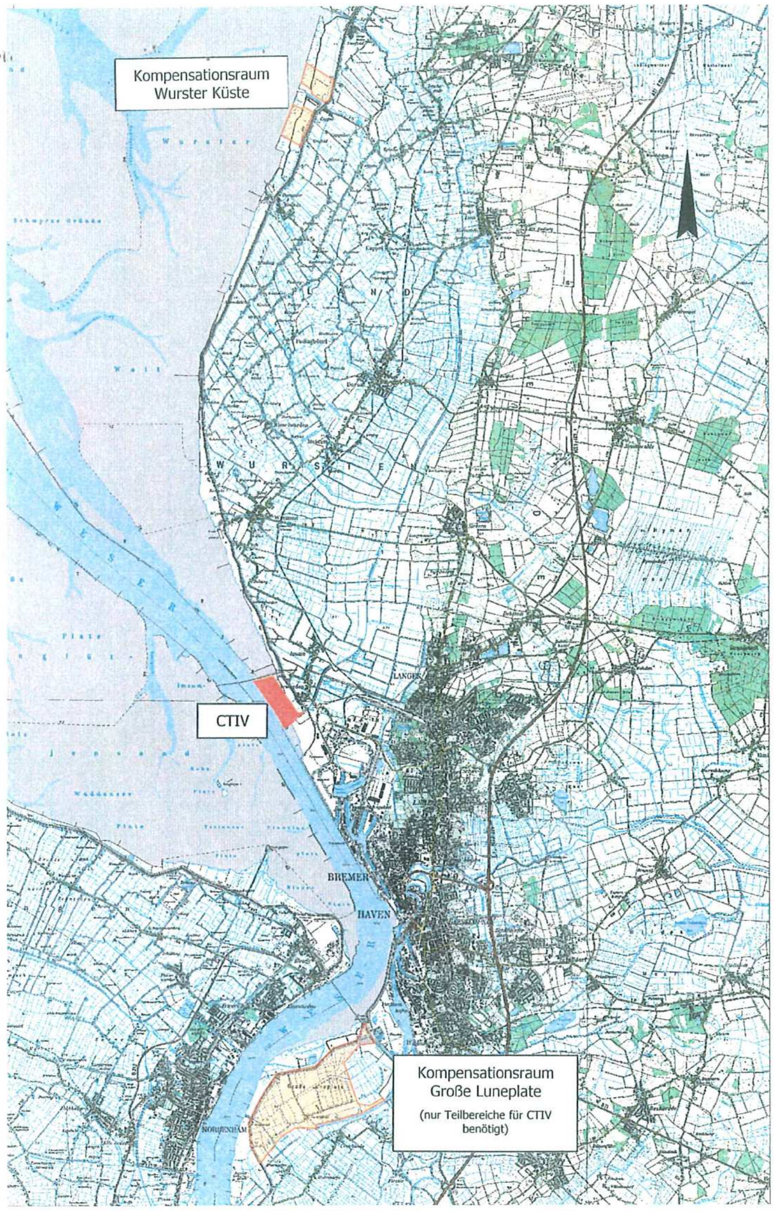


Figure 7.1 Overview of the compensation areas (the northern compensation area is 'der Wurster Küste' and the southern compensation area is die 'Groβe Lune Plate') and the location of the proposed CTIV project (Bremenports 2002a).

The project directly degrades 154 ha of valuable estuary habitats. The compensation is mainly for the habitat loss, but also species loss mainly in brackish mudflats (H1130) due to construction works (building of the terminal) and related construction, such as the building of dikes. Birds are not affected negatively. A smaller area of saltmarsh (H1320 and H1330) is lost, and compensation was also proposed for this. Increased turbidity due to disposal of dredged material and the extraction of sand during the construction phase and maintenance dredging is not considered to be significant, and so no compensation was required for these aspects.

Since there was a lack of space in the Weser estuary (Federal State of Bremen), intertidal and brackish habitats had to be created by depoldering. The Federal State of Bremen had no location to compensate so they negotiated with the Federal State of Lower Saxony and worked together on a solution for compensation. Five sites were initially identified as potentially suitable locations. However, on further consideration of other uses (agriculture, coastal protection, spatial planning, etc.), two possible locations remained: Grosse Luneplate and Wurster Küste.

In total, about 500ha of land were developed for the purpose of nature conservation of which 320ha is directly connected to the requirements of CTIV. The compensation was carried out in two areas: the principle area is the so called Grosse Luneplate (Figure 7.1), a former island in the river Weser. In this area, a tidally influenced area was created (215ha). To achieve this, a dike was pierced and a storm barrage with a width of 30m was built to enable tidal inundation. High tides above spring tides were cut off for coastal protection reasons. Brackish mudflats, reed and tidal ponds will develop here and the area is left without any human use. In total 175ha represents compensation for the CTIV project, the rest are measures for other projects.

The second compensation area (Wurster Küste) is situated in the north in the National Park Niedersächsisches Wattenmeer (Figure 7.1). In this area dikes were pierced at 10 locations with a width of 20-50 m to allow tidal inundation and the development of natural saltmarshes.

7.2 Overview of relevant Natura 2000 sites

There are two Natura 2000 sites of relevance to the project, as described below

7.2.1 Niedersächsisches Wattenmeer

This site is designated as both SPA for its importance for waterbird populations and SAC. The conservation goal of this area is the protection and development of the habitat type 1130 (estuary) and its function as migrating corridor for the fish species twaite shad, river lamprey and sea lamprey. During the planning process this area was not yet notified and designated.

7.2.2 Weddewardener Aussendeich

This site is put forward as both SPA for its importance for waterbird populations and SAC. As explained above the site was not designated as a SAC, but treated as if it was for reasons of an ongoing designation procedure and the interest of legal security for the approval of CTIV. The important habitats and species to protect are H1130, H1330 and migratory fish.

7.3 Parties involved in the case study

During the EIA and consenting processes for the project, many organisations have been involved and consulted on the proposals. A summary of the organisations that have been involved and their role in the process is provided in Table 7.1.

Table 7.1 Summary of organisations involved in the case study

Organisation	Role (role or key interest)
Bremenports*	Applicant (developer). Privatised entity which is owned by the city of Bremen with the task to develop and maintain the infrastructure of the ports of Bremen/Bremerhaven. It was assigned by the Senator for Economic Affairs and Ports to develop the extention of CTIV.
Küfog Landschaftsökologische und biologische Studien	Private consultant agency which performed the EIAs and Appropriate Assessment.
Der Senator für Bau und Umwelt*	NCA: responsible for the AA regarding decision about compatibility of the project with the conservation goals of Natura 2000
Wasser- und Schifffahrtsdirektion Nordwest, Planfeststellungsbehörde	Responsible for decision about the approval of the EIA and the permission of the whole project.
The Bund für Umwelt und Naturschutz Deutschland (BUND), Landesvervand Bremen e.V.*	Nature Conservation NGO, consultee on environmental effects
NLWKN. Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency	Responsible NCA of the Federal state of Lower Saxony
Dr. Fricke	Biologist, specialist on migratory fish
National Park Niedersächsisches Wattenmeer	National Park of Lower Saxony - Responsible NCA of the Federal state of Lower Saxony (environmental effects for the Wadden Sea)
WSA. Wasser- und Schifffahrtsamt Bremerhaven.	Ageny of the Federal Waterway administration. Input of data
Wasser- und Schifffahrtsdirektion Nordwest	Consultee (safety and shipping)
Prof. Dr.-Ing U.C.E. Zanke, University of Darmstadt	Hydromorphological studies

* indicates that representatives from these organisations were interviewed as part of the reporting for this case study

The Federal State of Bremen was the commissioning party and gave the assignment to Bremenports to expand the container terminal (Bremenports was responsible for the planning, approval, the environmental solutions and their implmentation and the construction of the container terminal extension).

The Federal State of Lower Saxony was involved in providing the compensation solution at the Luneplate and the Wurster Küste in Lower Saxony.

Küfog Landschaftsökologische und biologische Studien undertook some of the EIAs and three Appropriate Assessment studies for the project. The Senator für Bau und Umwelt was the authority for the nature conservation law and judged the Appropriate Assessment.

The Wasser- und Schifffahrtsdirektion Nordwest Planfeststellungsbehörde is the authority for the EIA (i.e. it wrote the permit and was partly responsible for the Appropriate Assessment (examination of alternatives and overriding common interest).

Prof. Zanke undertook the assessment of the hydromorphological effects of the project. A specialist on migratory fish (Dr. Fricke) was consulted by the NCA and an expert group of specialists in the area was consulted for a second opinion on the effects of the activity on migratory fish.

7.4 Overview of the local NGO situation

The Bund für Umwelt und Naturschutz Deutschland, Landesverband Bremen e.V. did represent the nature conservation parties (NGOs) and was present at both formal and informal meetings. The other parties, that are member of the NGO-umbrella organisation in Bremen (Gesamtverband Umwelt- und Naturschutz Unterweser) (GNUU)) and the Naturschutzbeirat, a consultant expert group of the NCA Bremen, were informed formally.

7.5 Chronological overview of the study process

The notification of intention was made by the Senator for Economic Affairs and Ports. This was a public announcement. Bremenports, a privatised entity which is owned by the city of Bremen, got the task to develop and maintain the infrastructure of the ports of Bremen/Bremerhaven. The extension of CTIV was instructed by the Senator for Economic Affairs and Ports.

Bremenports was responsible for the planning, approval, environmental solutions and their implementation and the construction of the container terminal extension.

Bremenports commissioned KÜFOG to undertake the Appropriate Assessments for the project (three separate documents) and Prof. Zanke to undertake the hydromorphological modelling (2002). Whilst undertaking the Appropriate Assessment (2002), informal and formal meetings were organised to discuss content and process. These meetings were mainly organised by the NCA, but also by Bremenports. The Appropriate Assessments were reviewed by the NCAs.

Bremenports drafted the EIA (2002). It was ensured that the best methods were used and all gaps of knowledge were filled, as far as possible. Specialised studies were performed and expert meetings were held.

The NCA (2002) wrote a recommendation to the Wasser- und Schifffahrtsdirektion Nordwest and this recommendation is included in the permit for the project.

A specific workshop on migratory fish was organised (2003) to discuss uncertainties on this topic. During the first half of 2004, the decision process took place and subsequently the public announcement.

After the public announcement people could object. The objections were taken into account and responses to the objections were given in the permit that is drafted by the Wasser- und Schifffahrtsdirektion Nordwest, Planfeststellungsbehörde (2004). The potential impacts described in the EIA were mitigated by formulating specific regulations with mitigation measures in the permit. Compensatory requirements were also described in the permit.

In 2004 the permit was given and the project could start, including monitoring and compensation. The development took four years to complete and in 2008 the extension of the container terminal was ready to use.

Figure 7.2 summarises the timescale for the EIA and consenting processes for the CTIV project.

7.6 Overview of the consultation process

In every approval procedure formal public meetings/discussions about the project and its impact (not only environmental) have to take place with all stakeholders and the NGOs (see Section 7.5.2 of Royal HaskoningDHV (2012)). This was also the case for the CTIV project.

The public was consulted at different stages in the proces. Formal consultation took place at the notification of the project, the public announcement and the decision/permit, and there was an opportunity to object against the project in court.

The important planning process for the EIA, Appropriate Assessment and the compensation measures started much earlier than the formal process. Bremenports and the NCAs were having consultations from an early stage, because in Bremen there is a legal obligation to reach an agreement by the time of making an application. The NGOs were asked to join these meetings, but they refused, although there were informal talks with the NGOs. During the EIA process there were a number of informal meetings with NGOs and stakeholders, but not on a regular basis.

Time	2001	2001	2002	2002			2003	2003	2004	2004	2005	2005-2008
	Q1-Q2	December	July	September	December	December	Q1-Q2	December	Q1-Q2	June	Q1-Q2	2nd
Activity	Scoping	Notification intention	Modelling and AA	Advice of NCA to WSD	EIA	Public announcement (WSD)		Expert group on migratory fish	Decision making and announcement	Permit and start of building	Building of the terminal, monitoring and compensation	
Consultation points		Public announcement		Consultation formal and informal		Formal consultation	Informal consultation	Informal consultation	Formal consultation		Appeal	

Figure 7.2 **Summary of the timescale for the EIA and consenting processes for the CTIV project**

A specific workshop (2003) was organised with regional experts to discuss uncertainties (e.g. the uncertainty on the effects on migratory fish). Most of the experts are also active in the regional NGOs, but this workshop was not an official consultation with the NGOs.

All relevant parties were consulted and had the opportunity to make objections on the project; these were taken into account in the permit.

The NGOs decided not to go to court as they were limited in capacity and decided to focus on other projects rather than to fight aganst this project, knowing that they would lose in court as all aspects were carefully addressed by Bremenports.

7.7 Analysis of research tools and methods

7.7.1 Hydromorphological modelling

Description

The hydromorphological software TIMOR3 was used (3D) in the EIA process. For the investigations on the sea surge, the Boussinesq model BOUSWAM was used.

The Instituts für Wasserbau und Wasserwirtschaft of the TU Darmstadt performed the research. TIMOR3 was specifically used to describe the sediment (bed load) and the suspended sediment transport. The TIMOR3 model was used in several studies and considered to be the best at that time (state of science).

The modelling work comprised assessment of the predicted effects of the project on water levels, changes in velocities, morphological changes, influence on the surge and dispersal of deposited dredged material.

The model was updated using the latest soundings undertaken by WSA Bremerhaven. The particle interaction was validated by using results of different laboratory investigations (Zanke, 1995); storm surges of 28 January 1994 were included and weather conditions of the national weather authority (DWD) were included. To predict the effects of the project, the proposed CTIV terminal and other related construction works were included in the model.

The validation of the water levels, flows and streams were made in earlier investigations on the Weser (Zanke, 2000). The disposal of dredged material was considered as a constant purge flow for both disposal areas.

The numerical modelling predicted that only temporary hydromorphological effects would occur, with no changes in sediment composition in the system. Other effects (e.g. on water levels, tidal penetration, large scale morphology) were minimal and temporary and not of significance.

In the vicinity of the proposed quay, minor, localised changes in flow velocities were predicted during the construction phase of the quay; after 1-2 years a new equilibrium would be reached.

Overall, the effects were predicted to be temporary and not significant for the protected species.

Compensation measures were proposed for the direct loss of habitat.

7.7.2 Data and knowledge gaps

Hydromorphology

There were no issues of concern with regards to the 3D model in terms of uncertainties or gaps in knowledge according to the nature conservation agencies. The model was considered to be the best available method at that time and the University performing the research was also one of the best institutes in the field. Uncertainties concerning the model were accepted since no better method was available and, based on experience of using the model for preceding projects, there model was well validated as the predictions compared well with observations in the field.

The legal authority commissioned another party (Bundesanstelt für Wasserbau) to undertake an expert review of the 3D modelling work. The Bundesanstalt für Wasserbau agreed with the methodology and results of the modelling.

Hydrological effects

There was no influence on the groundwater (ZANKE, 2002) because there there is a quay wall that stops any influence to the saltmarshes (salt water loss, or salt water rise). This item was considered not to have gaps in knowledge nor uncertainties.

Sediment quality

Analysis of organic compounds, PAH (Polycyclic Aromatic Hydrocarbons), PCB and heavy metals in the sediment (dredged material) were made. The disposal sites are located in Lower Saxony and it was important to understand the sediment quality of the material to be deposited as well as how the material would disperse following its deposition. This item was considered not to have gaps in knowledge nor uncertainties.

7.7.3 Ecological assessment

Approach

As described earlier, the Weddewardener Aussendeich and Nationalpark Niedersächsisches Wattenmeer SPAs and SACs were not notified to the European Commission at the time of the planning process. However, according to the precautionary principle, the two sites were treated as if they were notified and designated. This means that all the legal procedures of the Habitats Directive were implemented (consideration of alternative solutions, imperative reasons of overriding public interest, and compensation).

The ecological assessments undertaken as part of the EIA and Appropriate Assessments were made using available data and by carrying out additional surveys to fill gaps in knowledge. The conservation objectives and targets and distribution and extent of protected habitats and species were described as if they were designated.

The ecological assessment was undertaken using expert judgement following three steps

1. Identifying the potential sources of ecological impact;
2. Describing how these could influence the various protected species and habitats; and,
3. Making of prediction of the implications for the relevant conservation objectives of the protected species and habitats.

The assessement studies were checked by the authority.

Benthos
An inventory of macrozoobenthos on the margins of the navigation channel was made. No potential impacts of the project on macrozoobenthos were predicted beyond 2 years after the construction phase. It was considered that there was sufficient available data for this aspect of the ecological assessment.

Fish
General fish populations were described using historic data available from the National Park and NLÖ; in additon, data from other studies and monitoring was used. A specific study and survey was undertaken by Küfog (2002) for the project. It was, however, considered that there were large uncertainties concerning this topic, and very little information was known on the distribution of migratory fish in the vicinity of the project and in the outer Weser.

Birds
Bird populations were described using existing data and a survey of feeding and roosting birds was undertaken for one year (April 2001 to April 2002) by Küfog (2002). In addition, experience from previous projects (e.g. CTIII) was used.

Marine mammals
Marine mammal populations were described using existing data (TSEG, 2000) and counts made from an aerial survey undertaken by the Niedersächsisches Wattenmeer National Park. These data are from 1991-2000. No additional surveys were undertaken specifically for the project.

7.7.4 Cumulative effects

There were very few other projects or plans to incorporate within a cumulative impact assessment. The maintenance dredging is the one activity that could potentially give rise to a cumulative impact with the CTIV project. It was concluded that cumulative effects are negligible as both projects, in isolation, had minimal effect on the hydrodynamic and sedimentary regime. The deepening of the Aussenems (-14m) was already completed and no cumulative effects occurred. The further enlargement (-15.2-155 m) of the Aussenweser was only being discussed at the time and too uncertain to take into account in the assessment of cumulative effect.

7.8 Analysis of areas of uncertainty and risk

7.8.1 Hydromorphological modelling

The 3D model was considered the best available technique at that time; it was even criticised as being too detailed for this project, meaning that the grid of the model was too fine. The model could have been coarser and still have produced useful results. There was a lot of experience of using the model through previous projects in the Weser estuary which resulted in a well calibrated and validated model.

Monitoring of earlier projects (CTII project), which also used this model to make predictions as part of the impact assessment studies, demonstrated that the predictions made using this model fitted well with the observations of biologists made during monitoring. Biologists took samples for turbidity and primary production and the results from the field corresponded with the results predicted by the model. This gave confidence to all parties involved that the predictions made using the model were reliable and uncertainties acceptable. All parties supported the use of the model and absolute values were used to describe the effects. Based on the results of monitoring programmes performed by the Water State Authority for the CTIII project it appears that the predictions made during the EIA were accurate.

7.8.2 Ecological assessment

The Nature Conservation Authority (NCA) had to deal with a lot of uncertainties; for example, how to address, in a legally robust way, areas that were not yet designated, a lack of information on migratory fish, what are proper coherence measures, when is compensation sufficient and how to make the permit 'court–proof'.

To deal with the above issues, the NCA firstly scoped the procedure with the stakeholders and, secondly, established a working group with Lower Saxony and other stakeholders to consider compensation requirements. The NCA ensured that all investigations were thoroughly undertaken and there were no (or as little as possible) gaps in knowledge.

The precautionary principle was the most important factor in this project (e.g. into dealing with the uncertainties in prediction of effects on migratory fish).

The compensation measures (habitat creation) were progressed on a 1:1 basis for habitat loss. The habitat creation goal was to replace the habitat type "estuary", not specifically mudflat, reedbed or shallow water, for example. The decision to take this approach was made by the NCA together with the stakeholders.

The main problem and uncertainty in the project related to potential impact on migratory fish given that very little was known about them in the area. Given the lack of knowledge of migratory fish and the prediction that the piling required for the construction of the container terminal could cause severe effects on twaite shad at the population level (through preventing this species from migrating upstream in the Weser) a prominent expert on fish species - including twaite shad - was asked by the City of Bremen for a statement regarding potential implications for these species. He announced that the project could not be performed because of the potential impact on twaite shad.

To get more information and because there were still many questions, the NCA organised a workshop to discuss the potential effects on twaite shad with nine fish experts from northern Germany and the NGOs, to seek a second opinion. The result of the workshop was that the twaite shad could not be so sensitive, and that effects would not be significant for the population if mitigation measures are taken and monitoring is carried out.

In addition, further knowledge on the species in the Weser was gained through a specific investigation undertaken by Bioconsult (in 2002) who investigated the distribution of the twaite shad population. This revealed that the population was viable and stable. An analysis was also made of the results and experiences from other investigations and projects.

Based on all of the above discussions and evidence, the NCA was convinced that there would not be severe harm to the twaite shad population and determined that the risks were sufficiently low to enable the project to proceed.

7.8.3 Uncertainties in the permit decision making process

The NCA sent an additional statement about the outcomes of the ecological assessment (see Section 7.8.2) to the Wasser- und Schifffahrtsdirektion Nordwest, who was the decision-making authority for the project. The Wasser- und Schifffahrtsdirektion Nordwest adopted this statement in the permission for the project. The NCA prescribed monitoring and mitigation measures in the form of a bubble curtain and only one pile a day (preferably by means of vibration) could be put in place during the migratory period. This was equivalent to 1 hour of disturbance a day.

Additional data were collected during the construction of CTIV as part of a monitoring programme for migratory twaite shad during the migration period in a specific area from the harbour to the turning circle for ships. It was clear from monitoring data that the mitigation as regulated in the permit was appropriate and sufficient.

For the NGOs, the main issue of concern was the loss of the tidal flats (the container terminal was constructed on this habitat); the quality of the habitat was considered high. The best locations to compensate for this impact were, however, not available due to landowner issues. Consequently, alternative (less optimal) locations were sought.

The NCAs and Bremenports worked together to identify appropriate locations for creation of compensatory habitat. Two compensatory habitat areas were identifed: Wurster Küste and Grosse Luneplate (see Section 7.1). The compensation area does not have identical quality as the habitat impacted by the project, but it was considered that this was best possible solution and the NGOs could agree with this. A comprehensive monitoring programme was designed for the compensation areas.

Several years later, the Integral Management Plan for the Weser was written and it was clear that the estuary of the river Weser shows a lack of specific habitat types, such as shallow water and mudflats. The focus of compensation was reed beds and saltmarshes, and it appears that intertidal mudflat compensation was minimal. To achieve the goals for the estuary habitat type (H1130), this should be taken into account in the management plan for the Natura 2000 area and special measures may need to be taken. Bremenports also stressed that at the Luneplate, the realignment of the main dike was not accepted by the Federal State of Lower Saxony. A storm surge had to be built, to get tidal habitats behind the main dike, but storm tides are cut from the area meaning this area does not function in a natural way. This is a suboptimal compensation area. For the Wurster Küste the summer dikes are open and saltmarshes are created.

7.8.4 Outcome for the project

Although being against the project, the nature conservation NGOs decided not to go to court as they felt that there were too little grounds (gaps in knowledge or badly performed investigations) to formulate an appeal. They were limited in capacity and decided to focus their effort on other projects rather than to fight aganst this project, knowing that they would lose in court. They could accept the compensation measures as they were the best possible measures at that time. The uncertainties that remained after using the best available methods and data were accepted by all parties.

7.9 Overview of output of the interviews

The cooperation between the stakeholders was very good and the NGOs and Bremenports developed a partnership approach. This helped communication and exchange of information.

The main aim of Bremenports was to find good solutions for environment, economy, ecology and society, but to do this the cooperation of two states was needed. The Federal State of Lower Saxony was so far willing to give this support. The NGOs tried to fight against the need for the container terminal expansion and looked for alternatives, but there were none (also largely due to the different states in the area). This makes the situation quite complex.

The Luneplate is a compensation area that belonged to the Federal State of Lower Saxony (political decision). Both compensation areas, Luneplate and Wurster Küste, were situated in the Federal State of Lower Saxony. After the decision on compensation was arranged, the Luneplate was transferred to the Federal State of Bremen. This was not ideal since there was a building of a storm surge instead of having a natural tidal area.

Ultimately all parties could live with the way the project developed and how the EIA and Appropriate Assessment process was undertaken.

7.10 Conclusions

In total, the project took approximately 4 years to get a permit and to start construction. There were a few uncertainties during the project. Firstly, the Weddewardener Aussendeich and Nationalpark Niedersächsisches Wattenmeer SPAs and SACs were not notified to the European Commission at the time of the planning process. According to the precautionary principle the two sites were treated in the environmental studies as if they had been notified and designated already, and the legal procedures of the Habitats Directive were implemented.

The second significant area of uncertainty was the potential effect of the project (piling) on migratory fish, especially for the twaite shad as very little on the species was known in the area. An expert group was formed and a workshop was held to discuss the effects. In this workshop experience from previous projects in similar estuaries was used. The experts decided that the project could be performed without harming the species, and a monitoring programme was established.

The permit described several mitigation measures, and also a package of compensation measures as tidal habitats were destroyed by the construction of the CTIV terminal. However, there were insufficient appropriate compensation areas in the small Federal State of Bremen and, therefore, collaboration with the State of Lower Saxony was necessary, which made the situation complex.

Two compensation areas were identified after a thorough analysis of other uses. One of the compensation areas was not perfect as a storm surge had to be built for safety, and conditions were not completely natural. It was, however, the best solution at that time.

The NGOs did not go to court as they were short in capacity but, more importantly, they felt they had little chance to win the case as the underlying studies had a solid base and there were little gaps in knowledge or uncertainties. The CTIV project was completed in 2008.

8 Discussion of the outcome of the study

8.1 Approach to the EIA and AA studies

8.1.1 Application of SEA

A notable difference between port development projects within the UK compared with other Member states is that there is no requirement to undertake SEA for plans or programmes that include port developments in the UK. This contrasts with (for example) the Scheldt case study where an SEA was undertaken on a development plan (2010) that stemmed from the long term vision for the Scheldt estuary (established in 2001). The vision comprised the following three pillars and was known as the 'package deal':

1. Conservation of the physical characteristics of the estuary (naturalness);
2. Maximum safety against flooding; and,
3. Optimal accessibility for the ports.

The SEA undertaken on the development plan concluded that the project discussed in the case study (Section 5) would not have negative effects if an improved disposal strategy was applied and alongside the creation of sustainable estuarine habitat.

Through applying the above approach, uncertainty regarding the likely acceptability of the project can be reduced as the potential environmental impact can be understood earlier during the planning stages and there is an opportunity for designing mitigation measures into the overall project. The EIA that is subsequently required for the project itself is therefore based on the earlier consideration that has been given to the project through the SEA process. This approach also has other potential benefits, such as the EIA being able to better demonstrate that alternative approaches (e.g. project design, design of mitigation) have been considered through the SEA process.

For the Eems and Weser case studies, the projects were not included within a wider plan that was subject to SEA; the projects were subject to EIA only.

8.1.2 Defining the scope of the studies

For the case studies included in this project it is apparent that different approaches were taken to define and agree the scope of the EIA studies.

The UK case studies (Humber and Stour and Orwell) adopted a similar approach whereby the scope of studies is defined through a scoping stage of the EIA process. In summary, this involves the production of an environmental scoping report which is typically produced by a consultant team working on behalf of the applicant (developer). The environmental scoping report defines the approach that is proposed for each aspect of the EIA, including details of the methodology to be adopted for technical studies (such as numerical modelling).

Throughout the environmental scoping phase it is standard good practice – but not a legal requirement - to consult with key organisations (such as those with a statutory role, such as Natural England and the Environment Agency) to agree the scope of issues to be addressed within the EIA and the methodology for further studies. The environmental scoping report can then be submitted to the regulatory body which will consult with any organisation it deems relevant and provide a scoping opinion to the applicant.

It should be noted that it is not a legal requirement to seek a scoping opinion, but it is good practice as this can be considered as setting the 'terms of reference' for the EIA. This does not, however, prevent any organisation raising additional issues later in the process (e.g. when they are consulted on the application by the regulatory authority after submission of the EIA), but it does reduce the risk of significant unforeseen issues being raised.

The process followed for the Scheldt and Eems case study was similar to the UK approach in that the research programme for the EIA is defined by the EIA contractor together with the developer. For the Scheldt it was, however, checked scientifically by working groups and by a group of independent experts from different universities (Schelde MER commission) and for the Ems by the EIA Commission who drafted guidelines for the EIA. Governmental organisations and the public also had the opportunity to comment on the research programme during the consultation process.

For the Weser study a similar process was followed. There was, however, no scientific working group or an EIA Commission that reviewed the research programme or drafted guidelines. This was done by the Wasser- und Schifffahrtsdirektion Nordwest (permit authority) together with the NCAs.

8.1.3 Expert review of EIA

For the Scheldt and Eems case studies, a formal review body ('EIA commission') was established to assess the quality and the results of the EIA. For the Eems case study, the advice of the EIA commission was also important in informing the conditions for the permit that is issued by the regulatory authorities.

For both of the UK case studies there was no formal EIA commission established, and this approach is not a standard procedure in the UK generally. However, the formal consultation that is undertaken by the regulator when the application (supported by the Environmental Statement) is submitted effectively constitutes a similar process. During this process, the organisations that are consulted by the regulator review the findings of the EIA and provide their opinion on the quality of the Environmental Statement, its findings, their view on the acceptability of the project and any recommendations for conditions that should be included in the licence (permit).

For the Weser case study, the process was similar to that described for the UK case studies. There was no formal EIA commission established. Instead the regulator initiates the consultation process together witth the Wasser- und

Schifffahrtsdirektion Nordwest (decision-making authority) and the Senator für Bau und Umwelt (NCA). The consultation process and the processing of the remarks of consulted parties are similar to that described for the UK case studies.

8.2 Sources of uncertainty

8.2.1 Numerical modelling

It is apparent from all case studies that the main source of uncertainty in the EIA process is linked to understanding of morphological processes operating within the estuary systems and, in the case studies included in this project, this has implications for uncertainty in a number of areas of the EIA studies. For example, in the Scheldt study, a lack of knowledge on sediment transport studies meant that the exact effects of the disposal strategy could not be calculated and a range was given based on results of the numerical modelling.

In all case studies, numerical modelling was used as a tool to predict the potential impacts on estuarine habitats. It was recognised that all modelling has some degree of error which will always represent a source of uncertainty, and this was acknowledged in all case studies but not necessarily possible to quantify. This is a key aspect for all case studies because the implications of the projects on designated estuarine habitats are the main issue of concern to relevant consultees.

The use of numerical modelling tools was discussed and agreed with consultees as part of the EIA studies for each case study. It was accepted that the tools used were the best available, and most appropriate, in each particular case. However, this does not mean that there are no uncertainties in the predictions made though the numerical modelling, as noted above.

One common theme that emerges from the analysis of the case studies is that organisations that are consulted during the EIA often want the predictions made by numerical modelling to be quantified precisely. This approach can be misleading in that whilst modelling can provide a quantitative prediction (e.g. predictions of annual rate of intertidal erosion), there is a tendency to place too much reliance on such numbers when defining what constitutes a significant effect within the estuarine system. For example, a prediction can be well within the margin of error of the model but, when quantified, is often taken as an absolute effect which is then used to define mitigation and compensation measures. In a number of cases studies (Humber, Stour and Orwell and Scheldt) the interviewees stated that more reliance should be placed on the interpretation of modelling results by experts in the field when considering whether or not an effect is significant. It was considered that interpretation of the results of the modelling by an expert who understands the functioning of the estuary system is more important than the quantitative predictions made through numerical modelling when determining what represents a significant effect.

8.2.2 *Consideration of significance*

The question of what constitutes a significant effect is clearly linked to the determination of whether or not an effect on the designated status of a site is likely and the evidence needed to support this consideration. In the UK, the consideration of potential for 'likely significant effect' under the Habitats Directive is a low threshold; it is often the case that if there is a route for a project to influence a designated site, then this is considered significant within the meaning of the Habitats Directive. This then triggers the need for Appropriate Assessment, with the nature of the evidence need to support this assessment depending to an extent on the likely degree of risk to the designated site and the mechanisms through which the effect of the project could affect the site.

When considering the question of what constitutes a significant effect, there are no universally accepted limits or thresholds (e.g. a change greater than X% is significant). This would be a very difficult mechanism to develop and the application of such an approach would be dangerous because definition of what constitutes a significant effect has to be made on a case by case basis given that particular environmental characteristics prevail in different estuaries. What constitutes a significant effect in one estuary may not be significant in another. Even within an estuary system, an impact that may be considered significant at one point in time may not be significant at another time due to, for example, environmental changes or changes in regulatory or management policy.

For the UK case studies, thresholds were not defined in an attempt to conclude whether or not an effect was considered significant. The approach adopted was to quantify, as far as possible, the predicted effects on habitats within the estuary system and then to develop a strategy to mitigate potential impact (see Section 8.3). In this sense, any potential effect could therefore be considered a significant effect despite the fact that the effects were predicted to be small in the context of the estuary system (particularly for the Humber case study).

In the case of the Scheldt estuary, the view of the environmental organisations was that because the condition of the Scheldt was unfavourable, all possible negative effects associated with the project had to be avoided because any negative effect would be considered a significant negative effect. Given the strategy that was adopted to deal with uncertainties (see Section 8.3), no negative effects were predicted and so there was no debate over what constituted a significant effect. It should be noted, however, that the environmental organisations challenged the premise that no negative effects could occur given the implementation of the strategy proposed (this is discussed in Section 8.3).

For the Eems case, the opinion of the NGOs (represented by the Wadden Vereniging (WV) was that no activity should be allowed as their view was that the Eems-Dollard system is currently in a poor condition. The WV considered that there is significant lack of understanding of the functioning of the ecosystem and that studies are needed to understand what needs to be done to resolve any existing problems in the system. The view was that these issues needed to be resolved before any new activity should be allowed.

8.2.3 Uncertainty related to success of mitigation

An area of uncertainty for the Stour and Orwell estuaries and Scheldt case studies was the likelihood of success of mitigation measures. Although mitigation measures were implemented for the project in the Eems and Weser, there were no specific uncertainties related to the success of such measures.

For the Stour and Orwell case study, one significant area of uncertainty related to the success of mitigation measures (i.e. the programme of sediment replacement) proposed as part of the 1998-2000 Approach Channel Deepening. Maintenance dredgings are discharged from the dredger at certain defined diposal locations within the estuary system adjacent to intertidal areas. Disposals are made under specific tidal conditions that encourage material to disperse over intertidal areas. This represents a novel approach and whilst this technique has since been proven successful, there were uncertainties regarding the likely success of this approach when it was first proposed as it was untested.

Similarly, in the Scheldt case study, there was also uncertainty regarding the effects of the proposed disposal strategy for dredged material.

The approach adopted to deal with these uncertainties is discussed in Section 8.3.

8.3 Approaches to deal with uncertainties

Through the analyses undertaken for the case studies it is apparent that a number of mechanisms have been identified to deal with uncertainties. These mechanisms address both uncertainties that are associated with the prediction of potential impacts and also uncertainties associated with the success of mitigation and compensation measures that are proposed to address predicted negative effects (i.e. to deal with the sources of uncertainty discussed in Section 8.2). These mechanisms are described with the various case studies and are summarised below.

All of the approaches to deal with uncertainties described below were effective in the context of the projects for which they were proposed. In other words, the approaches described are fit for purpose for the particular project and it is not possible to conclude whether one approach is better than another. The principles described below could, however, be adopted and used for projects in other areas, but it is likely that the approach would need to be adapted to the particular circumstances of the project in question.

- Incorporating a project into a wider package of measures

This approach was adopted in the Scheldt project. The proposed dredging to improve accessibility was part of a wider package including safety and naturalness. The fact that the enlargement of the navigation channel was thus counterbalanced by the improvement of the ecological quality of the estuary, ensured that (initially) there was broad support for the project. Subsequently the naturalness part of the package was dropped and, therefore, the port authorities had to try to ensure that project was independent of naturalness part by ensuring no negative effects. A new disposal strategy was adopted to create enough positive effect (though creation of intertidal area) to balance the negative effects of the project. This strategy also dealt with the uncertainty/error in modelling predictions.

- Implementing precautionary compensation

For the 1998-2000 Approach Channel Deepening project in the Stour and Orwell, precautionary compensatory habitat was required in order to deal with the uncertainty associated with sediment replacement into the estuary system that was proposed as mitigation for the predicted increase in rate of intertidal erosion. The area of compensatory habitat allowed for an assumed 5 years of failure of mitigation.

- Compensatory habitat

In cases where an adverse effect on the integrity of a Natura 2000 site is predicted to occur, it is necessary to implement compensatory measures.

As with most compensatory habitat schemes, there is an element of uncertainty with regards to the quality of habitat that will be created and, therefore, whether or not the scheme would deliver sufficient compensatory measures. Given this uncertainty, in determining the compensatory habitat requirement for the Bathside Bay container terminal project in the Stour and Orwell estuaries, a risk-based approach was adopted and a compensatory habitat ratio of approximately 2:1 was required in light of the predicted impact. This contrasts with the Weser case study where the compensation measures (habitat creation) were progressed on a 1:1 basis.

- Legal agreements

One of the key mechanisms for dealing with uncertainty in the Stour and Orwell case studies was the use of legal agreements between the applicant and other organisations, such as Natural England and the RSPB (e.g. Compensation, Mitigation and Monitoring Agreements). Such agreements were seen as crucial as they develop mitigation and monitoring commitments that are enforceable, together with a Regulators Group which has the authority to make decisions regarding the refinement of the mitigation and monitoring programme.

Through the mitigation and monitoring commitments, nature conservation bodies were able to ensure that ‘safeguards’ were built into the mitigation and compensation proposals and this was crucial is providing certainty that the commitments were deliverable. For example, mitigation could be adjusted (scaled up or down) if necessary depending on the results of the monitoring.

Part of the three stage rocket approach that was developed for the Scheldt case study included committments built into the permit to enforce the undertaking of necessary measures to counteract any negative effects of the project and, potentially, to stop the project. In this sense, the Scheldt case study also made use of a legal agreement to deal with uncertainty.

- Dredging and Disposal Strategy

The Dredging and Disposal Strategy developed for the Immingham Oil Terminal Approach Channel Deepening project in the Humber was a key component of the EIA. The measures set out in the strategy would mitigate the potential effect of the increased maintenance dredging commitment on designated habitats by aiming to distribute material throughout the estuary to supplement sediment supply.

This strategy is referred to here separately to the legal agreements (above) because in itself it was not a signed legal document. However, the licence that was granted for the project included a condition that the dredging and disposal operation must be carried out in accordance with the agreed Dredging and Disposal Strategy and, therefore, the strategy was enforceable via the licence.

The flexible disposal strategy developed for the Scheldt case study is a similar mechanism to deal with uncertainty in relation to prediction of potential impact of the project.

- Applying knowledge from past experience

One issue that is apparent from the case studies is that past experience is often crucial in gaining acceptance to a project. The proposed use of a mitigation technique (e.g. sediment management as a measure to mitigate predicted adverse impacts on estuarine habitats) is more easily accepted if it has been previously applied for other projects and has been demonstrated to be successful (or if no adverse impact has been noted as a consequence of the implementation of the project). This has been important in both the Stour and Orwell estuary system and the Humber estuary where evidence from previous projects has been used to demonstrate the effectiveness of a mitigation technique. This minimises the risk and uncertainty for the regulator, and acceptance of the continuation of the technique (with modification if necessary) for subsequent developments has been critical in gaining approval for projects.

- Monitoring programmes

Monitoring programmes were established for all of the projects discussed in the case studies. The main purpose of the monitoring is to verify the predictions made within the EIA process and, importantly, to verify whether the mitigation and compensation measures proposed were effective in meeting their objectives.

The establishment of monitoring programmes forms an important part of managing uncertainty. Such programmes, together with a mechanism to report the findings of the monitoring and make adjustments to mitigation and compensation measures, are important in enabling nature conservation bodies to accept a degree of risk.

- Future estuarine management

One interesting discussion point, that is specific to the Stour and Orwell estuarine system, relates to the habitat enhancement schemes that were constructed on the intertidal areas at Shotley and Trimley in the lower Orwell estuary.

The areas of land behind the seawalls at Shotley and Trimley are designated as Sites of Special Scientific Interest (SSSI) for freshwater habitats and the regulators recognised that, in the longer term, it may not be sustainable to maintain seawalls and, therefore, maintain the freshwater habitats. As a consequence, there is uncertainty regarding what the future policy may be for the management of flood defences and habitats in the longer term.

In light of the above, the regulators stated that it was important that the habitat creation schemes should not be considered to be permanent structures and that they should be designed to evolve and erode over time. This was considered desirable as the habitat enhancement schemes would not constrain future options for the sustainable management of flood defences and habitats in the estuarine system.

8.4 Approaches to consultation

During the EIA processes for the various projects, the consultation process was essentially similar for all of the projects. In the UK, there is no legal requirement to undertake consultations throughout the EIA process, but it is standard good practice to consult as widely as necessary to ensure that the issues of relevance to interested parties are addressed through the EIA process. This consultation is often largely initiated through undertaking an environmental scoping exercise, where a report is normally produced which sets out the issues to be included in the EIA process and the methodology that is proposed to assess those issues (e.g. survey design, approach to modelling). This report is issued to the regulator, which then circulates it for review and comment to those organisations it deems appropriate. The regulator then issues a 'scoping opinion' covering the issues to be addressed in the EIA.

Although in the other case studies there is no process specifically referred to as scoping, there is informal consultation with relevant bodies throughout the EIA process to agree the scope of the studies.

The approach adopted in the UK is perhaps more useful in that the scoping process enables coordination of consultation and the scoping opinion that is issued by the regulator (based on consideration of the environmental scoping report and comments received from consultees) helps define the ‘terms of reference’ for the EIA. This could also affect the time taken to make a decision on the EIA, and issue a licence following submission of the application (and EIA) because, in theory, the EIA should address all the issues of concern to the consultees and the regulator.

For the case studies included in this project, one notable difference was the way in which the consultees were organised. In the Scheldt and Eems case studies the main environmental organisations formed a coalition and consultation was undertaken with this coalition, rather than on an individual basis. This did not occur for the UK case studies, and consultation was on an individual basis. These different approaches did not seem to have significant impact with regards to uncertainty in the EIA processes or how these were addressed.

9 Recommendations

Through undertaking the analysis of the five case studies, a number of aspects have been identifed as good practice measures that could be considered for wider application in other projects. A summary of these measures, which are all related to dealing with uncertainty in EIA and AA, is provided below.

1) Early consultation with relevant stakeholders is a very important part of any project. In addition, consultation should be maintained at appropriate points throughout the project. One of the benefits of this approach is that stakeholders can understand how the studies are progressing, what the relevant issues are and the nature of studies that are being undertaken to inform the EIA and AA process. This approach enables stakeholders to have a better understanding of uncertainties involved in the EIA and AA studies and minimises the risk of challenges to the project when an application is made.

2) Agreeing the scope of work for the EIA and AA with stakeholders is an important part of the consultation process because the studies will then address the issues of importance to the stakeholders. In the UK this is normally done by producing an environmental scoping report which is submitted to the regulatory body. This body then consults with various organisations and provides a scoping opinion on the issues that the EIA and AA should address. A similar procedure operates in Belgium.

3) In terms of EIA and AA studies, the main source of uncertainty appears to be related to the understanding of physical processes and morphological evolution of the estuarine system. These issues should be investigated in detail to lead to a clear scientific view on the current situation and the baseline conditions that are to be used in assessing new plans and projects. If uncertainties or lack of knowledge on physical, morphological or biological processes remains, these should be minimised as much as possible by additional research.

4) As the acceptance of certain mitigation techniques proposed for a particular project can be important for subsequent developments, ports and competent authorities should collaborate in establishing a more systematic approach towards monitoring, so that new evidence about previous mitigation measures (e.g. effectiveness) can be fed back into the scientific knowledge system and – if necessary – also be used for refining numerical models.

5) The appropriate use of conditions on the licence/permit can be a means of dealing with scientific uncertainty with regard to the effects of a plan or project or the related mitigation or compensatory measures. Conditions can define, for example, corrective measures that may need to be undertaken if monitoring reveals that a proposed mitigation measure has not been successful.

6) The establishment of a long term forum, including the developer, stakeholders and regulatory authorities, that is authorised to implement changes to a programme of mitigation or compensation measures on the basis of the results of monitoring programmes can be a valuable mechanism for managing mitigation or compensation commitments. This approach can give comfort to stakeholders that areas of uncertainty and risk that remain following EIA and AA studies can be accommodated and managed through a process of reporting of monitoring and feedback.

7) The use of legal agreements that set out mitigation, compensation and monitoring commitments (and the proposed approach to reporting and management of such commitments) can give regulators confidence that such measures are enforceable and such agreements can form part of the permit / consent for the project.

10 Literature

Alkyon, (2007a). Hydromorphological study for EIA of Eemshaven and EIA of fairway to Eemshaven, April 2007.

Alkyon, (2007b). Hydromorphological study for EIA of Eemshaven and EIA of fairway to Eemshaven. Additional work, detailed 3D-flow model for the Eemshaven, by G. Hartsuiker. Report A1836R3r2, November 2007.

Alkyon, (2007c). Hydromorphological study for EIA of Eemshaven and EIA of fairway to Eemshaven. Additional work, tidal characteristic numbers and storm events, by G. Hartsuiker. Report A1836R4r2, November 2007.

Alkyon, (2008a). Effects of dumping silt in the Ems estuary, 3D model study. prep. for Rijkswaterstaat, Waterdienst. Marknesse, juni 2008.

Alkyon, (2008b). Hydromorphological and ecological effects of disposing cay and boulder clay in the Randzelgat. Prepared for Rijkswaterstaat Waterdienst. Report A1836, November 2008.

Arcadis, (2006). Startnotitie verruiming vaarweg Eemshaven-Noordzee, oktober 2006.

Brasseur, S.I., (2007). Zeezoogdieren in de Eems, cumulatieve effecten van de activiteiten rond de ontwikkeling van de Eemshaven. IMARES Rapport C107/07, 44 p, 2007.

Bremerports (2002a) Nördliche Erweiterung des Containerterminals in Bremerhaven (CT IV). Algemein verständliche Zusammenfassung der Umweltauswirkungen gem. § 6 UVPG. EIA. Head document.

BremenPORTS GmbH (2002b): Ausbau des Containerterminals „Wilhelm Kaisen“ in Bremerhaven (CT IV). Landschaftspflegerische Untersuchung der Auswirkungen von Sandentnahme und Baggergutunterbringung.

BUND FÜR UMWELTSCHUTZ UND NATURSCHUTZ DEUTSCHLAND (BUND) (1999). Meldung besonderer Schutzgebiete zu den Richtlinien (79/409/EWG (Vogelschutz-Richtlinie) und 92/43/EWG (FFH-Richtlinie) des Rates. Hier: Schattenliste für das Bundesland Bremen.

Commissie m.e.r., (2006). Verruiming vaarweg Eemshaven-Noordzee, advies voor richtlijnen voor het milieueffectrapport. December 2006/ rapportnummer 1826-18.

Consulmij, (2007). Ecologische effecten studie. Deelrapport 1 t/m 3, Bestaande toestand/autonome ontwikkeling, Effectenstudie en Baggeradvies. Concept 6 juli 2007.

Consulmij, (2008). Aanvullende notitie vertroebeling (3D effecten). 4 juli 2008.

Court Decision (uitspraak Raad van Staten). www.raadvanstaten.nl

Der Senator für Bau, Umwelt und Verkehr (2003). Nördliche Erweiterung des Containerterminals (CT IV) in Bremerhaven. hier: Naturschutzfachliche

Einschätzung der Verträglichkeit gem. § 34 Abs. 1 Bundesnaturschutzgesetz (BNatSchG) in Bezug auf FFH-Fischarten. Bremen 23 Dezember 2003.

Fricke, R. (2003). Auswirkungen des geplanten Ausbaus des Containerterminals CT IV, Bremerhaven auf FFH-Fisch- und -Rundmaularten in der Unterweser. Stuttgart (Staatliches Museum für Naturkunde Stuttgart), 20. November 2003

Graaf, A.J., van der, (2007). Verkenning bodemfauna vaarweg Eemshaven-Noordzee, rapport 2007-13, Koeman en Bijkerk b.v., Haren.

Haskoning (2009 c). Passende beoordeling (Main document appropriate assessment) Verruiming vaargeul Eemshaven-Noordzee'. In opdracht van Rijkswaterstaat Noord-Nederland.

Haskoning (2009a). MER/EIA 'Verruiming vaargeul Eemshaven-Noordzee'. Hoofdrapport Milieueffectenrapport deel A/B (Main document EIA). In opdracht van Rijkswaterstaat Noord-Nederland.

Haskoning (2009b). Bijlagenbundel Milieueffectenrapport (Appendices)

Haskoning (2009d) Ontwerp-Tracébesluit Verruiming Vaargeul Eemshaven-Noordzee. In opdracht van Rijkswaterstaat Noord-Nederland.

Haskoning (2009e) Tracébesluit Verruiming Vaargeul Eemshaven-Noordzee. In opdracht van Rijkswaterstaat Noord-Nederland.

Haskoning (2010). Aanvullingen Milieueffectenrapport. Suppliments on EIA: Useful use of dregded materials, nautical safety.

Jager Z. & Vorberg, R., (2008). Effecten van de door Nederland voorgenomen ontgrondingen en verspreiding van baggerspecie in de Eems op garnalen en vis. Literatuurstudie in opdracht van RWS Waterdienst. Rapport 08-01, December 2008. ZiltWater Advies en Marine Science Service.

Kleef, H.L. & Jager, Z., (2002). Het diadrome visbestand in het Eems-Dollard estuarium in de periode 1999 tot 2001. Rapport RIKZ/2002.060. Rijkswaterstaat, Rijksinstituut voor Kust en Zee, Middelburg.

Koomans, R.L., Vries, K. de, (2007). Vaargeul Eems, kartering bodemsamenstelling, rapport 2006-P-144R3, Medusa Explorations B.V. Groningen.
Marin, (2007). Nautische risicostudie voor de aanlooproute naar de LNG terminal in Eemshaven, Conceptrapport 25 mei 2007

Küfog 2002a Bauhilfsmasnahmen Sandentnahme und Baggergurunterbringung. Verträglichkeitsstudie nach §34 BNatSchNeuregG

Küfog 2002 b. Ausbau des Containerterminals "Wilhelm Kaisen" in bremerhaven (CT IV). Verträglichkeitsstudie nach §34 BNatSchNeuregG

Küfog 2002 c. Verträglichkeitsstudie nach §34 BNatSchNeuregG. Ausendeich Weddewarden.

Letter from NCA to Freie Hansestadt Bremen with recommendations about the AA.

List of application documents. Verzeichnis der Planunterlagen für das Bauvorhaben Erweiterung des Containerterminals in Bremerhaven um um vier weitere Grossschiffsliegplätze (CTIV).

Movares & Marin, (2008). Eemshaven Vaargeulsimulaties, Deel 1 en 2. Oktober 2008.

Mulder, H.P.J., (2008). Herziening verspreidingsstrategie en hoeveelheden baggerspecie voor de verruiming van de vaarweg Eemshaven-Noordzee en de verdieping en uitbreiding van de Eemshaven.

Nördliche Erweiterung des Containerterminals (CT IV) in Bremerhaven

Objections (Zienswijzen) on the Permit in the frame oft he Nature conservation law.

Permit Nb-wet vergunning vaargeulverruiming Eemshaven-Noordzee

Planfeststellungsbeschluss für den Ausbau der Bundeswasserstrasse Weser durch die nördliche Ergängzung des Containerterminals in Bremerhave um vier weitere Grossschiffsliegplätze (CTIV).

Royal Haskoning, (2007a). Variantenstudie scheepvaartbewegingen Eems,

Royal Haskoning/Groningen Seaports. Definitief rapport, 27 april 2007.

Royal Haskoning, (2007b). Nautisch Deelonderzoek, MER verruiming vaarweg Eemshaven-Noordzee, Definitief rapport, 4 december 2007.

RoyalHaskoningDHV (2012). Evaluation of assessment tools and methods used in Environmental Impact Assessment (EIA) and Appriopriate Assessment (AA). Lot 1 Legal and procedural aspects of the EU Directives. Prepared as part of the TIDE project.

Tebodin Consultants & Engineers, (2006). Passende Beoordeling in het kader van het MER LNG terminal Eemshaven. In opdracht van Eemshaven LNG Terminal B.V.

Vlas, de, J. & Mulder, H., (2009). Notitie over de effecten van verspreiding van bagger op Nederlandse en Duitse mosselbanken. Conceptnotitie.

Wiertsema en Partners, (2007). Waterbodemonderzoek ten behoeve van het verruimen van de Eemsvaargeul. VN 41193. Tolbert, februari 2007.

Wanderfische. Bestandssituation und Auswirkung von Containerterminals CT IV. Protokoll Workshop on migratory fishes. 18.12.2003.

Zanke, U.C.E. (1995). Sachstandbericht zur Entwickelung eines numerischen Modells mit beweglicher Sohle, II – Sohle aus Korngemisch, (hydro-consult-hannover), in beschränkter Anzahl veröffentlicht.

Zanke, U.C.E. (2000). Verfüulung des überseehafens in Bremen. Gutachten im Auftrag des Hansestadt Bremischen Hafenamtes Bremen, Bezirk Bremen.

Zanke, U.C.E. (2002). Hydrodynamisch-morphologisches Gutachten. Erweiterung des Containerterminals in Bremerhaven CT IV. Im Auftrag von BremenPORTS. Unveröfftl. Gutachten.