Appendix 3

Review of Shoreline Management Plans

Southern North Sea Sediment Transport Study, Phase 2
Sediment Transport Report

Appendix 3 Review of Shoreline Management Plans

The following SMPs (Shoreline Management Plans) were reviewed.

Sub-cell	**Area**
2a/2b	Humber Estuary Coastal Authorities Group SMP: Subcell 2a/2b Flamborough Head to Donna Nook (April 1998)
2c	Lincolnshire SMP: Donna Nook to Gibraltar Point (December 1996)
2d	The Wash SMP: Gibraltar Point to Snettisham (December 1998)
3a	North Norfolk SMP: Sheringham to Snettisham Scalp (July 1996)
3b	Sheringham to Lowestoft SMP, cell 3b (May 1996)
3c	Lowestoft to Harwich SMP, cell 3c (May 1998)
3d	Essex SMP Harwich to Mardyke (April 1998)
4a/4b	North Kent Coast, Isle of Grain to Dover Harbour (August 1996)

The date of the SMP is given in brackets in the title.

1. SMP REVIEW SUB-CELL 2A/2B

Humber Estuary Coastal Authorities Group SMP: Subcell 2a/2b Flamborough Head to Donna Nook (April 1998)

1.1 BASE DATA AND ANALYSIS

1.1.1 Hydrodynamics

An offshore wave climate is based on wave hindcast results for the Dowsing Light Vessel (HR Wallingford 1990).

Various sources were used to examine inshore wave climates. The most extensive data set was obtained from the Feasibility study for Holderness Joint Advisory Committee for Coast Protection (Halcrow 1986). Other data sets include those from the Institute for Estuarine and Coastal Sciences (IECS 1992), ABP and Bullens 1994. Further data was obtained from analysis of wave rider buoy data off Flamborough for Dec. 1984 to May 1986 (IOS).

Combined water level and wave conditions were based on analysis by HR Wallingford and Bullens (1993).

1.1.2 Sediment Transport

No new sediment modelling or measurement was undertaken for the SMP. However, there was extensive previous work both in terms of modelling and inferred results from analysis of erosion profiles, identified by the SMP.

Modelling by Posford Duvivier (1992) and IECS (1994) gives consistent sediment transport rates along the shore, ranging from 150,000m^3 to 360,000m^3. Work by Pethick and Leggett (IECS) 1994 indicates the importance of more extreme conditions in moving from a relatively stable to a strong southerly drift regime.

The SMP draws strongly upon estimates of cliff erosion. Eight different estimates are included ranging from 1Mm^3 to 3.5Mm^3 per year. The lower values do not include possible foreshore erosion. Typically, and consistently, 25% of the input is identified as sand and shingle with 75% as mud. Figures of coarse supply range from 250,000m^3 to 1Mm.^{3}. Of this higher figure up to 70% may derive from erosion of the foreshore.

Estimates of input at the northern shoreline boundary are made at 40,000m^3 per year. Stapleton (IECS 1991) suggests the possibility that some of this material is moved back to the north under specific storm conditions.

Drift along Spurn is believed to be less than that for the main Holderness frontage. The northern section of the frontage (Bridlington) is seen as being predominately a separate sediment system.

Work by HR Wallingford (1976) suggested only a limited movement of material below the 18 m contour and this has been taken as the offshore boundary for the SMP.

Only a limited amount of information is reported for the offshore areas. Principal in this is sediment transport pathways determined by Halcrow/ Geosea (1990) suggesting a sediment movement from the shoreline regime at Easington, offshore and from offshore to the coast at Donna Nook. No direct pathway was suggested. Work by Robinson (1968), however, suggests that there is a direct pathway.

To the south of the Humber sediment movement is less well defined. There is little solid evidence of definable quantified drift rates. In part this stems from the complex and extensive sand banks around Donna Nook. Work by Pratt (1983), BMT and by HR Wallingford (1993) all agrees on Donna Nook being a sediment divide: material moving along the shore to Grimsby and south to the Lincolnshire coast.

1.1.3 Morphology

The morphological analysis presented in the SMP draws together previous surveys and studies, together with predictions relating to the erosion of the nearshore area and to the development of hard points and the evolution of Spurn.

Protection of areas of the frontage is recognised as potentially reducing sediment to the coast to the south.

1.2 COHERENCE

In general terms, there is good coherence within the SMP with respect to coarse material longshore transport in the shoreline zone. In terms of sediment budgets, developed broadly from a variety of sources, the input from the cliffs match well the estimates of movement of sediment. Input from the north is relatively small in relation to that along the main beach but is significant in relation to the development of the frontage around Bridlington.

There is a discontinuity in the drift rates beyond Easington, in that more material is moving down from the north than moves along Spurn. This is explained, reasonably, by the movement of sand and shingle offshore: although the quantities and pathway is recognised as being uncertain.

There is strong agreement as to a local circulation pattern from Spurn Head back to the north east through the inshore banks of the Binks.

The SMP tends to be quite linear in its approach, possibly for the reason, shown above, that there is a strong coherence for considering the non-cohesive shoreline drift as a relatively separate system. However, little information is presented as to the exchange pathway of fine materials offshore.

To the south of the Humber, although there is little quantification of sediment movement there is good agreement as to the Donna Nook drift divide.

1.3 CRITICAL ISSUES FOR CONSIDERATION

In terms of the behaviour of the coast, that defined by the SMP (at the broad level of SMPs) demonstrates a good coherence and confidence both qualitatively and quantitatively for the Holderness section of the shore. In effect the main questions arising are boundary conditions.

In the north:

- the sediment supply into the area and to the Smithic Bank

In the south:

- the offshore movement of material at Easington and its possible pathway to the south of the Humber
- The possible closed pathway between the Binks and Spurn
- The fine sediment transfer to and from the Humber
- The fine sediment transport to the North Sea regime
- The influence of the Humber hydrodynamics on the offshore pathways to Donna Nook.

Along the Donna Nook frontage the critical issue is the source of material, and as such is closely linked to the second bullet point above. Further quantification of the sediment divide would be beneficial.

2. SMP REVIEW SUB-CELL 2C

Lincolnshire SMP: Donna Nook to Gibraltar Point (December 1996)

2.1 BASE DATA AND ANALYSIS

2.1.1 Hydrodynamics

An offshore wave climate is based on wave hindcast results for the Dowsing Light Vessel. Inshore wave climates are presented for 7 sites along the 50km. frontage. The initial wave climate and inshore data was obtained from the Mablethorpe to Skegness Sea Defence Strategy Study (NRA1991)(MabSkeg) and extended as part of work undertaken in the SMP. Dominant wave direction is from the NE but inshore wave climates show significant directional spread. The SMP reports that shoreline wave activity is strongly influenced by the nearshore bank systems, particular at the northern end (Donna Nook) and at the southern end (Skegness).

Nearshore tidal flow data was obtained from MabSkeg and from Admiralty data for the offshore area. At both the northern and southern ends of the site the SMP highlights complex laning of tidal residuals. To the north, while the main residual from Donna Nook is southerly, this in effect is split between northerly residuals to the inshore and offshore further south at Saltfleet. Similarly, to the south of the frontage the residuals generated by the influence of the Wash inflow and discharge on the general flow pattern along the open coast results in complex residual currents reflected in and modified further by the nearshore banks off Skegness and Gibraltar Point.

Further offshore only limited information is presented showing a residual flow pattern strongly influenced by the offshore banks.

2.1.2 Sediment Transport

Sediment drift patterns to the north were determined from two sources. To the north data comes from the Anglian Coastal Management Atlas (ACMA 1988) and over the rest of the frontage from the MabSkeg Beach Nourishment Scheme study NRA1995)

In addition to model results, information was provided in the form of extensive beach monitoring dating back to 1959 (possibly one of the longest data sets on the East Anglian coastline).

The general pattern of movement determined from the SMP was that:

- to the north of Donna Nook net drift is to the west (in towards Cleethorpes).
- on the southern side of the Donna Nook System there is significant gross movement but this could vary ion direction year on year. There is little net movement.
- there is a strong southerly movement of material over the central section of the frontage feeding into the complex series of banks adjoining Skegness.
- Material from the nearshore banks is fed to the shore at Gibraltar Point.

From observation the central section of the frontage is characterised by a southerly progressing ridge and runnel system.

Robinson (1956) identified significant draw down of fine material from the frontage to the nearshore channel over winter storms.

McLaren/Halcrow (1990) demonstrated a feed from the sand banks offshore of Donna Nook to the shores to the south.

2.1.3 Morphology

Beach profiles show a general steepening of the beaches along the central section of the frontage. To the north, the Donna Nook bank system appears relatively stable, but with some steepening of the offshore edge. To the south there has been a movement of the Skegness bank to the south, this has been accompanied by a southerly movement of the erosion/ accretion balance point at Skegness, which is put down to increased wave exposure due to the movement of the bank (Dugdale 1995). The SMP identified the importance of the banks at either end of the frontage both in terms of the protection they provide and in terms of their interaction with sediment movement along the shore.

Interaction between tidal flow and the nearshore banks gives rise to turbulent overflows.

2.2 COHERENCE

The SMP suggests a relatively closed system, with little direct transfer of material to the shore to the north, and a closed system of sediment movement in the nearshore bank regime to the south.

There is a recognition that material enters the system, most probably, from the offshore (rather than directly from Holderness (McLaren/ Halcrow 1990) on to the Donna Nook banks. From here, there is a drift divide into the Humber and to a smaller degree to the south.

That there is a deficit between material moving down from the north and the increasing southerly drift from Mablethorpe, is explained in the recession of the coastline evident from long term monitoring data.

At the southern end, the growth and change in the banks and in Gibraltar Point is felt to provide a coherence to the overall system in terms of a sink.

In general this description of the regime seems consistent. There is, however, little discussion of the possible movement directly offshore along the central section of the frontage, and the possible direct interaction with the offshore banks.

An improved SMP interpretation would rely strongly on a better definition of the linkage with the offshore banks to the north and in equating the change in size of the sediment sink to the south with the predicted rates of drift. There is some concern, at present regarding the movement of foreshore recharge, and how this may move beyond Gibraltar Point.

Therefore, while there is a relatively good coherence within the SMP, there are issues either identified or emerging, which need to be addressed, relating to the boundaries.

2.3 CRITICAL ISSUES FOR CONSIDERATION

The main questions arising are boundary conditions.

In the north:

- the sediment supply onto Donna Nook and its subsequent dispersion.

In the south:

- the movement of material within the Skegness and Gibraltar Point system
- the possible feed into the Wash
- the possible movement of material back into the offshore bank systems, either to the north or onward to North Norfolk.

In addition, the offshore banks along the whole frontage are identified as being important in reducing exposure of the frontage. How these banks fit within the broader offshore processes may be critical to the management of dredging.

3. SMP REVIEW SUB-CELL 2D

The Wash SMP: Gibraltar Point to Snettisham (December 1998)

3.1 BASE DATA AND ANALYSIS

3.1.1 Hydrodynamics

The SMP states that measured wave data is only available for a few locations within the Wash embayment itself. Given the variable nature of the bathymetry within the Wash, this data will be very site specific. Wind data was therefore used within a numerical model to generate inshore wave data at more locations. However, the model used had limited ability to account for the shallow water processes that will be of importance due to the complex bathymetry.

Annual maximum tide levels at King's Lynn for return periods of 1 in 10 yrs to 1 in 1000 yrs are quoted within the report, as calculated by Mott Macdonald, 1989.

In terms of tidal currents, the SMP draws on previous field measurements and interpretation. The most recent below surface velocity measurements were those taken by HR Wallingford during the Wash Water Storage Study. More recent surface data has been recorded. However, this cannot be taken as indicative of sub-surface currents.

3.1.2 Sediment Transport

Sediment supply into the Wash has been assessed from both the Lincolnshire coast and from the offshore. This has been achieved using a combination of satellite images, field data and existing research.

Sediment movements within the Wash embayment itself have been interpreted using previous research (much of which draws on the field data from the above noted HR Wallingford Wash Water Storage Study) along with the 1988 Halcrow Anglian Coastal Management Atlas.

3.1.3 Shoreline Movement and Morphology

Within the reports, shoreline evolution is examined using a variety of sources of information. The evolution of the entire Wash coastline was originally examined by HR Wallingford. This work was subsequently extended by Posford Duvivier to become the Wash Extended Shoreline Evolution Report. The findings of this report are utilised alongside several published papers relating to the evolution of the low water mark.

In addition to this, a report for the Nature Conservancy Council by Hill (1988) comparing saltmarsh surveys from 1971 and 1985 has been used to assess the change in saltmarsh area. Finally the work by HR Wallingford (1975) analysing historical bathymetry charts has been used with reference to changes in (a) shoreline position, (b) position and width of channels and (c) the various sand banks.

3.2 COHERENCE

In terms of the general sediment circulation within the Wash embayment itself, there appears to be a good coherence between the results, available study results and the analysis made within the SMP based on hydrodynamics and previous understanding. Observed and calculated tidal current residual circulations match the general observed sediment transport patterns and the isolated pockets of erosion on the shoreline correlate with areas of higher wave energy concentration. Bed sediment distributions are also consistent with wave distributions within the area.

However, there is less coherence in terms of the sediment entering the Wash. The SMP quotes quantities of material transported into the Wash from both the Lincolnshire coast and offshore sources. There appears to be some discrepancy between the quantities estimated as entering the Wash and the level of accretion observed in the area.

3.3 CRITICAL ISSUES FOR CONSIDERATION

Through the examination of the SMP, one main issue can be highlighted as being of critical importance in terms of improving the understanding of sediment movement:

- to allow the effective management of both the coastlines within the Wash itself and the adjacent coastlines of Lincolnshire and north Norfolk, it is important that a coherent understanding is developed of the sediment transport pathways into and out of the Wash.

4. SMP REVIEW SUB-CELL 3A

North Nofolk SMP: Sheringham to Snettisham Scalp (July 1996)

4.1 BASE DATA AND ANALYSIS

4.1.1 Hydrodynamics

In terms of tidal data, the SMP utilises information from the Halcrow Anglian Coastal Management Atlas (1988). The variation in tidal ranges is presented and discussed along with a discussion regarding tidal velocities and tidal current residuals. These current residuals were calculated within the Halcrow work through the use of a hydrodynamic model covering the East Anglian coast.

Extreme water levels are quoted for local ports (Graff, 1981). In terms of waves, data is drawn from the Anglian Coastal Management Atlas and used to describe wave heights and energy distributions. The utilised wave data is used within the SMP to provide qualitative indications of drift directions along the frontage.

4.1.2 Sediment Transport

Within the SMP, previous work relating to sediment transport is drawn together to provide an overview of present understanding along the frontage. In addition to this, transport pathways (Mc Cave 1978) have been inferred using the technique of evaluating trends in grain size distributions. The results of this analysis are in agreement with drift directions suggested through the analysis of wave data. However, the SMP highlights the fact that conflicting evidence exists that implies differing transport directions.

Figures are quoted for the quantities of material moving along the transport pathways. This information has been drawn from previous research, such as that by, Clayton (1993) and Vincent (1979). In addition, figures relating to the overall sediment budget for the East Anglian coast are quoted from the work of McCave (1987) supplemented by Pye (1992).

4.1.3 Shoreline Movement and Morphology

The mean high water position has been examined within the SMP for a period from 1880 to 1970, in order to establish shoreline trends. The limitations of this data has been highlighted within the work and the information has been used mainly as being indicative of relative amounts of change along the shoreline.

The evaluation of morphology within the SMP utilises the work of Pethick and Leggett (1993). Within this work, the interaction between the inshore and the offshore is discussed. In addition North Norfolk is placed into the wider context of the East Coast.

4.2 COHERENCE

With respect to shoreline processes, the SMP has highlighted the conflicting evidence that exists. A number of studies have been presented in the past which, in themselves, provide a degree of coherence for drift along the frontage. However, when considered in conjunction with each other, there does not appear to be a coherent overall consensus for the frontage. The discrepancies that have been highlighted by the SMP are very much localised contradictions that would form the basis of future strategy level studies.

The SMP would appear to have insufficient data in order to fully assess the interaction of the nearshore and the offshore along this frontage. This is an area that has not been examined in detail within the reports.

4.3 CRITICAL ISSUES FOR CONSIDERATION

Through the review of the SMP the following has been found to be of importance with regard to improving understanding for management purposes:

- developing a coherent understanding of drift along the North Norfolk frontage.
- an improved understanding of material movement into the Wash

To achieve this would require localised strategy studies in order to be able to address the issues involved on the correct spatial scale. This task is beyond the scope of the SNS2 project. However, SNS2 does have a role to play in issues at this level. The study should provide input through the provision of the overall context in which such local issues can be addressed; in particular, in defining the transfer of material between the shore and the offshore banks and improving the understanding or confirming the likely drift rates at the boundary to the SMP.

5. SMP REVIEW SUB-CELL 3B

Sheringham to Lowestoft SMP, cell 3b (May 1996)

5.1 BASE DATA AND ANALYSIS

5.1.1 Hydrodynamics

The SMP utilises offshore wave data from the UK Met Office wind wave model from three locations. This consists of time series data from 1991 to 1994. In addition to this hourly wind velocity and direction measurements are available from the Met Office site at Gorleston for the period 1974 to 1986. This data was used within the SMP to produce hourly hindcast values of wave height, period and direction at a point offshore of Great Yarmouth.

Extreme offshore wave heights were calculated, using a GEV analysis, for return periods of 1 in 2 yrs to 1 in 200 yrs. In addition storm reports are developed by and presented in the SMP to identify the severity and frequency of storms. Wave energy was used as an indicator of storm severity

A wave backtracking model was used to transform the offshore waves to 10 previously established inshore locations. These inshore waves were analysed in terms of the distribution of longshore and cross-shore wave energy. This distribution was then taken as being indicative of potential transport rates.

POL time series water level data was used within the reports covering a period of 1991 to 1994 at Cromer and Lowestoft. The extreme water levels quoted within the SMP are drawn from the Anglian Sea Defence Management Study and work by Graff (1980) and Coles & Tawn (1990). Within the work, insufficient data was available to extrapolate combined extreme waves and water level figures.

In terms of currents, the reports state that little measured current data is available for the region. Current data was therefore generated using a hydrodynamic model. The results of the modelling were used to produce tidal residuals presented as vector plots.

5.1.2 Sediment Transport

No specific section is included in the SMP with reference to sediment transport. However, potential sediment transport rates are referred to through use of the results of hydrodynamic modelling. Specifically the inshore wave analysis, referred to above relating to cross-shore and longshore energy distributions, has been used to infer sediment movements. In addition some reference is made to sediment movement within the discussion of the modelled residual tidal currents.

Within the shoreline movement section, rates of sediment supply and drift are quoted from previous research. The two principle sources for this data are the East Anglian Coastal Research Programme (University of East Anglia) and the Sea Defence Management Study (Halcrow).

5.1.3 Shoreline Movement and Morphology

A morphological description of the shoreline is provided within the SMP based on field observations, shoreline photographs and previous work. Specifically two previous reports were used: (1) The BGS, geological synopsis for the Great Yarmouth Shoreline Management Plan (1993) and (2) Anglian Sea Defence Management Study, Stage III (1990).

With respect to the morphology of the offshore area, a description is given within the reports based largely on 3 previous Halcrow studies for Waveney District Council, NRA and Great Yarmouth Borough Council.

Historical charts from 1883 to 1993 were used to assess the position of mean low water through time. A method based on Influence Function Theory was then developed to provide predictions for the future position of the shoreline. This analysis lead to the production of a 'do nothing' retreat line along the length of the SMP frontage.

5.2 COHERENCE

The coherence of the patterns of movement of material provided within this SMP are very much dependent on cross-shore transport. The exchange of material between the offshore / nearshore banks and the coast is fundamental to circulations along this frontage. The behaviour of the shoreline itself is, as a result, determined to a large extent by the cross-shore movement.

5.3 CRITICAL ISSUES FOR CONSIDERATION

Through examination of the SMP, there are two main topics within this region regarding sediment transport which requires further understanding for management purposes:

- the degree to which the direction longshore (or along the coast) movement of material varies over the profile between the shore and the banks.
- the interaction between the coast and the bank systems, particularly with respect to the linkage between different bank systems.

Within sub-cell 3b there is one area within which an understanding of the interaction and exchange between the nearshore banks and the coast is critical to the management of the coast. This is the frontage from Winterton Ness to Lowestoft Ness.

6. SMP REVIEW SUB-CELL 3C

Lowestoft to Harwich SMP, cell 3c (May 1998)

6.1 BASE DATA AND ANALYSIS

6.1.1 Hydrodynamics

The SMP has derived offshore wave data in the form of hourly averaged hindcast values for height, period and direction. For this purpose wind data was used from the Met Office station at Gorleston 1974 to 1986, supplemented with data from the Met Office wind / wave model to extend the temporal coverage to 1994. A GEV extreme analysis was performed on offshore data to determine return periods for extreme wave heights.

In addition to the above offshore wave analysis, storm reports were developed using SANDS to identify the severity of storms and their frequency. Within this analysis storm behaviour was characterised by season, direction and energy.

The REFPRO model was used to develop an inshore wave climate at nine points along the coast. A statistical analysis was used then used to assess average energy flux at each location.

Water level data from March 1992 to July 1994 was acquired from NRA telemetry stations at Felixstowe and Southwold. This was supplemented with POL data to extend the temporal coverage from September 1988 to December 1993. This therefore provided a 6 year record to transform the offshore wave data inshore.

A joint probability analysis was performed to produce data for the 1 in 50, 100 and 200 yr events.
Tidal currents were calculated using a hydrodynamic model covering the East Anglian coast. The results of the modelling were used to produce tidal residuals presented as vector plots.

6.1.2 Sediment Transport

Within this study, no new data has been collected or modelling results produced specifically relating to sediment transport. Instead the report draws on previous research and compares this with inferences that can be made from the hydrodynamic modelling results (waves and currents).

6.1.3 Shoreline Movement

Within the report, historical mean low water data was reviewed to analyse shoreline changes and identify accretion and erosion trends.

This historical information was used within Influence Function Theory to predict future changes in shoreline position. The technique involved using shoreline movement data, obtained from analysis of low water lines from 1884 to 1993, within a coastal evolution equation that predicts the change in shoreline position over time allowing for sea level rise. This analysis resulted in the production of a 'do nothing' retreat line along the length of the SMP frontage.

6.1.4 Morphology

The morphological analysis presented in the SMP draws together previous surveys and studies. The nearshore morphology was assessed using the work from BMT Ceemaid survey (1989) and an NRA survey (1992), along with the Anglian Sea Defence Management Study.
The analysis of offshore morphology utilised previous ABP and Halcrow work [specifically the Coastal Monitoring Study (1998) and the East Anglian Bank System study].

6.2 COHERENCE

In general terms, there is good coherence within the reports with respect to longshore sediment transport in the nearshore zone.

However, the overall coherence of the sediment circulation within the SMP area is very dependent on the interpretation of cross-shore movement of material. This movement of material is cited as being of critical importance along large sections of the sub-cell frontage. Given the existence of nearshore and offshore banks within the SMP area, the movement of sediment cross-shore provides definition to the relationship between the coast, nearshore and offshore regions.

6.3 CRITICAL ISSUES FOR CONSIDERATION

Through the examination of the SMP a number of issues can be highlighted as being of critical importance in terms of improving current understanding:

- the Interaction of the Coast and the Bank Systems

There are two distinct areas within sub-cell 3c within which the cross-shore movement of material has been highlighted as being of critical importance to both the natural sediment circulations that occur and to the maintenance of beach levels. An improved understanding of the precise nature and extent of these circulations and cross-shore movements is therefore vital for management purposes along the frontages.

The two regions are:
(i) Lowestoft Ness to Benacre Ness
(ii) Walberswick to Aldeburgh

- the Mouth of the Deben.

At the mouth of the Deben estuary a mobile system of shingle bars occurs extending from the north side of the estuary, known as the ‘Knolls’, and a further spit extending from the south side of the estuary. These features are known to fluctuate in terms of magnitude and position over time. The features are believed to play a vital role in sediment movement in the area, specifically with regard to sediment exchange from the coast to the north of the estuary to the Felixstowe frontage to the south.

Some of these issues have been addressed in Strategy Studies.

7. SMP REVIEW SUB-CELL 3D

Essex SMP Hawich to Mardyke (April 1998)

7.1 BASE DATA AND ANALYSIS

7.1.1 Hydrodynamics

Wave and tidal flow modelling was undertaken by Shoreline Management Systems (SMS) of the Environment Agency, with extreme water levels and extreme wave conditions determined from Graff (1981) and Halcrow (1988) respectively.

Tidal residuals were determined from the modelling by SMS providing information as to bedload, suspended sediment and net movement. This indicates a clockwise gyre within the southern section of the area, with a general northerly movement along the Tendring area. The centre of the gyre creates a null point along a line east of the Naze. To the north of this line residual tidal flow tends to be to the north.

7.1.2 Sediment Transport

No new sediment modelling or measurement was undertaken for the SMP. Rather, it draws upon extensive research by others. Such work tends to concentrate on the southern part of the frontage within the Thames Estuary. Little quantitative information is quoted for the shoreline drift along the Tendring frontage and Mersea Island, although estimates are included for sediment movement within the Harwich system.

The focus of sediment transport within the SMP is rightly on finer material rather than having the non-cohesive material focus of SMPs further north. Furthermore, the emphasis of the SMP has been on the nearshore and offshore sediment patterns rather than the more linear approach adopted elsewhere.

Veenstra (1971) and Balson and D'Olier (1990) suggest that the southern Essex coast receives little or no non-cohesive sediment supply, although Balson and D'Olier do recognise the reworking of older deposits to provide nearshore beach or offshore bank deposits.

Eisma (1987) calculated (approximately) that there is a suspended sediment volume of 1.5 Mm^3 within the area to the west of the line between the Naze and North Foreland. In comparison to the pool of material the net import of material from the North Sea is relatively small. Some supply is identified as coming from the adjoining marine sources, mainly from the English Channel, with some material possibly coming from the North Atlantic (Eisma and Kalf 1987). Some fine grained material may derive from the cliffs to the north (Suffolk, Norfolk and Holderness).

It is suggested that there is a major sediment parting along a line east of the Naze (Kenyon, Belderson, Stride and Johnson, 1981).

A general interpretation of sediment divides was prepared by IECS for the SMP. These indicate a sediment path from the south towards Clacton, shedding material to the east and west. At the shore this interpretation shows a movement towards the Naze and to the south towards the Colne. At the same time there is a general movement out from the Thames moving north to the Crouch, where the pathway converges with a southward path along the Dengie, before moving offshore under the influence of flows from the Crouch estuary.

The Dengie is seen as a sediment parting zone, with material also moving north to the Blackwater/ Colne system, converging at Colne Point with the sediment stream along the southern part of the Tendring frontage.

The northern section of the area of the Naze is seen as a sediment store area, with material moving from the Clacton area, converging with part of the Harwich circulation system. This latter system suggests movement of some 70,000m^3 coming from the north (the Felixstowe frontage) feeding the Cork Sands from whence it feeds into the Harwich sink.

Other interpretations suggest movement north to the Naze, with the possibility of material from Tendring and from the north moving out into the Suffolk and Norfolk offshore bank system and south into the Thames Gyre (Eisma and Kalf 1987).

7.1.3 Morphology

Various works are reported on the Thames banks system. Considerable emphasis is given to the balance between sinks and sources, and to the anticipated need for additional materials to compensate the present system for the influence of sea level rise.

At present, generally the system is seen as keeping pace, with inputs matching the need for deposition. It is anticipated that with predicted sea level rise there may be a need for a doubling of inputs to the Thames system.

7.2 COHERENCE

In itself the SMP infers a coherent pattern of movement. It is however quite different from that put forward in Stage 1 of SNSSTS, particularly with respect to seabed sediments and in relation to the location of sediment parting zones. The same evidence appears to have been used in both interpretations and highlights the possible weakness in lack of data at critical link points.

7.3 CRITICAL ISSUES FOR CONSIDERATION

Clearly there are some fundamental issues which need to be addressed. There appears to be:

- uncertainty and lack of consensus as to the location of the offshore parting zone associated with the Thames
- a significant lack of understanding as to the processes within the Naze/ Harwich system.
- associated with the above, uncertainty as to the nature and supply of the Clacton Sediment corridor.

Influencing all these are the definition of sinks and sources and the balance of flux and reservoir of material present within the area.

8. SMP REVIEW SUB-CELL 4A/4B

North Kent Coast, Isle of Grain to Dover Harbour SMP (August 1996)

8.1 BASE DATA AND ANALYSIS

8.1.1 Hydrodynamics

Offshore wave conditions were obtained from hindcast results based on offshore location 1.94 E and 51.25N. Wave transformation inshore was modelled using SCATTOR and WATRON of Delft Hydraulics. The results were verified through inshore wave data at Tankerton.

Tidal modelling was undertaken using a nested model TRISULA developing on the North Sea Model Znwkbol (Dutch Department of Transport and Public Works).

Various other sources of information were used to support the new data created by the above modelling exercise.

8.1.2 Sediment Transport

Sediment transport modelling (UNIBEST LT) was undertaken for the SMP, using beach profile and observational data as a check. Other studies were incorporated into the overall assessment of the nearshore processes.

Work by Dobbies and Partners (1990) and D'Olier (1989) on cliff recession and potential sediment supply was also considered in developing the overall interpretation for the frontage.

Cross shore movement of coarse sediments was considered, but not felt to be of significance generally along the frontage. However, there was a recognition of significant transfer of sediments between the beach and Margate Sands identified by D'Olier (1989, 1993). This work also identified links between these sands and the Goodwin Sands.

The SMP puts forward a pattern of non-cohesive sediment transport linking the shoreline processes closely with the Margate Sands. The general pattern of drift indicates a focussing of material on the Swale Estuary. Annual average drift rates from the west, along the face of Sheppey East amount to $1000m^3$ to $3000m^3$. To the east of the Swale, drift is consistently westward but increases from $3500m^3$ at Margate to $16000m^3$ along the Whitstable frontage. The variation or discontinuities are explained as resulting from supply from cliffs, areas of erosion and accretion and feed to and from the Margate sands and the Hook of Margate.

Beach profile data and estimates made on more local sites, particularly at Whitstable, suggest that the predicted drift magnitude is possibly an order of magnitude too high.

In terms of suspended sediment movement, the SMP develops its argument based on residual currents determined from the modelling. This indicates a net movement from west to east, with a movement out, into the outer Thames estuary, offshore of Herne Bay. It also shows a significant gyre offshore of Margate.

8.1.3 Morphology

Discussion of sinks and sources within the SMP tends to focus on the shoreline, with a discussion of potential sediment supply from the cliffs, from recharge and sand streams from the Goodwins and Margate

Sand. The SMP identifies the weakness in information on sources and sinks, particularly in regard to fine sediments.

8.2 COHERENCE

With the quantified drift rates, it might be expected that the Swale Estuary would quite rapidly accrete. In fact there is some debate as to whether this estuary is ebb or flood dominated and certainly there is little evidence to suggest that it is receiving the quantity of beach material predicted. There is, therefore, good evidence to support the lower drift rates observed rather than those modelled. The pattern of sediment movement is, however, consistent with observations, providing a believable regime along the shore.

This overall coherence is dependent on the hypothesised interaction with the nearshore banks.

In terms of fine material, while the pattern of movement is not inconsistent with other data, it does not sit comfortably with either the model predictions produced in the Essex SMP or with the broader picture given in Phase 1 of SNSSTS.

8.3 CRITICAL ISSUES FOR CONSIDERATION

The potential discrepancy between predicted and actual rates of shoreline drift are not seen as significant in the context of SNS2, although clearly there is a need to resolve this issue better at a local level.

The main critical areas are:

- the need to reconcile the movement of suspended sediment. This is critical in providing a better understanding of the behaviour of the estuaries. Along with this is the need to relate such movement to the larger capacities of sinks within the Thames Estuary.

- the need to confirm the link, or effective absence of a link, between the Margate Sands and the northern side of the Thames. While there is strong evidence for the link between the shore and the bank, it is necessary to establish what links there may be between the Sands and the broader area.

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