

***BEST PRACTICE IN
ESTUARY STUDIES:
Data requirements***

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**A Guide to Prediction of Morphological Change within
Estuarine Systems**

Version 1B



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What does the guide do?

- It explains the data requirements for a hydraulic (morphological) study
- It provides a systematic approach to undertaking a morphological study
- It provides the project proponent (estuary manager) with a variety of prompts as to how to gain confidence in the results of studies undertaken on his/her behalf

Generic approach

- Scoping
 - Analysis of existing data
 - Collection of new data
- } *Data requirements*
- Application of predictive method(s)
(calibration, validation, sensitivity and scenario testing)
 - Synthesis and development of conceptual model
 - ‘What-if’ testing
 - Presentation of results

Confidence and Credibility

- Quality (and quantity) of data
- 
- A robust conceptual model
- 
- Confidence in the results (certainty)

Confidence and Credibility

RUBBISH IN
↓
RUBBISH OUT

Analysis of existing data

- Consider a wide range of potential data sources
- Sources include: bathymetric surveys, maps, photographs, LIDAR, CASI, boreholes/cores, surface sediment samples, archaeological data
- Data on historical activities (locations of dredging, dredging volumes, sea level rise, reclamation, vessel movements, fluvial flows, abstraction, sediment supply)
- Data on episodic events
- Check quality of data, datums and projections
 - TRUST NOTHING WITHOUT CHECKING

What data?

- Bathymetry/Coastline/Topography
- Tidal levels, waves, currents, salinity, water quality
- Seabed sediments, Suspended sediments, bedforms
- Sediment and Sedimentary Characteristics
- Biota, vegetation
- Geological

Collection of new data

- To understand process
 - If no existing baseline exists
 - For calibration and validation of methods
 - Ensure quality of data is adequate
 - Be aware of errors inherent in the method used
 - Ensure that new data complements existing data
 - Consult before collection of data. Make sure the surveyor knows what the data is being used for.
- Not a trivial task

Collection of new data

- Collection requires permission (FEPA, Notice To Mariners)
- Be aware of time and cost implications

Data uncertainty

- Data is paramount to a study. Allow adequate time to review it, prior to analysis and use in modelling.
- Errors/queries often don't arise until the data is used in earnest. Ensure that those providing the data have resources to provide follow-up support.

How relevant is data

- Decisions about the relevance of data need to be made by an experienced person
- This can be a huge task, and time-consuming
- Equally, when providing data, don't assume what is needed or leave anything out

Data for modelling

- Setting up a model
 - Defining the model domain, limits, bathymetry
 - Defining the model boundaries and how you will drive them
- Establishing calibration data
 - define target performance before running - what are you aiming to achieve, given that you won't reproduce exactly
 - performance statistics to aid calibration
 - Don't expect the data to be right!

Bathymetric data (1)

- Bathymetric data is used for:
 - Establishing the history and rate of change of morphology
 - In running the baseline simulations
 - For providing calibration data for sediment transport models
- Bathymetric data needs to be detailed and consistently measured or its use becomes limited

Bathymetric data (2)

- Sources of Bathymetric data :
 - Surveys (usually navigation channels but sometimes intertidal)
 - Admiralty Charts
 - LiDAR
 - Dredging surveys
 - Aerial photographs and satellite images
 - OS maps (MHW, MLW)
 - Beach profile surveys
- Bathymetric data can contain errors
- Navigation surveys are usually biased towards the high spots

Bathymetric data (3)

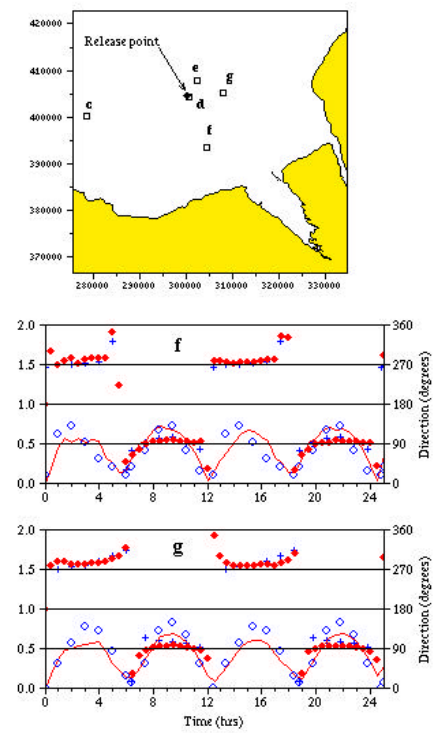
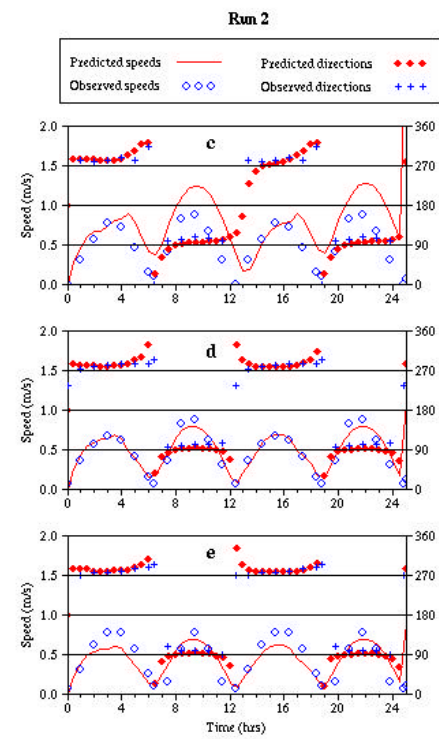
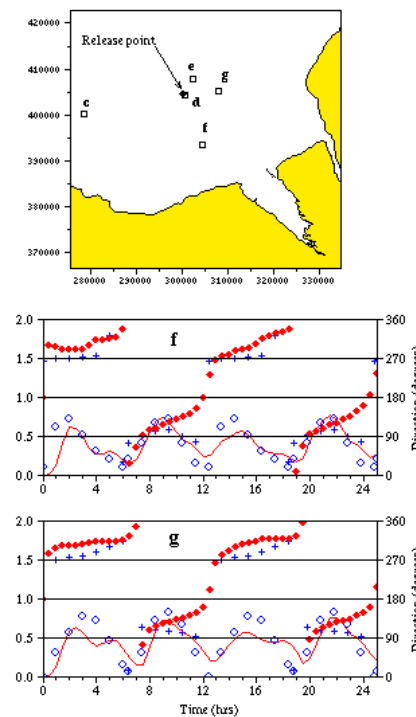
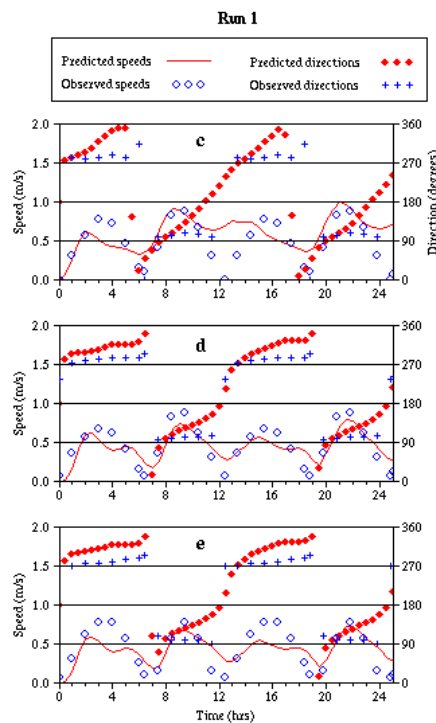
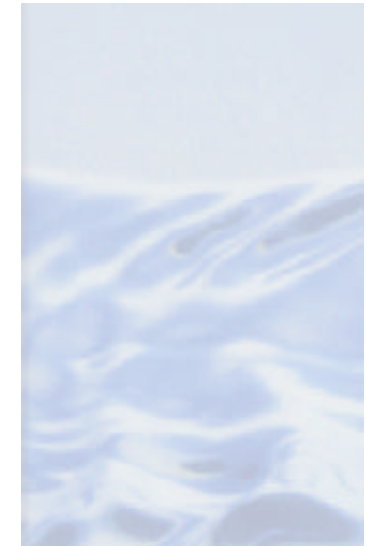
- Coverage of Bathymetric data :
 - Subtidal (e.g. boat survey)
 - Intertidal (LiDAR, land survey)
 - Coastline - do you really know where it is?!
- Beware of mixing data sets
 - Different survey methods
 - Different datums
 - mis-match due to morphology change

Flow data

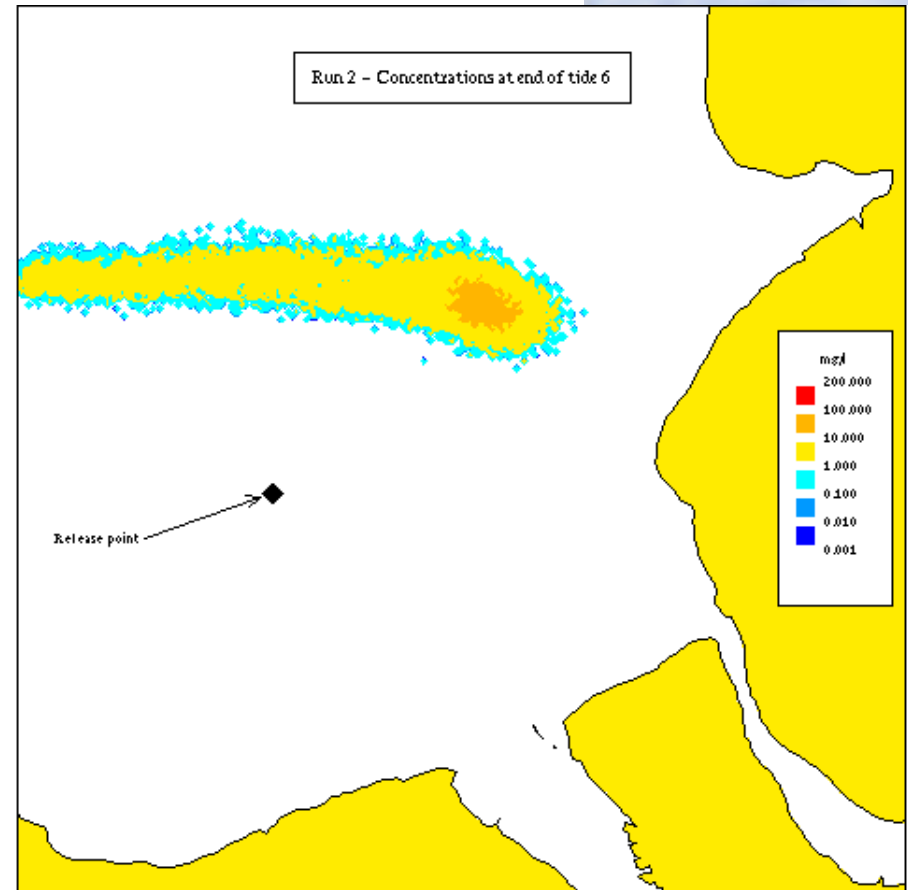
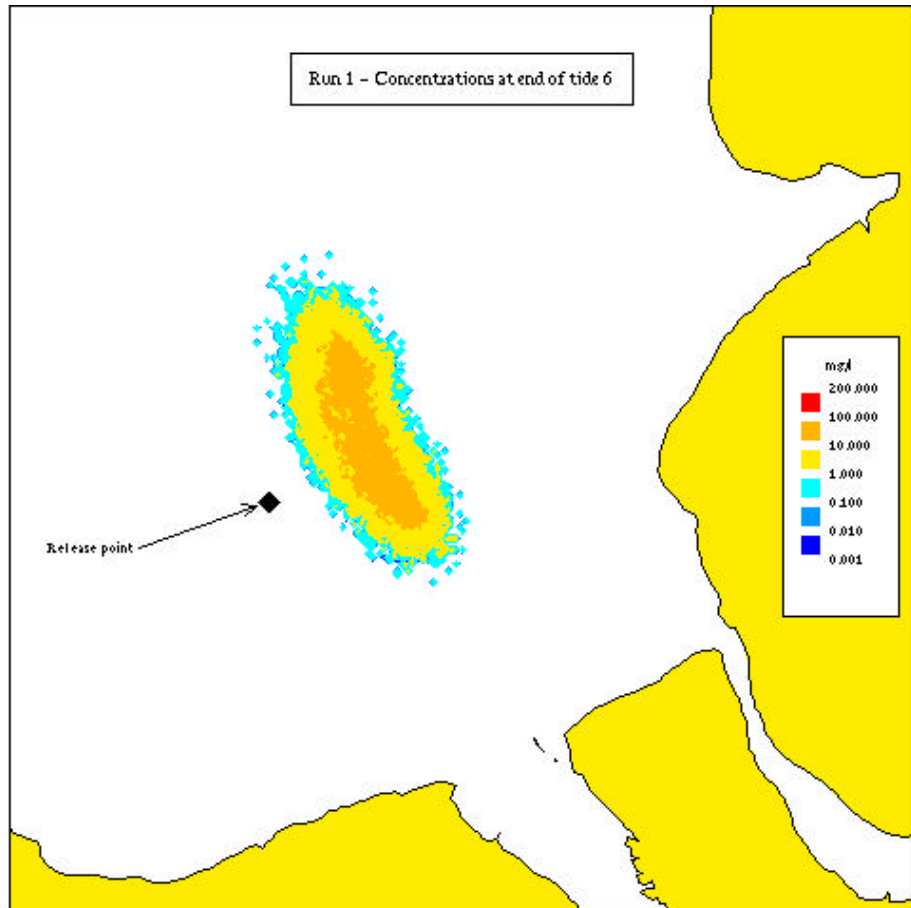
- ADCP
- Bed frame measurements
- Current meter
- Admiralty Tidal Diamonds
- Float tracking
- Water levels (*tide gauges, etc*)
- (Salinity measurements)

Flow data (2)

“.... and it can be seen that the model reproduces the observations well.”



Flow data (3)



Wave data

- Non-deterministic
- Offshore-generated and locally-generated
- Need for offshore wave climate information
- Need for inshore wave climate information
- Need to reduce to a manageable set of representative events

Sediment transport data

Sand

- Proper measurements - expensive, and perhaps non-representative (collected on calms)
- Morphological change
- Dredging records & other mechanisms (ship passage?)
- Bedforms
 - side-scan and multi-beam sonar

Sediment transport data

Mud

- Concentrations
 - ADCP back scatter
 - Water samples
 - Optical device measurements
 - Deposition/erosion
 - Morphological change
 - Dredging records
 - bed density
 - Settling velocity
- } Without (and sometimes with!) something to compare against the prediction error can be large



Sediview on the River Thames, London

*A demonstration survey undertaken by
Dredging Research Ltd and HR Wallingford
for The Port of London Authority*

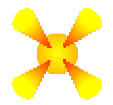
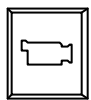
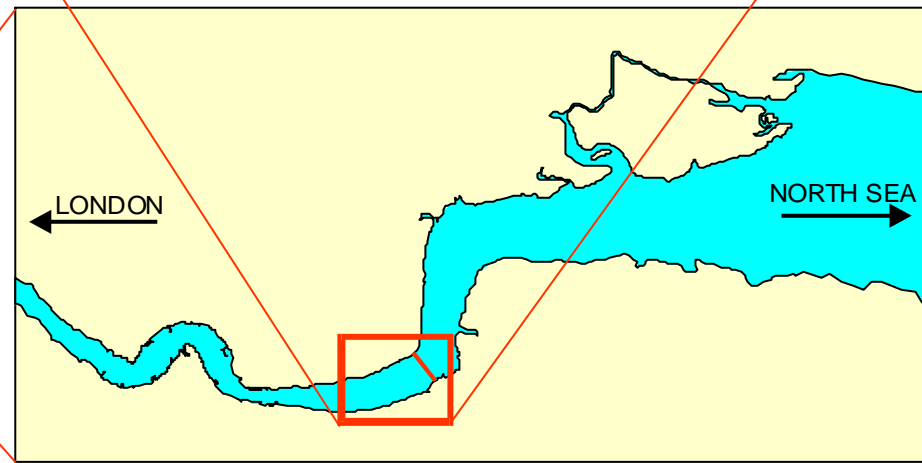
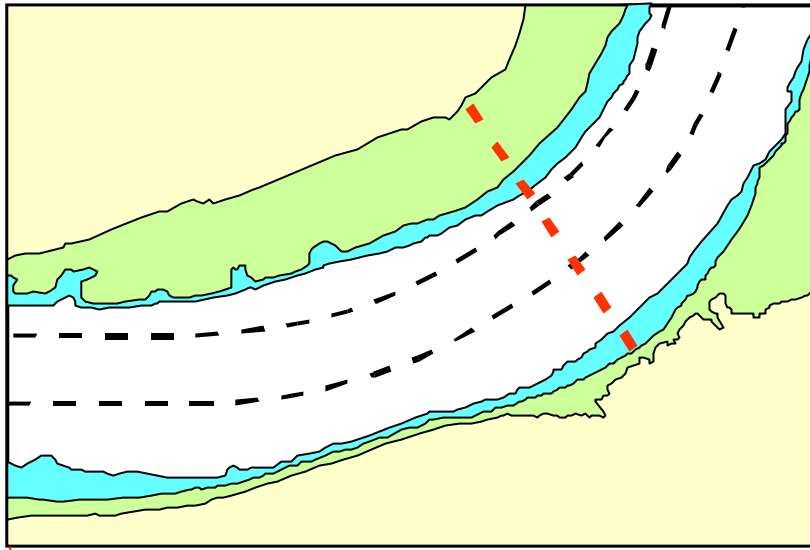


HR Wallingford



DRL Software





Dredging data

- Usually dredging data is the only way of calibrating the deposition/erosion parameters in a sediment transport model
- Decent dredging records (where, when and how much) are an *extremely* valuable resource
- They also need to be kept over a decent period to be reliable
- Plan well in advance of your development
 - start collecting now!

Dredging data (2)

Types of Data:

- (Repeat) bathymetric surveys following a dredge
- Pre-post dredge bathymetric surveys
 - Good since these tell you exactly what was taken from the bed
- Hopper loads
 - Leaves out what was lost into suspension
- MAFF (DEFRA) Database
 - Only tells you (some of) what was disposed

History of management

- Anthropogenic effects
 - archaeology
 - embanking/land claim
 - training/dredging/disposal
 - foreshore/dune management
- Anecdotal/local information/old records

Data for long term prediction

Date requirements similar to short term modelling. Additional data needs may include:

- Climate change data
 - sea level change
 - history of wind and waves climate
- Synoptic historical data sets

Data for long term prediction

... and geological data

- Bedrock geology
 - thickness, hardness
- Surface geology
 - geotechnical properties
 - age structure
 - sedimentation rates
- Tectonic movements - rate and direction
- Sediment sources
 - type
 - scale
 - rate of supply

Demonstration Projects

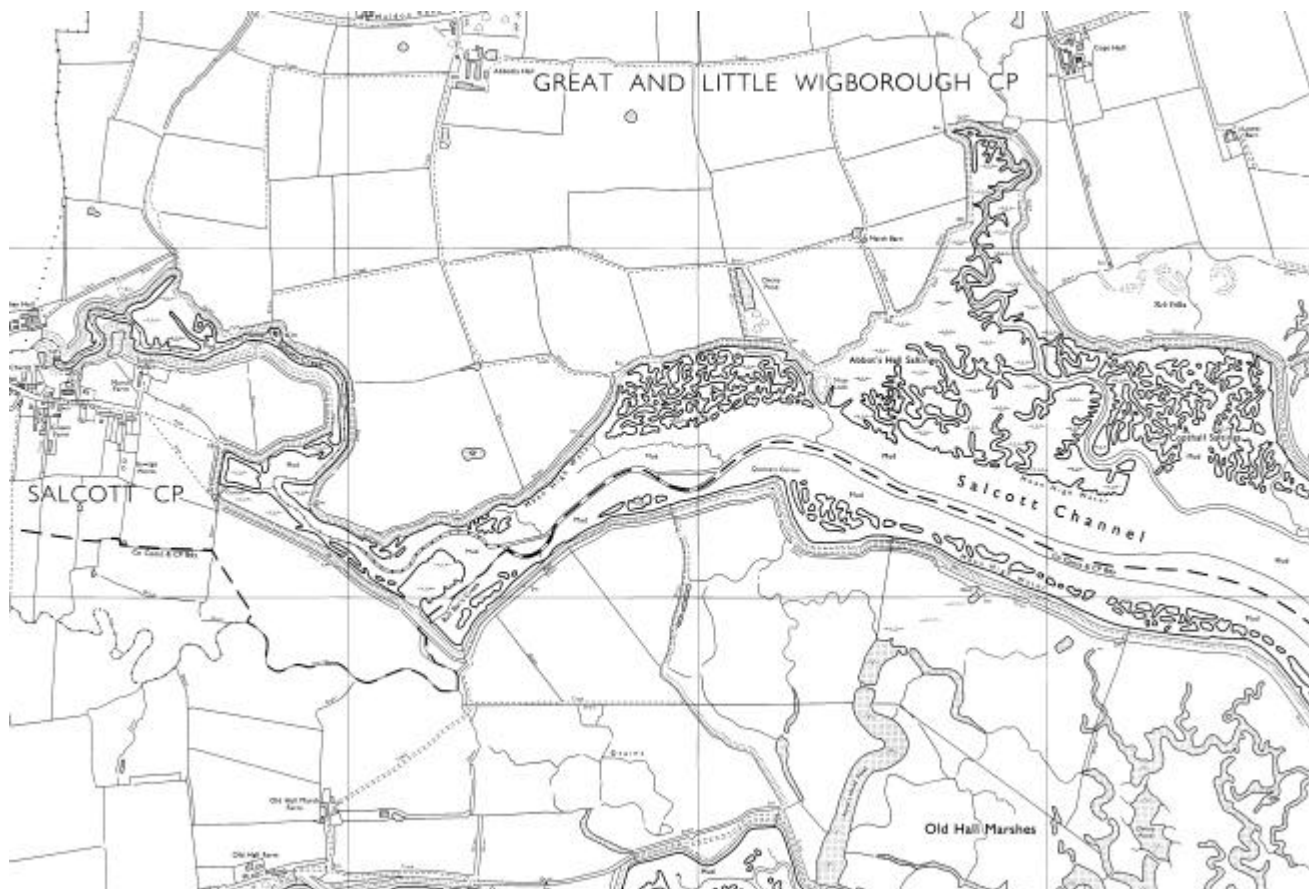
Choice of projects

- Funders decided that best practice should be disseminated through demonstration projects
- These demonstration projects were to be chosen through consultation with end-users
- Consultation with Blackwater stakeholders resulted in the choice of Managed realignment in Salcott Creek as a demonstration project

Blackwater Demonstration Project

Salcott Channel

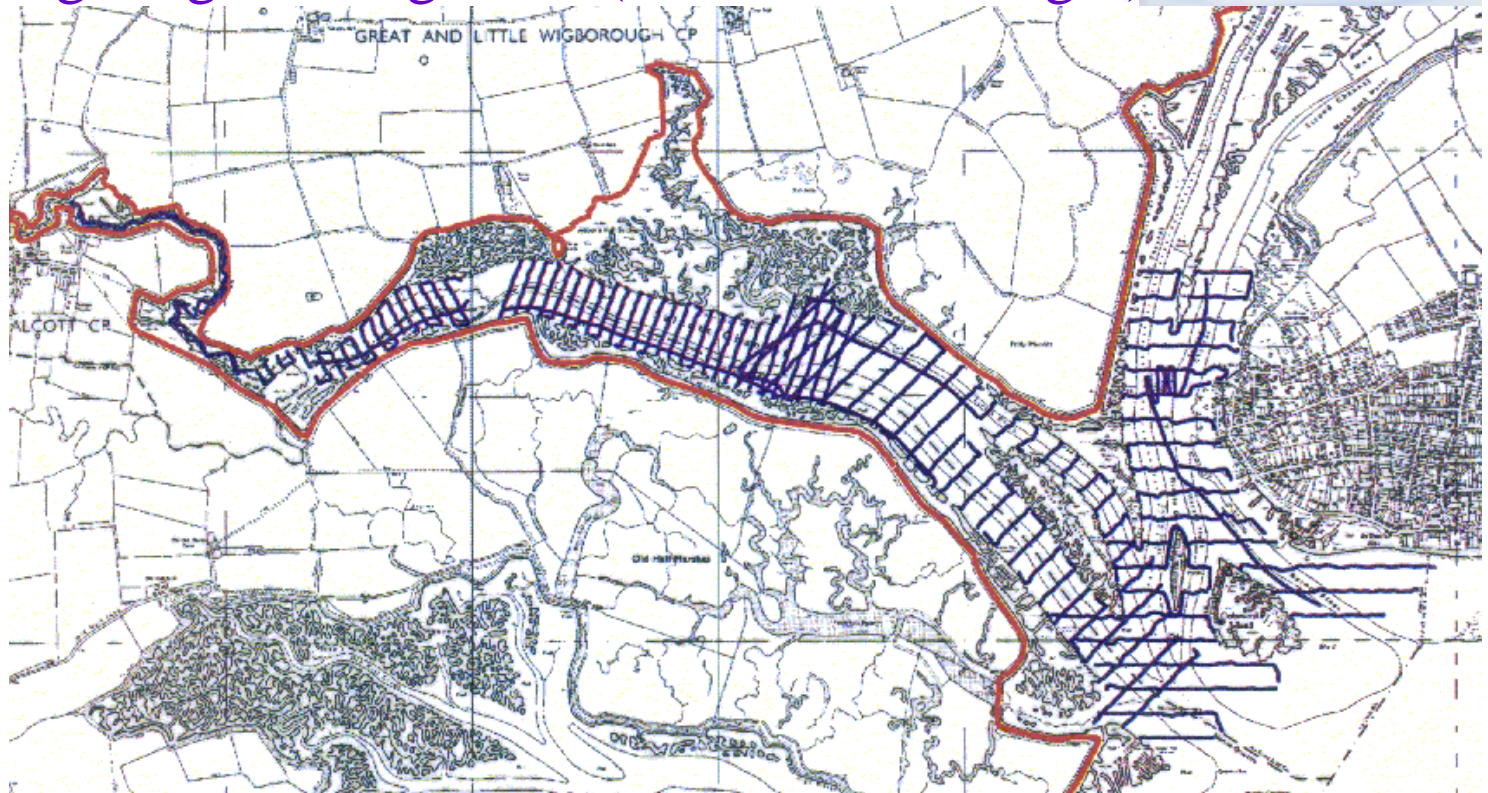
Real case of a study of the impacts of five breaches on the nearfield/ farfield morphology of Salcott Creek



Blackwater Demonstration Project

Bathymetric Data required

- Bathymetric survey of subtidal - full estuary (Salcott)
- LiDAR to cover the intertidal
 - ground truthed
 - what is it giving the height of? (when was the flight)
 - Errors?



Blackwater Demonstration Project

Flow Data required

ADCP

Simultaneous Currents at 3 locations for a period of one month

TIDAL LEVELS

Simultaneous levels at 6 locations for a period of one month

REPEAT SURVEYS ANNUALLY FOR 5 YEARS

Blackwater Demonstration Project

Flow Data required

Freshwater Discharge
Very low (usually)

Waves
Measured at the entrance to the Estuary (very low)

Blackwater Demonstration Project

Sediment Data required

Suspended Sediment Concentrations

Simultaneous at 3 locations over spring and neap tides

NB representativeness?

Blackwater Demonstration Project

Other Data

Nature of the seabed along the estuary
Erodible mud or eroded gravel?

Additional data regarding freshwater input and SSCs

Anecdotal information for context. The need to liaise with other stakeholders and the risks of this

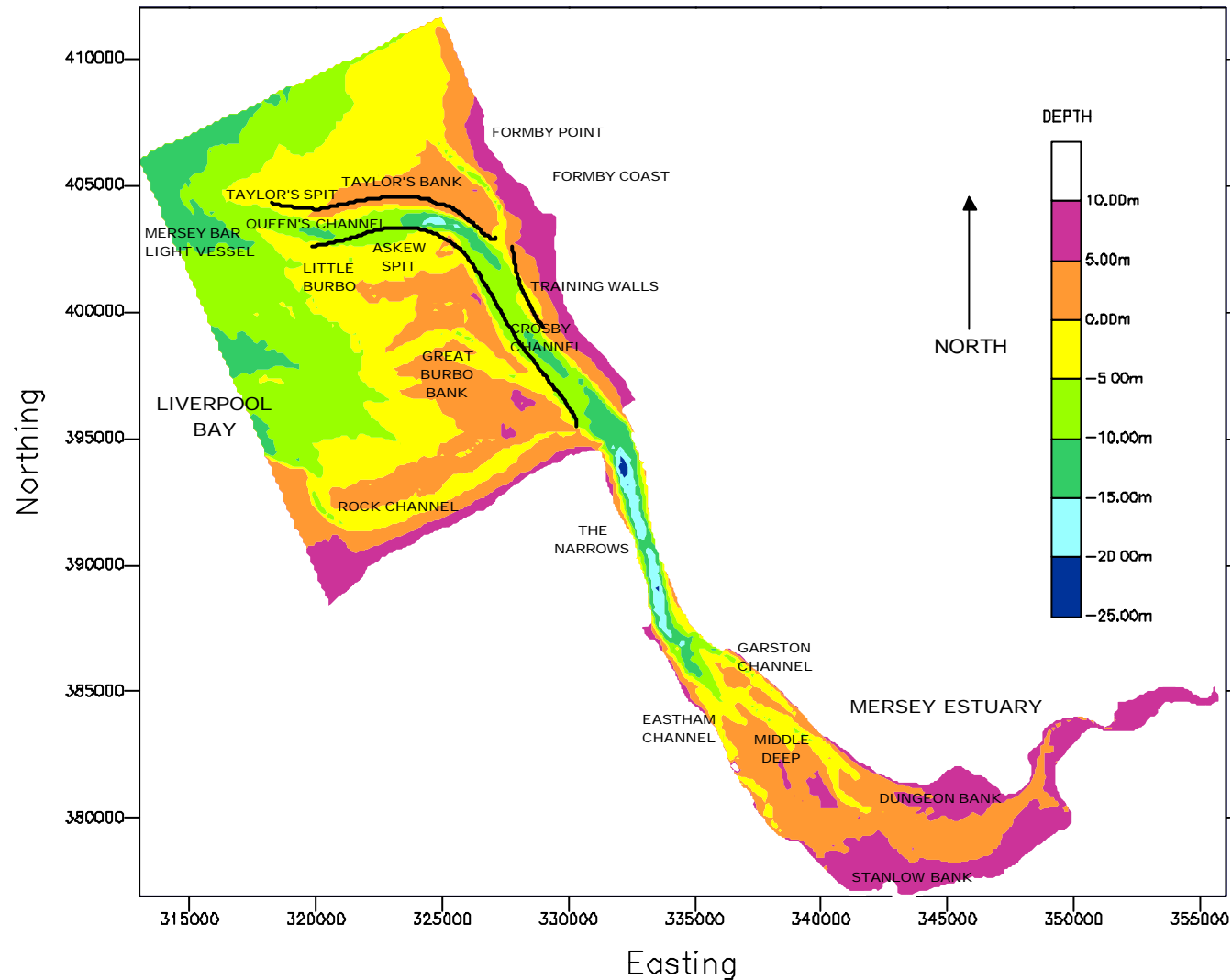
Mersey Demonstration Project

Introduction

- Consultation with Mersey end-users resulted in the choice of “removal of the training wall” as a project
- Our demonstration project considered a part removal of the training wall
- Though this type of scheme is not relevant for most estuaries the demonstration project should be viewed as typical of major works near the mouth of an estuary

Mersey Demonstration Project

The Mersey Estuary



Mersey Demonstration Project

Bathymetric data required

- Surveys of Liverpool Bay
 - Historic and up to date. Obtain as many as possible
- Surveys of Mersey Estuary
 - These available every 5 years from 1871 to present date along 100 or so transects downstream of Runcorn
 - These also cover the intertidal
- LiDAR
 - This will improve the coverage of intertidal areas in models, can cost a lot for a big estuary

Mersey Demonstration Project

Flow data required

- ADCP
 - Simultaneous transects throughout Liverpool Bay and Mersey Estuary for different tidal ranges
 - Number of transects will depend on sensitivity of scheme/probable size of impact
 - This is very costly

Mersey Demonstration Project

Flow data required

- Tidal water levels
 - Required for calibration
 - Required for offshore boundary condition (Proudman Ocean Laboratory)
- Discharge data
 - fluvial flow data field measurements

Mersey Demonstration Project

Flow data required

- Salinity data
 - Need to measure salinity over time at various points throughout Liverpool Bay and estuary on days when field data is taken
 - Through-depth profiles at middle of ADCP transects would suffice

Mersey Demonstration Project

Wave data required

- Wind data
 - Met Office or similar record
- Wave data
 - offshore measurements
 - Met Office model
 - Previous studies

Mersey Demonstration Project

Sand transport data

- Sand flux measurements
 - at locations throughout navigation channel and in estuary
 - For relatively small impacts may be enough to use measurements taken for Mersey Barrage Study (in Narrows)

Mersey Demonstration Project

Mud transport data

- ADCP backscatter
 - At transects throughout estuary and navigation channel
 - Number of transects will depend on sensitivity of scheme/probable size of impact
 - Uses same data as flow measurements but need LOTS of water samples and optical measurements to calibrate backscatter data - analysis of samples is a further cost

Mersey Demonstration Project

Other data

- Dredging data
 - Require everything that there is
 - Conservator reports
 - Contractor/operator surveys
 - MAFF (now DEFRA) database of placements
 - Need to calibrate sediment deposition and get mud sediment budget for estuary
- Density profiles
- Geological data (BGS)

Mersey Demonstration Project

Other data

(If impact on SPA significant)

- Data on saltmarsh changes
 - CASI
 - Airborne photography
 - Old charts
- Location of drainage/flood defence structures

Mersey Demonstration Project

Other data

(If impact on coastline significant)

- Beach profile surveys (Sefton Council)
- Dune erosion/accretion measurements (Sefton Council)

Data requirements

Conclusions

- Misconception that there is enough data that can be sourced
- Data is (generally) site-specific
- Data is fundamental, but provision is not the end of the problem
- Collection is time-consuming and expensive
- Review is essential (and also time-consuming and expensive)
- Need to keep flexible, and budget for actions arising from the review