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APPENDICES

to the

ENVIRONMENTAL IMPACT STATEMENT

supporting Able UK Ltd's Planning Application (January 2005)

for

Ship Recycling & Wind Turbine Manufacturing at TERRC, Hartlepool

RPS Planning, Transport and Environment

Seaton Port TERRC Facility

Environmental Impact Statement

Appendices

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RPS

January 2005

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Appendices

Appendices relate to sections of the EIS – if there is no appendix number that means there is not reference to an appendix in that section.

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Appendix 1.1

Types of Vessels, Marine Structures and Other Craft

Main Planning Applications Drawings

Appendix 1.1

Types of Ships, Vessels, and Other Craft Main Planning Applications Drawings

TYPES OF SHIPS, VESSELS, AND OTHER CRAFT WHICH CAN BE BROUGHT TO THE TERRC FACILITY FOR REPAIR, REFURBISHMENT OR DECOMMISSIONING, OR MAY BE BUILT THERE, OR FOR WHICH SECTIONS CAN BE BUILT DURING REPAIR AND REFURBISHMENT OPERATIONS

All types of ships that may be delivered to TERRC either on a floating vessel such as a barge or delivered under its own power or delivered by being towed include but not limited to:-

Aircraft Carriers
Amphibious Vessels
Barges
Battle Ships
Bulk Vessels
Buoys
Car Carriers
Cargo Vessels
Casualty Reception Vessels
Coast Guard Vessels
Container
Crane Ships
Cruisers
Destroyers
Dredgers
Dumb Barges
F,P,S,O
Ferries
Fish Factory Ships
Fishing Boats
Fleet Support Vessel
Floating Dry Docks
Frigates
Hospital Ships
Landing Craft
Large Barge Vessels
Lifeboats
Light Vessels
Liners
Livestock Carriers
Lo Lo (Lift on Lift off)
Lt.House/Buoy Tenders
Mine Warfare Craft
OBO (Oil/Bulk/Ore)
Passenger Ships
Patrol Craft
Reefer Vessels
Ro Ro (Roll on Roll off)
Submarines
Tankers
Target Vessels
Torpedo Boats
Tugs
Whalers
Wood Chip Carriers
Work Boats
Yachts

Name	**Drawing No**
Main Planning Application	SP/0/04/12/80
Cofferdam Option No. 1	SP/0/04/12/81
Cofferdam Option No. 2	SP/0/04/12/82
Blade Manufacturer Building A Plan	SP/GH/0/04/12/100
Blade Manufacturer Building A Elevations	SP/GH/0/04/12/101
Tower Manufacturing Building B1 Plan	SP/GH/0/04/12/102
Tower Manufacturing Building B1 Office Plan	SP/GH/0/04/12/103
Tower Manufacturing Building B1 Elevations	SP/GH/0/04/12/104
Tower Manufacturers Building B2 Plan	SP/GH/0/04/12/105
Tower Manufacturers Building B2 Elevations	SP/GH/0/04/12/106
Generator Manufacturer Building C1 Plan	SP/GH/0/04/12/107
Generator Manufacturer Building C1 Elevations	SP/GH/0/04/12/108
Generator Manufacturer Building C2 Plan	SP/GH/0/04/12/109
Generator Manufacturer Building C2 Elevations	SP/GH/0/04/12/110
Storage Building E Plan	SP/GH/0/04/12/111
Storage Building E Elevations	SP/GH/0/04/12/112
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Cofferdam Main Cross Sections	SP/GH/0/04/12/121
Cofferdam Alternative 1 Cross Section	SP/GH/0/04/12/122
Cofferdam Alternative 1 Bund Cross Section	SP/GH/0/04/12/123
Cofferdam Alternative 2 Cross Sections	SP/GH/0/04/12/124
Shear Accommodation Location	SP/GH/0/04/12/125
Typical Cross Sections of Quays 8 & 9	SP/GH/0/04/12/126
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Planning Application Legend

- A Blade Manufacturers
- B Tower Manufacturers
- C Generator Manufacturers
- D Storage Building
- E Storage Building
- F Accommodation Weighbridge
- G Metal Shear
- H Acoustic Barrier
- I Existing Hazardous Waste Store
- J Existing Dirty Dismantling Pad
- Quays 1, 10 & 11
- Planning Application Boundary
- Railway Line

Existing Buildings

- L Store
- M Dewax Facility
- N PDI Building
- O NDT Building

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\ Location:
Seaton Port TERRC Facility

Title:
Main Planning Application Plan

Able UK Ltd
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TS23 1PX
Tel: +44-(0)1642 806080
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Scale: 1:3500	Drawn	Checked	Approved
	H Garland	R Till	MCH
Date	01/12/04	17/12/04	21/12/04

Drg. No. SP/0/04/12/80/R0

Planning Application Legend

- A Blade Manufacturers
- B Tower Manufacturers
- C Generator Manufacturers
- D Storage Building
- E Storage Building
- F Accommodation Weighbridge
- G Metal Shear
- H Acoustic Barrier
- I Existing Hazardous Waste Store
- J Existing Dirty Dismantling Pad
- Quays 1, 10 & 11
- Planning Application Boundary
- Railway Line

Existing Buildings

- L Store
- M Dewax Facility
- N PDI Building
- O NDT Building

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\ Location:
Seaton Port TERRC Facility

Title:
Cofferdam Option 1

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Scale: 1:3500	Drawn	Checked	Approved
	H Garland	R Till	MCH
Date	01/12/04	17/12/04	21/12/04

Drg. No. SP/0/04/12/81/R0

Planning Application Legend

- A Blade Manufacturers
- B Tower Manufacturers
- C Generator Manufacturers
- D Storage Building
- E Storage Building
- F Accommodation Weighbridge
- G Metal Shear
- H Acoustic Barrier
- I Existing Hazardous Waste Store
- J Existing Dirty Dismantling Pad
- Quays 1, 10 & 11
- Planning Application Boundary
- Railway Line

Existing Buildings

- L Store
- M Dewax Facility
- N PDI Building
- O NDT Building

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\ Location:
Seaton Port TERRC Facility

Title:
Cofferdam Option No 2

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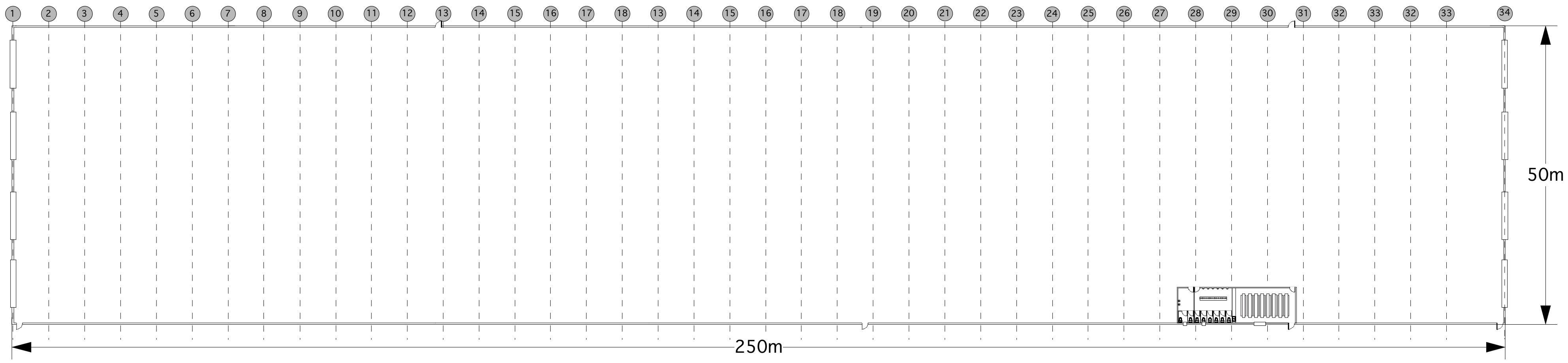
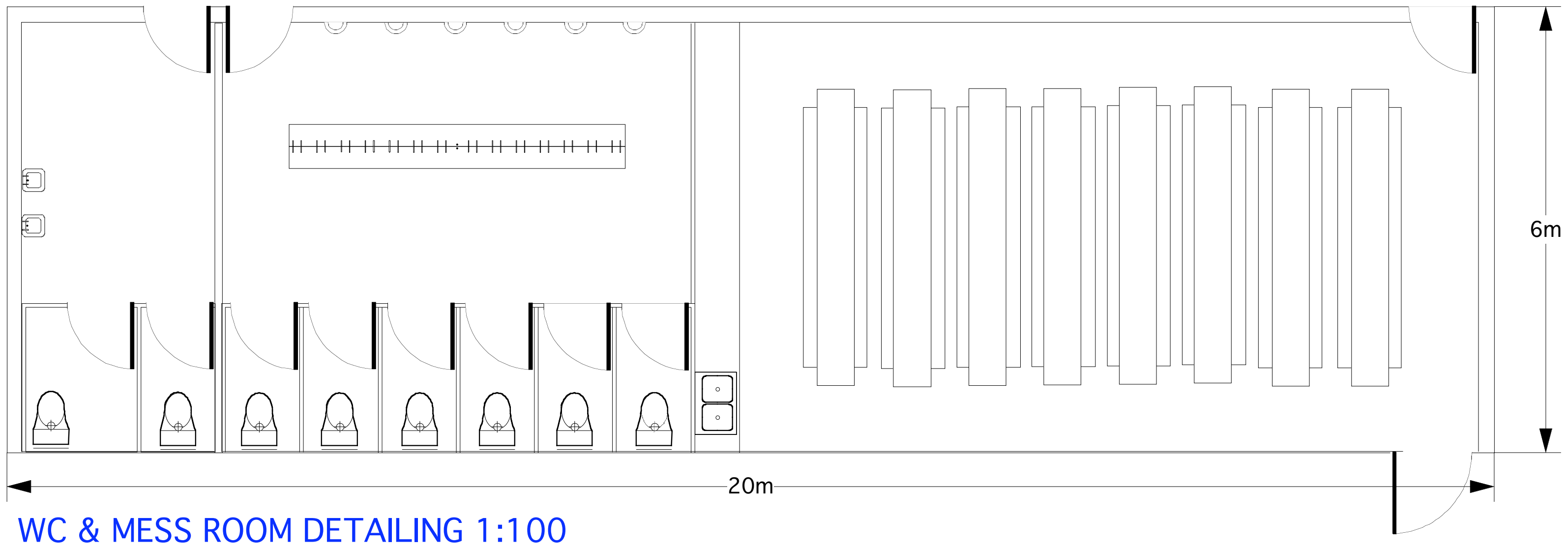


GROUND FLOOR PLAN 1:1000



WC & MESS ROOM DETAILING 1:100

Notes

1. Portal Steel Frame
2. Box Profile Colour Coded, Plastisal Coated Wall and Roof Cladding With 15% Roof Lights
3. Concrete Power Float Finish Slab
4. Blockwork to Communal Areas

All dimensions In Metres

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title:
Blade Manufacturer Building A Plan

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Contract No.		CAD Ref.		
Scale	1:1000 1:100	Drawn: H.Garland	Checked: S.Hughes	Approved: M. Hopkins
	Date	14/12/04	17/12/04	21/12/04

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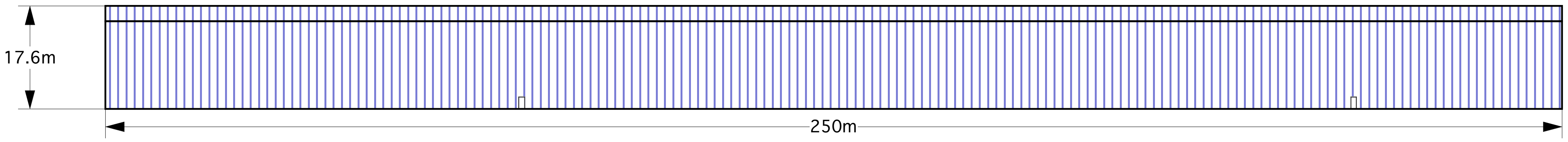
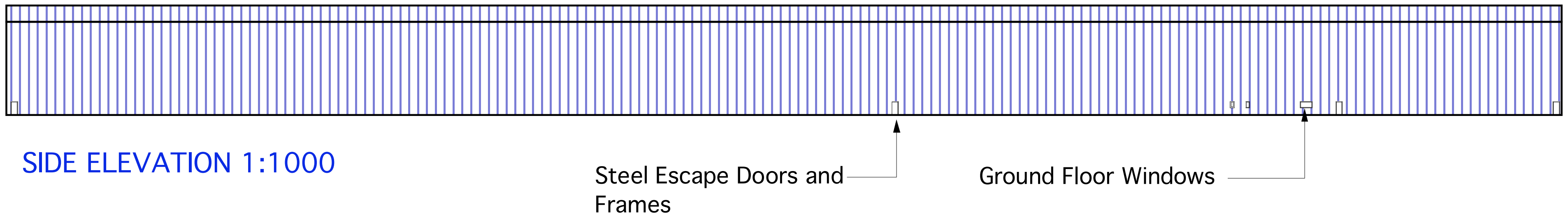


SIDE ELEVATION 1:1000



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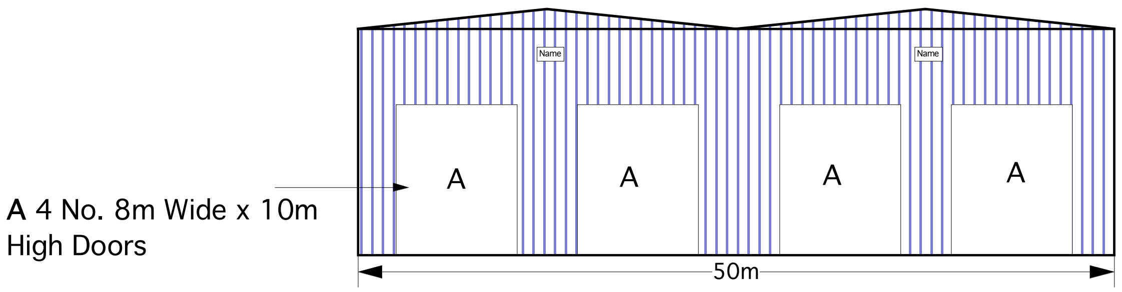

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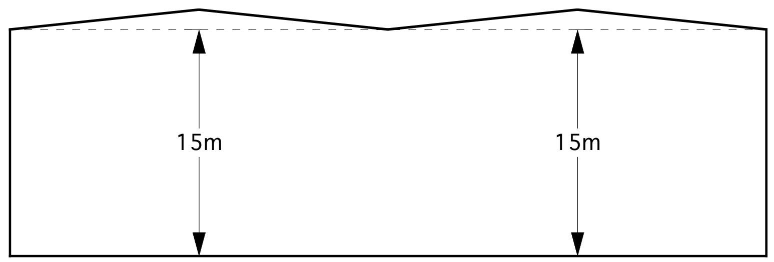
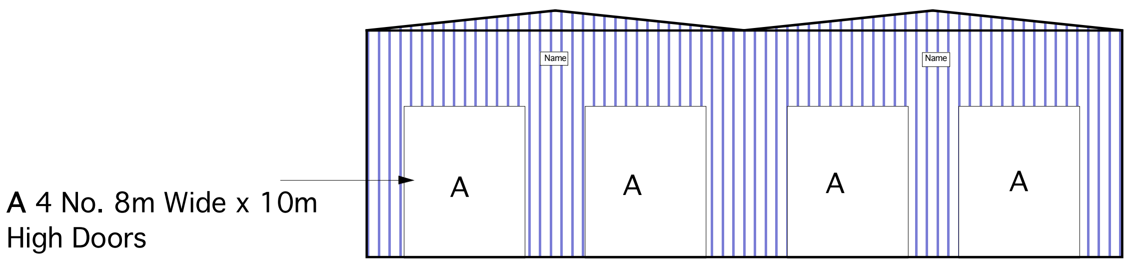


TYPICAL SECTION 1:500



REAR ELEVATION 1:500

Notes

1. Portal Steel Frame
2. Box Profile Colour Coded, Plastisal Coated Wall and Roof Cladding With 15% Roof Lights
3. Concrete Power Float Finish Slab
4. Blockwork to Communal Areas

All dimensions In Metres

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title:
Blade Manufacturer Building A Elevations

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Contract No.		CAD Ref.	
Scale 1:1000 1:500	Drawn H.Garland	Checked S. Hughes	Approved M. Hopkins
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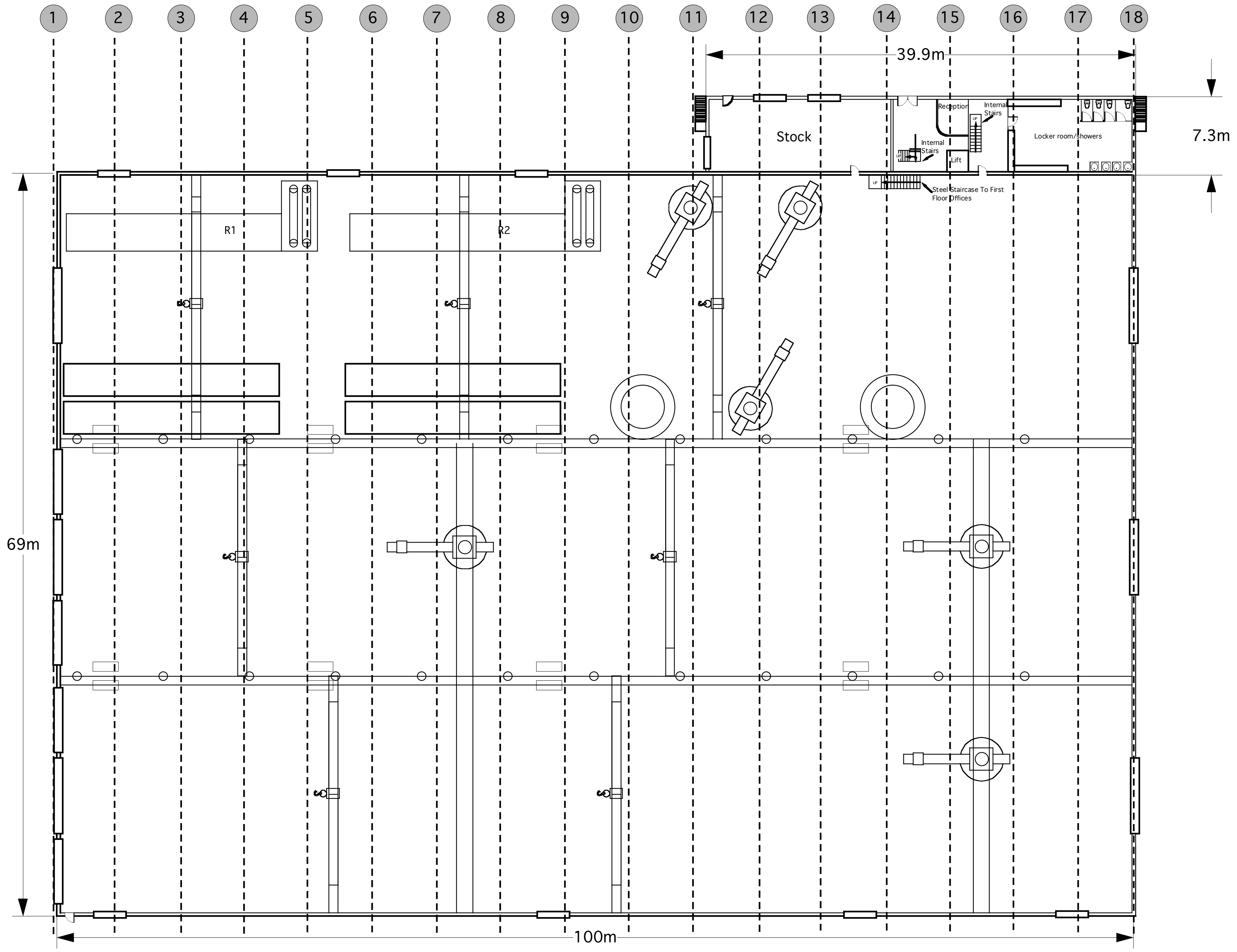

GROUND FLOOR PLAN

Notes

1. Portal Steel Frame
2. Box Profile Colour Coded, Insulate Wall, and Roof Cladding With 15% Roof Lights
3. Concrete Power Float Finish Slab
4. Blockwork to Communal Areas

R1 Roller
R2 Roller

All dimensions In Metres

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title: Tower Manufacturing Building B1 Plan

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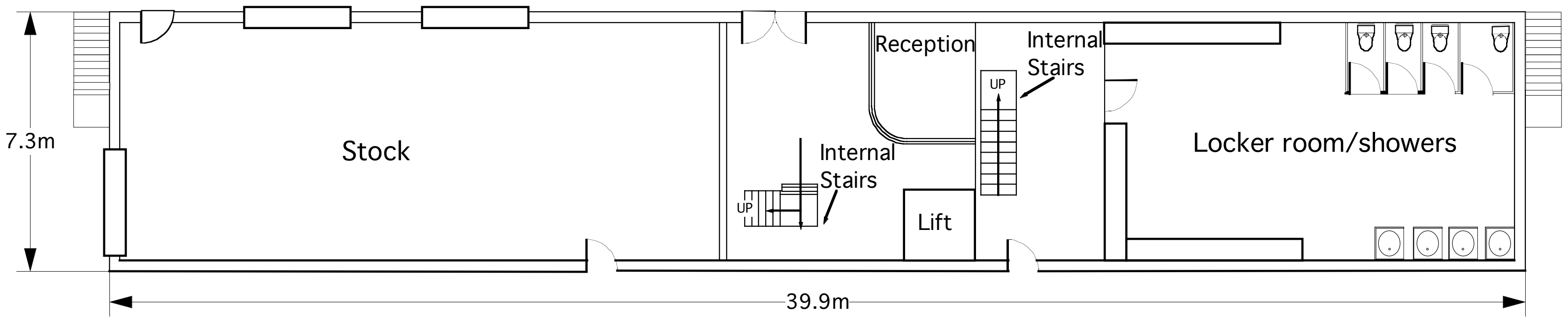
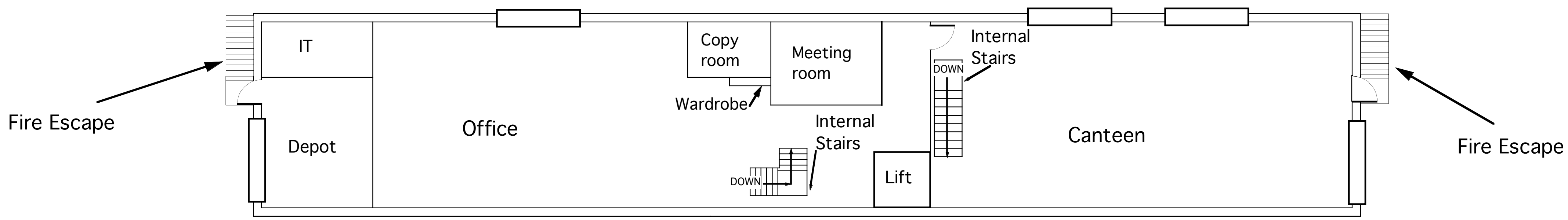


GROUND FLOOR PLAN - OFFICES



FIRST FLOOR PLAN - OFFICES

Notes

1. Portal Steel Frame
2. Box Profile Colour Coded, Insulate Wall, and Roof Cladding With 15% Roof Lights
3. Concrete Power Float Finish Slab
4. Blockwork to Communal Areas

All dimensions In Metres

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title: Tower Manufacturing Building B1 Office Plan

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Contract No.

CAD Ref.

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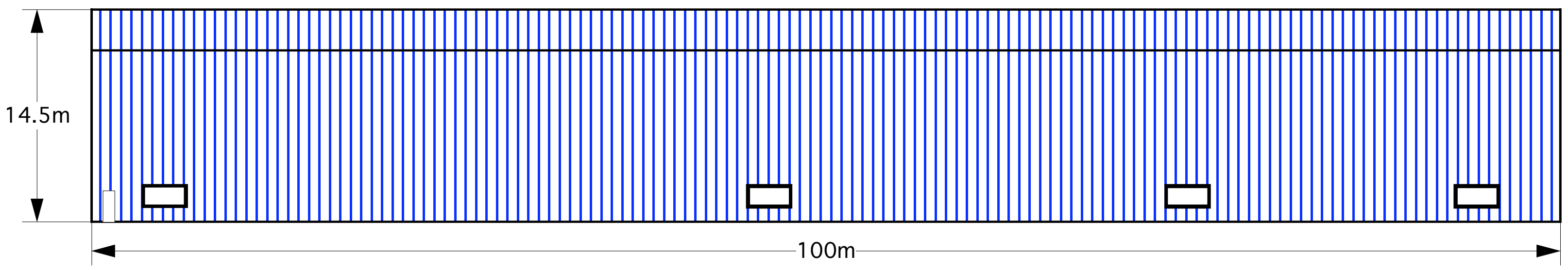
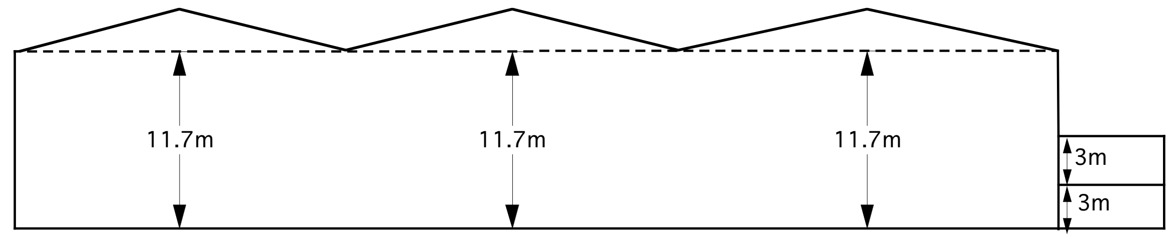
Sheet No. 02 of 03

Rev. 0



SIDE ELEVATION



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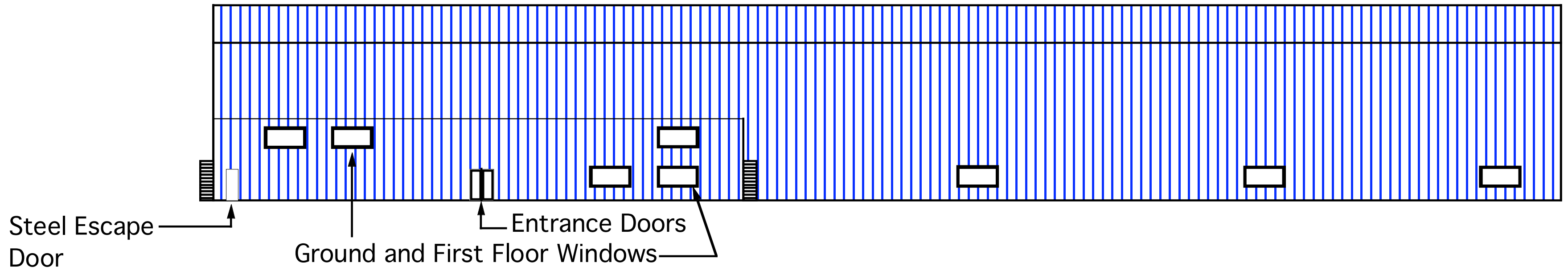

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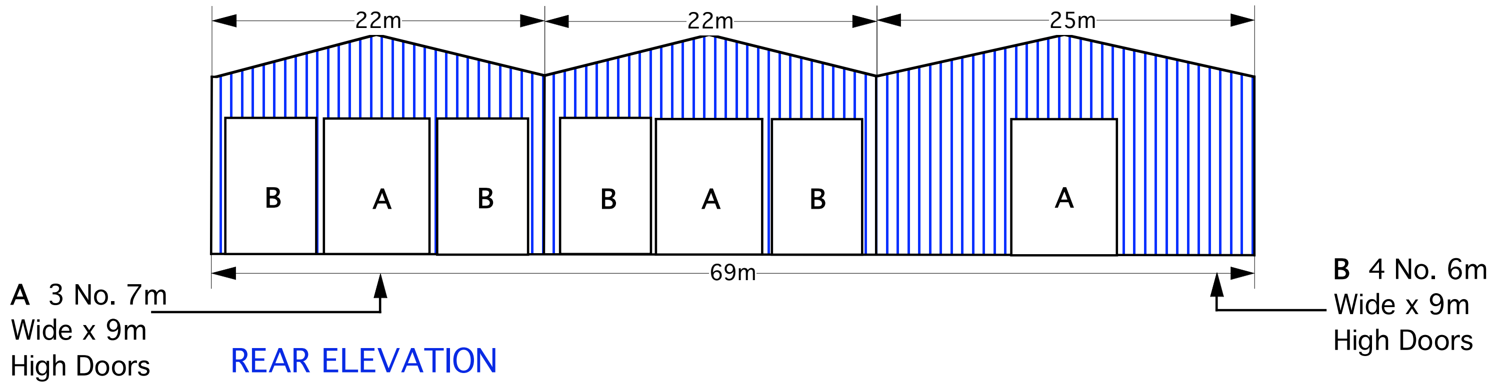

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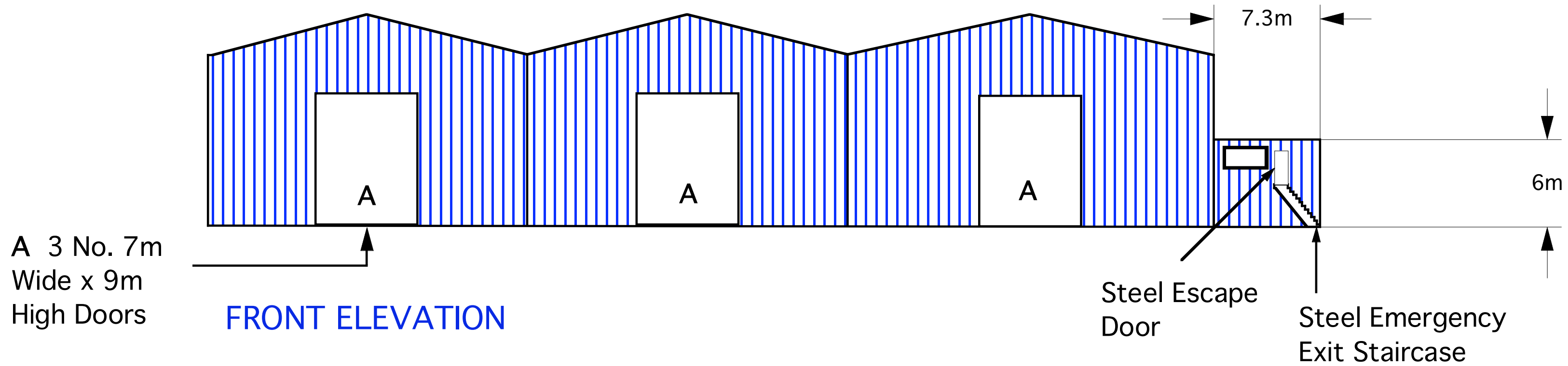

FRONT ELEVATION

Notes

1. Portal Steel Frame
2. Box Profile Colour Coded, Insulate Wall, and Roof Cladding With 15% Roof Lights
3. Concrete Power Float Finish Slab
4. Blockwork to Communal Areas

All dimensions In Metres

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title: Tower Manufacturing Building B1 Elevations

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Contract No.		CAD Ref.	
Scale 1:500	Drawn	Checked	Approved
	H.Garland	S.Hughes	M.Hopkins
Date	14/12/04	14/12/04	21/12/04

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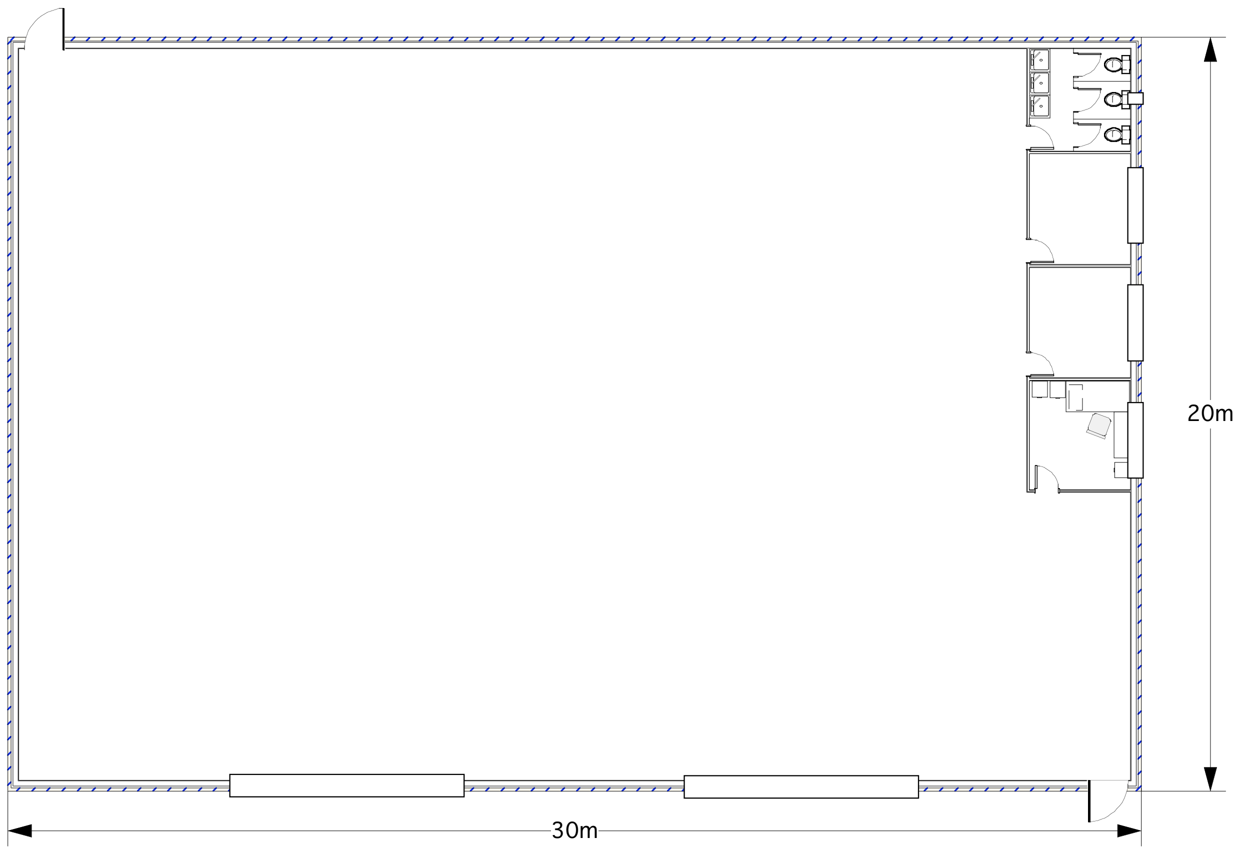
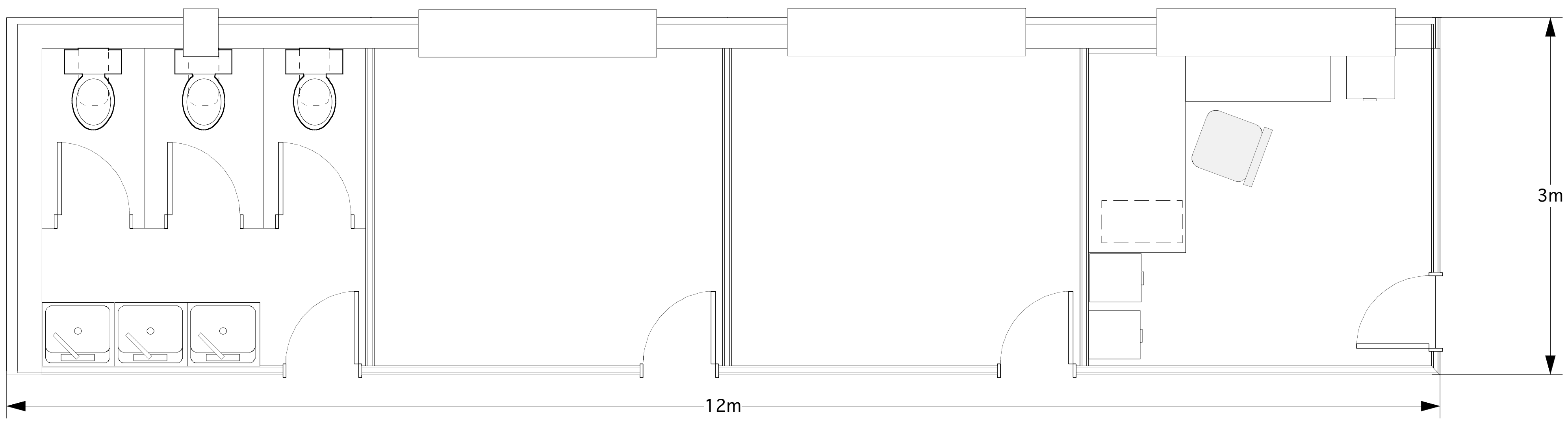


GROUND FLOOR PLAN 1:200



GROUND FLOOR PLAN DETAILING 1:50

Notes

1. Portal Steel Frame
2. Box Profile Colour Coded, Insulate Wall, and Roof Cladding With 15% Roof Lights
3. Brick and Blockwork dado walls 2.4m high
4. Concrete Power Float Finish Slab
5. Blockwork to Communal Areas

All dimensions In Metres

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:

Seaton Port TERRC Facility

Title:
Tower Manufacturers Building B2 Plan

AbleUK Ltd Able House Billingham Teesside UK TS23 1PX
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email: info@ableuk.com
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Contract No.	CAD Ref.

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	Date	14/12/04	14/12/04	21/12/04

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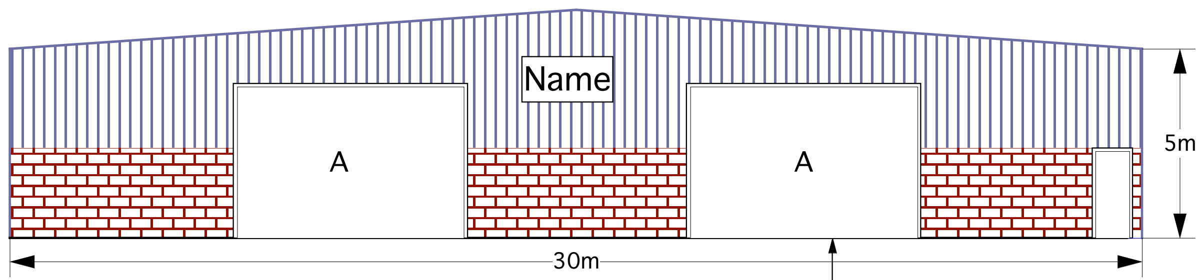
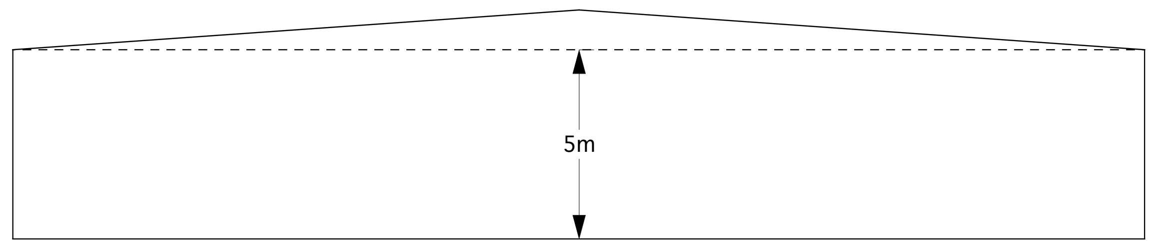
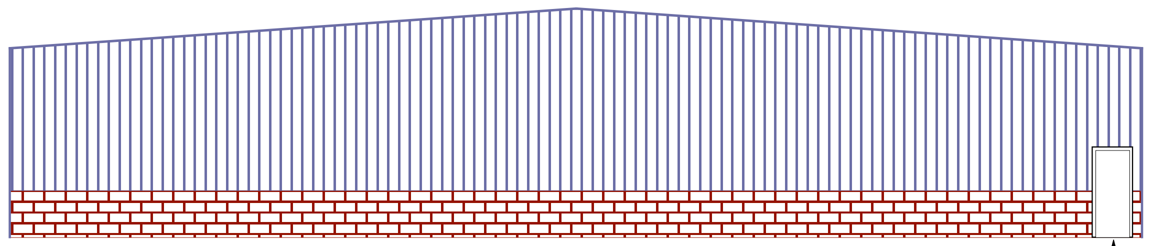


A 2 No. 6m Wide x 4m High Doors

FRONT ELEVATION

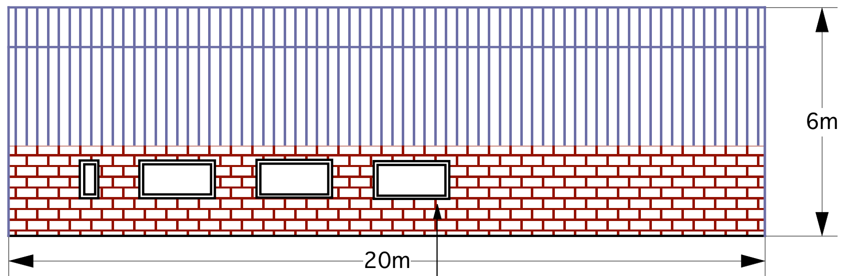


TYPICAL SECTION



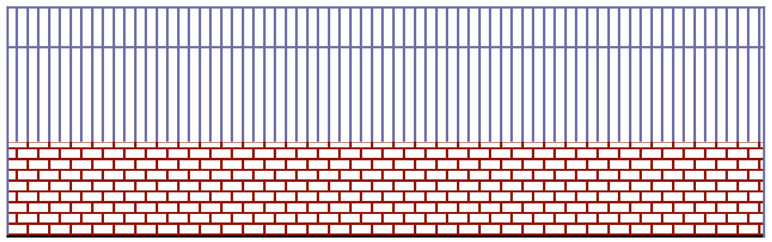
Steel Entrance and Escape Doors and Frames

REAR ELEVATION



Ground Floor Windows

SIDE ELEVATION



SIDE ELEVATION

Notes

1. Portal Steel Frame
2. Box Profile Colour Coded, Insulate Wall, and Roof Cladding With 15% Roof Lights
3. Brick and Blockwork dado walls 2.4m high
4. Concrete Power Float Finish Slab
5. Blockwork to Communal Areas

All dimensions In Metres

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:

Seaton Port TERRC Facility

Title:
Tower Manufacturers Building
B2 Elevations

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Contract No.
CAD Ref.

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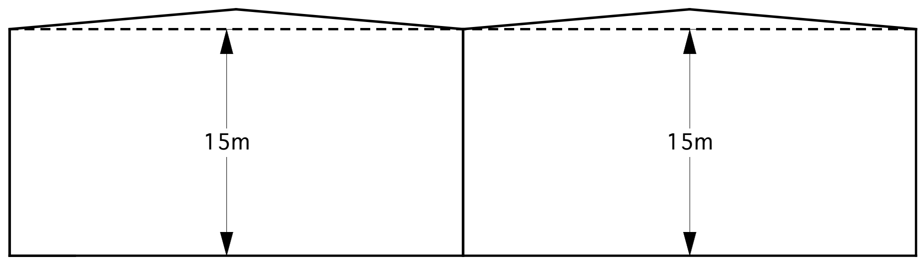
Rev. 0



TYPICAL SECTION

GROUND FLOOR PLAN

Notes

1. Portal Steel Frame
2. Box Profile Colour Coded, Insulate Wall, and Roof Cladding With 15% Roof Lights
4. Concrete Power Float Finish Slab

All dimensions In Metres

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title: Generator Manufacture Building C1 Plan

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Contract No.		CAD Ref.	
Scale 1:500	Drawn	Checked	Approved
	H.Garland	S.Hughes	M.Hopkins
Date	14/12/04	14/12/04	21/12/04

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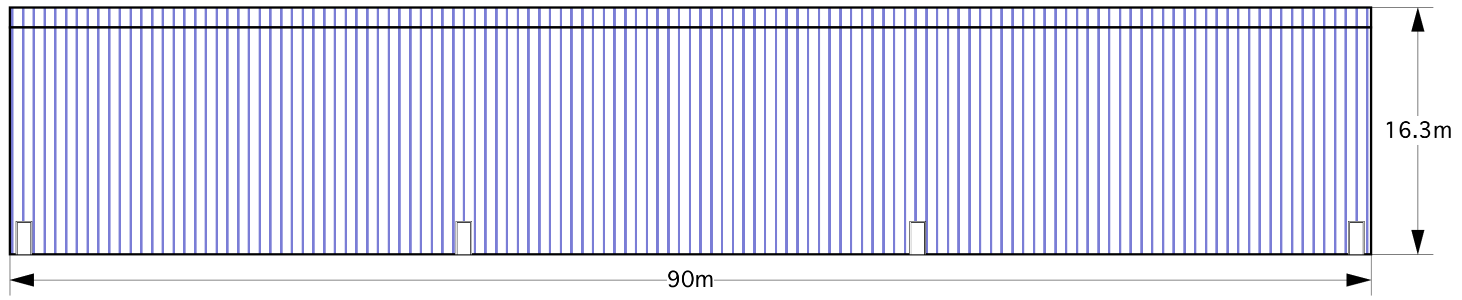

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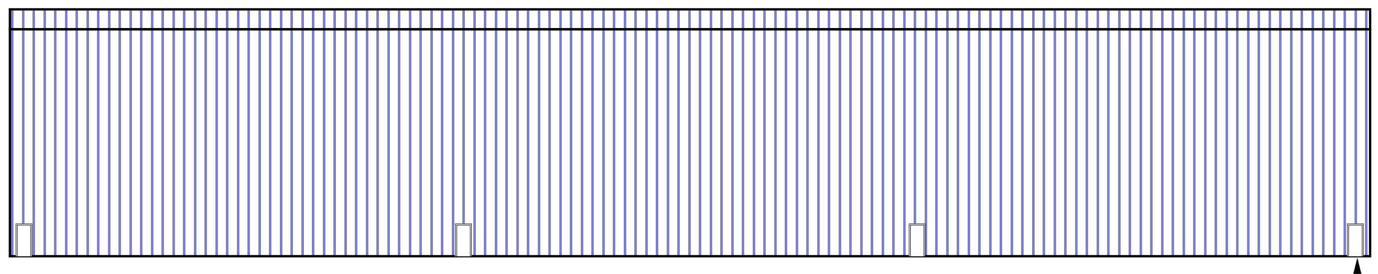
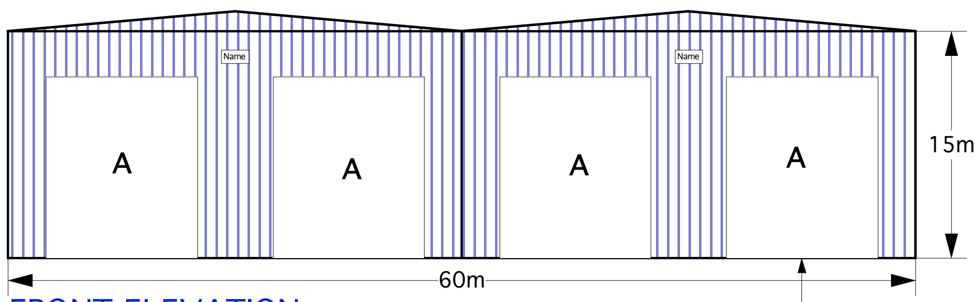


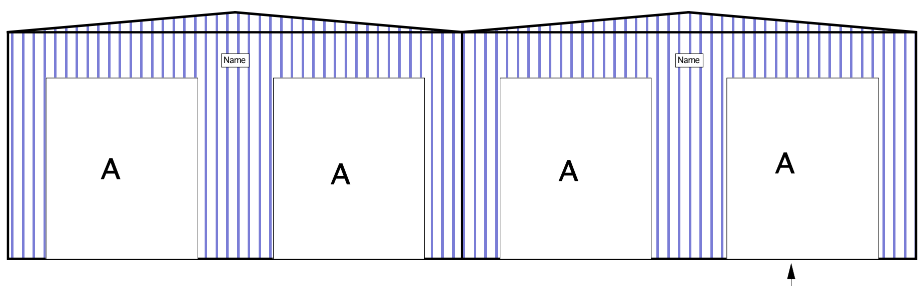
SIDE ELEVATION

Steel Escape Doors
and Frames



FRONT ELEVATION

A 4 No. 10m Wide x 12m
High Doors



REAR ELEVATION

A 4 No. 10m Wide x 12m
High Doors

Notes

1. Portal Steel Frame
2. Box Profile Colour Coded,
Insulate Wall, and Roof Cladding With 15%
Roof Lights
3. Concrete Power Float Finish Slab

All dimensions In Metres

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title: Generator Manufacturer
Building C1 Elevations

AbleUK Ltd
Able House
Billingham
Teesside UK
TS23 1PX
Tel: +44-(0)1642 806080
Fax: +44-(0)1642 655655
email: info@ableuk.com
www.ableuk.com

Contract No.

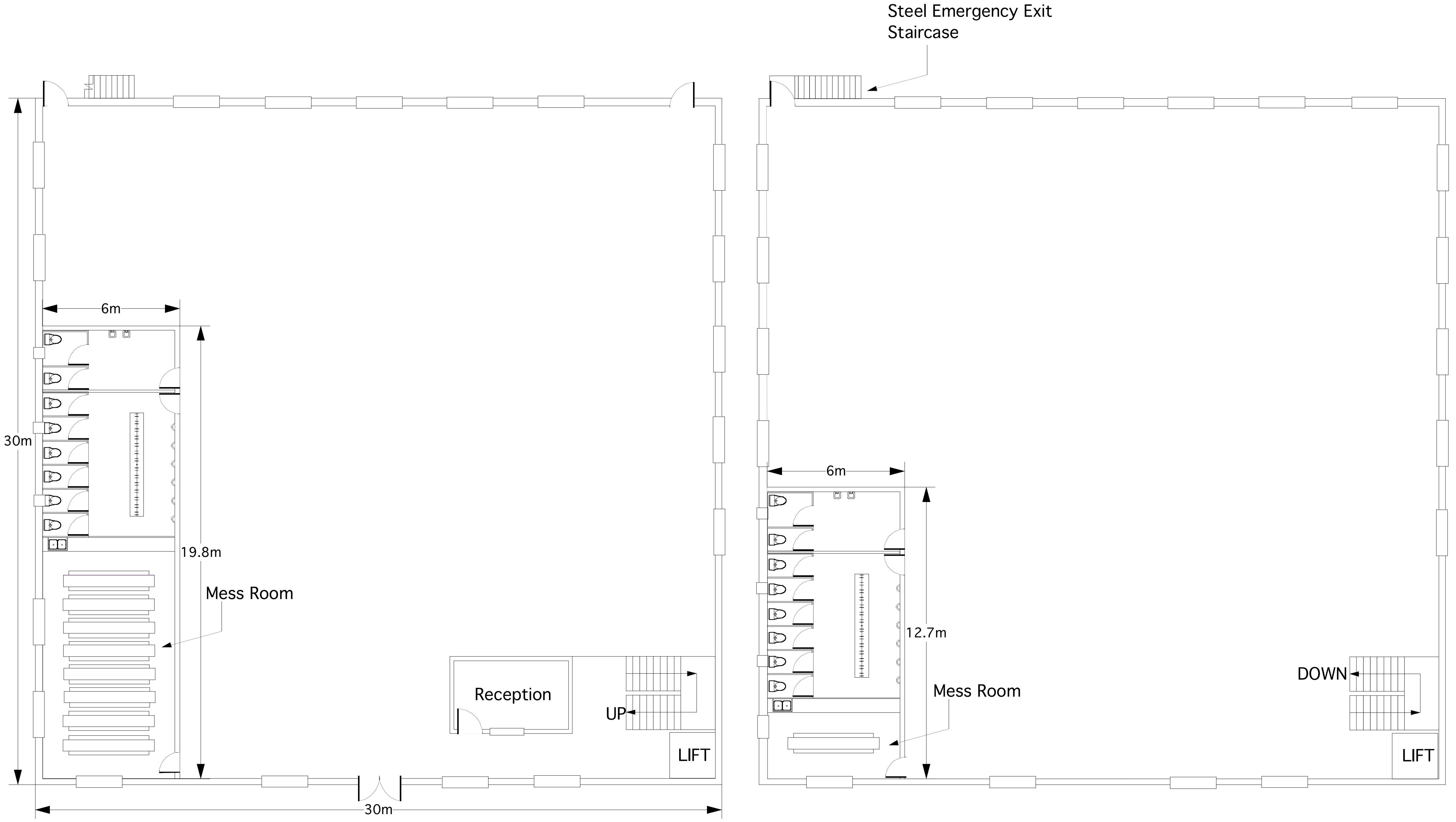
CAD Ref.

Scale	1:500	Drawn	Checked	Approved
		H.Garland	S.Hughes	M.Hopkins
	Date	14/12/04	14/12/04	21/12/04

Drg. No. SP/GH/0/0/4/12/108

Sheet No. 02 of 02

Rev. 0



GROUND FLOOR PLAN

FIRST FLOOR PLAN

Notes

1. Portal Steel Frame
2. Box Profile Colour Coded, Insulate Wall, and Roof Cladding With 15% Roof Lights
3. Concrete Power Float Finish Slab
4. Blockwork to Communal Areas

All dimensions In Metres

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title: Generator Manufacturer Building C2 Plan

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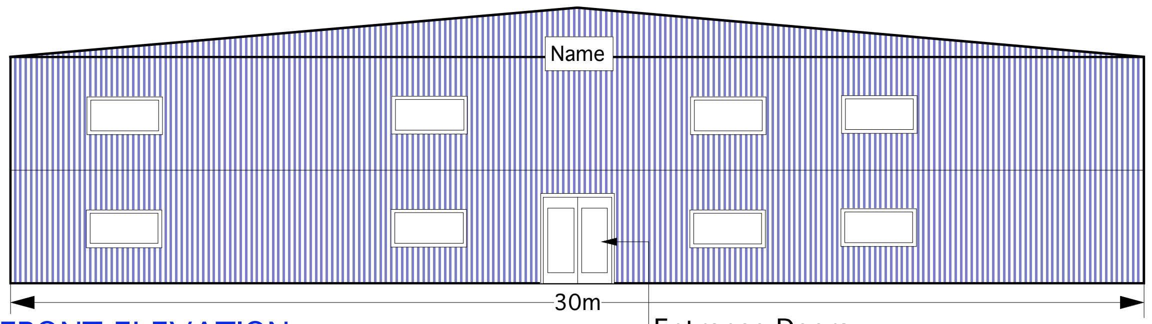
Contract No.

CAD Ref.

Scale	Drawn	Checked	Approved
1:200	H.Garland	S.Hughes	M.Hopkins
Date	14/12/04	14/12/04	21/12/04

Drg. No.	Sheet No.	Rev.
SP/GH/0/04/12/109	01 of 02	0



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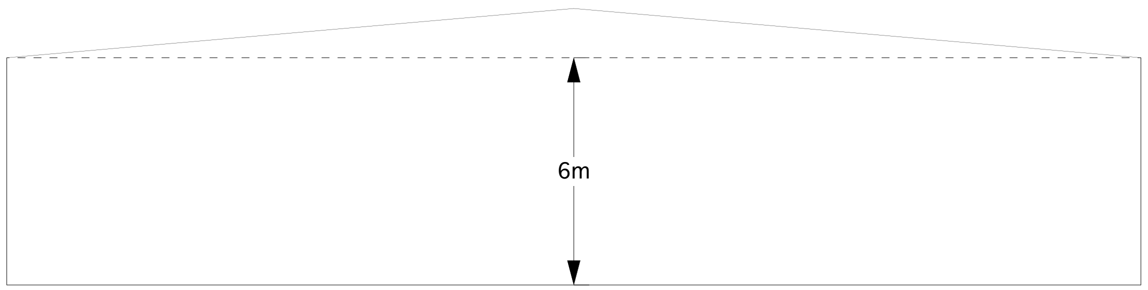

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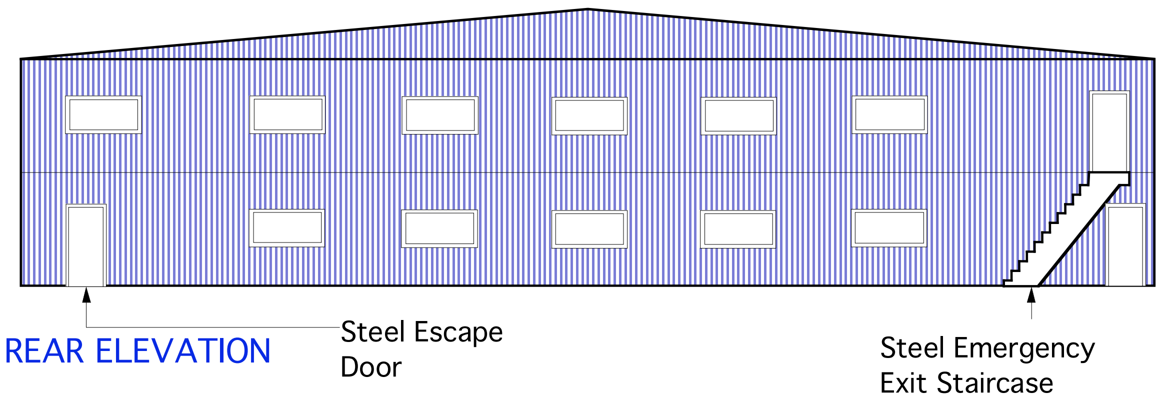

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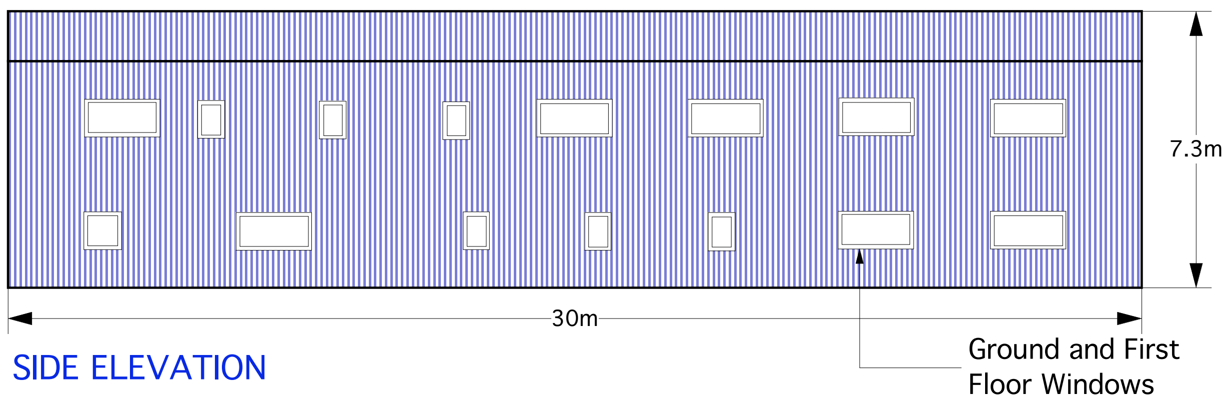
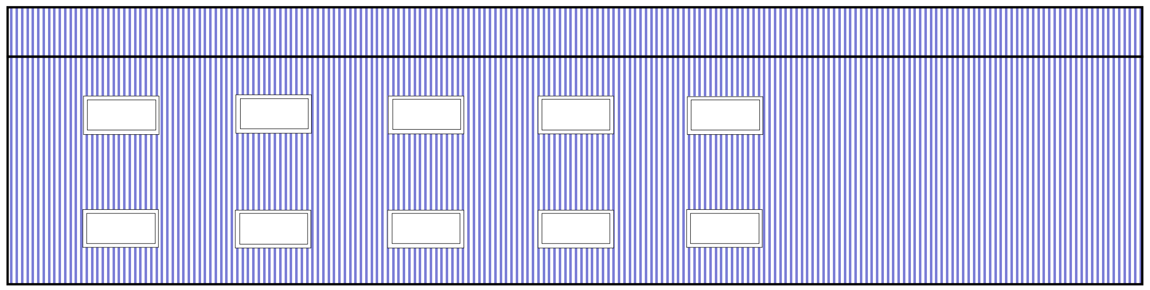


SIDE ELEVATION



SIDE ELEVATION

Notes

1. Portal Steel Frame
2. Box Profile Colour Coded, Insulate Wall, and Roof Cladding With 15% Roof Lights
3. Concrete Power Float Finish Slab
4. Blockwork to Communal Areas

All dimensions In Metres

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title: Generator Manufacturer Building C2 Elevations

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Contract No.

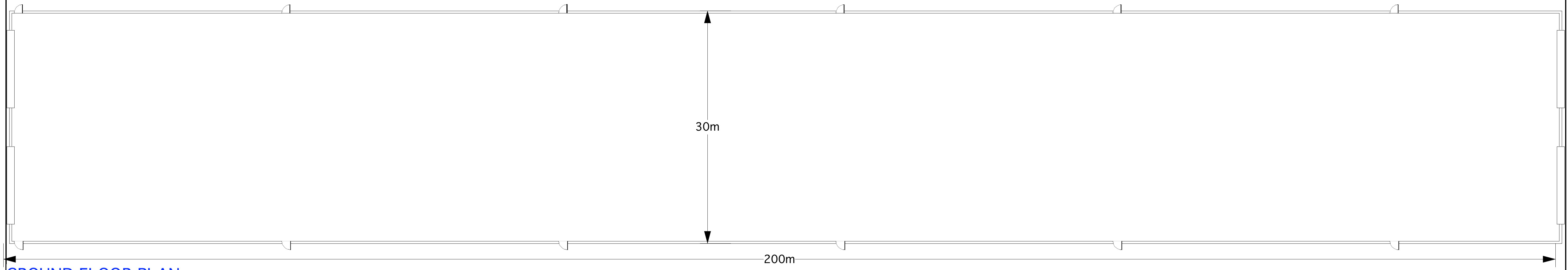
CAD Ref.

Scale 1:200	Drawn	Checked	Approved
	H.Garland	S.Hughes	M.Hopkins
Date	14/12/04	14/12/04	21/12/04

Drg. No. SP/GH/0/04/12/110

Sheet No. 02 of 02

Rev. 0



GROUND FLOOR PLAN

Notes

1. Portal Steel Frame
2. Box Profile Colour Coded,
Insulate Wall, and Roof Cladding With 15% Roof Lights
3. Concrete Power Float Finish Slab

All dimensions In Metres

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title:
Storage Building E Plan

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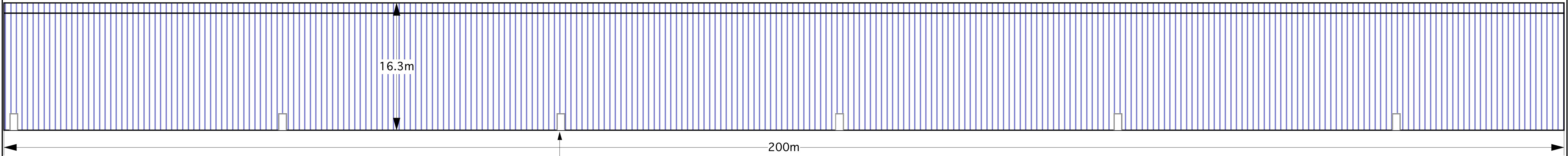
Tel: +44-(0)1642 806080
Fax: +44-(0)1642 655655
email: info@ableuk.com
www.ableuk.com

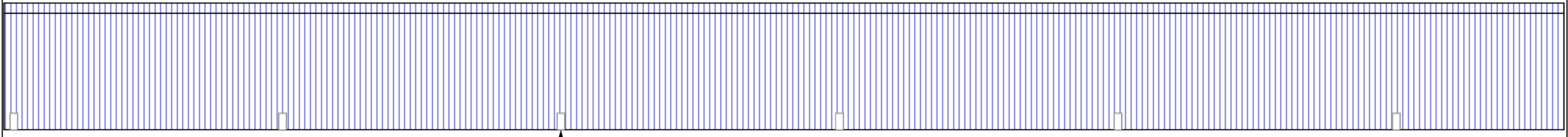
Contract No.	CAD Ref.	

Scale 1:500	Drawn	Checked	Approved
	H.Garland	S.Hughes	M.Hopkins
Date	14/12/04	14/12/04	21/12/04

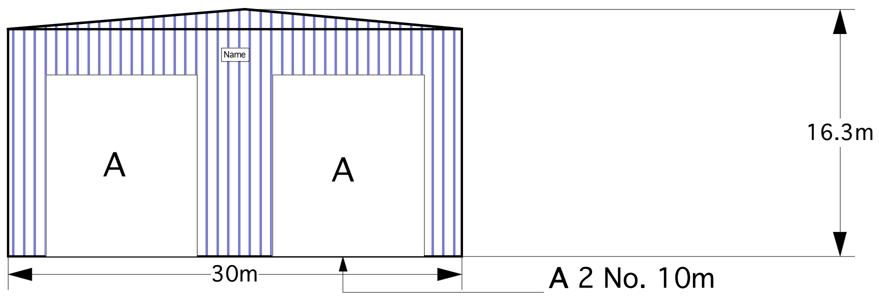
Drg. No.	Sheet No.	Rev.
SP/GH/0/04/12/111	01 of 02	1



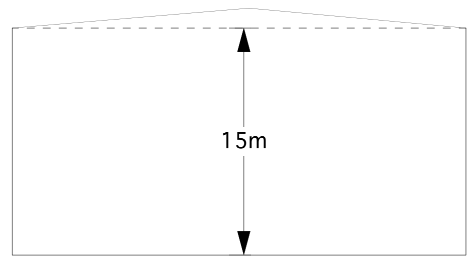
SIDE ELEVATION



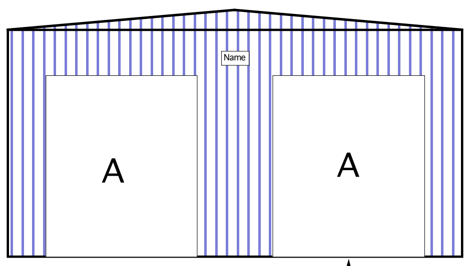
SIDE ELEVATION



FRONT ELEVATION



TYPICAL SECTION



REAR ELEVATION

Notes

1. Portal Steel Frame
2. Box Profile Colour Coded,
Insulate Wall, and Roof Cladding With 15% Roof Lights
3. Concrete Power Float Finish Slab

All dimensions In Metres

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title:
Storage Building E Elevations

AbleUK Ltd
Able House
Billingham
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Tel: +44-(0)1642 806080
Fax: +44-(0)1642 655655
email: info@ableuk.com
www.ableuk.com

Contract No.
CAD Ref.

Scale		Drawn	Checked	Approved
	1:500	H.Garland	S.Hughes	M.Hopkins
	Date	14/12/04	14/12/04	21/12/04

Drg. No. SP/GH/0/04/12/112

Sheet No. 02 of 02

Rev. 1

PLAN

Notes

1. Portal Steel Frame
2. Box Profile Colour Coded,
Insulate Wall, and Roof Cladding With 15% Roof Lights
3. Concrete Power Float Finish Slab

All dimensions In Metres

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title:
Storage Building D Plan

AbleUK Ltd
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Billingham
Teesside UK
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Fax: +44-(0)1642 655655
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www.ableuk.com

Contract No.

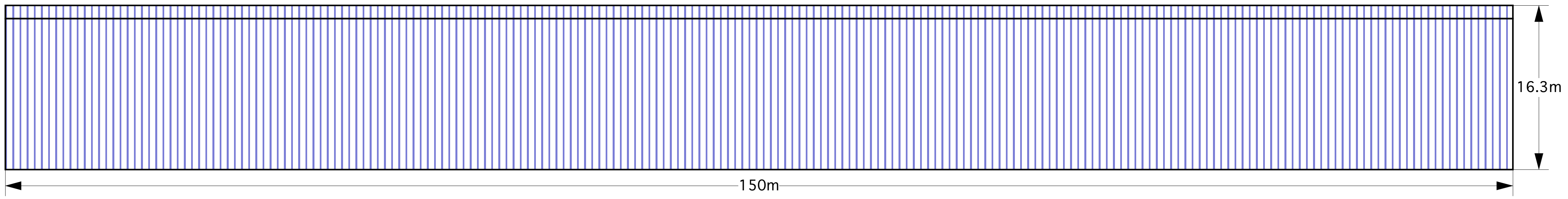
CAD Ref.

Scale	1:500	Drawn	Checked	Approved
		H.Garland	S.Hughes	M.Hopkins
	Date	14/12/04	14/12/04	21/12/04

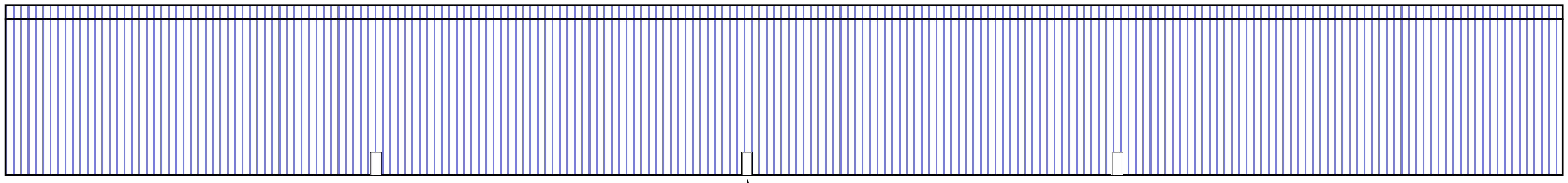
Drg. No. SP/GH/0/04/12/113

Sheet No. 01 of 02

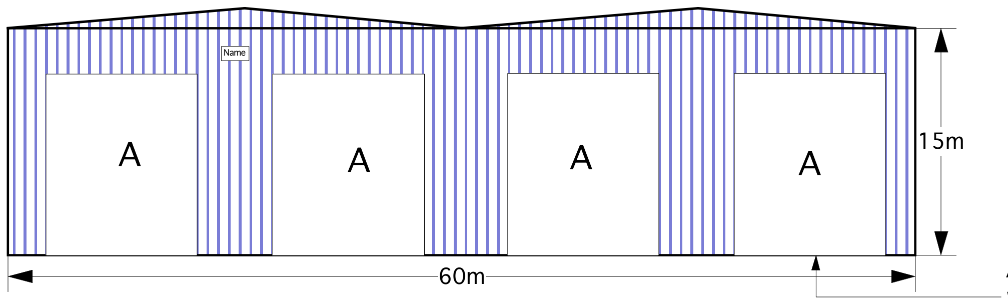
Rev. 1



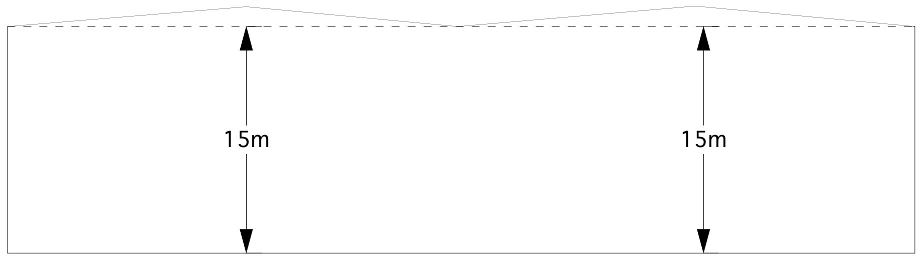
SIDE ELEVATION



SIDE ELEVATION



FRONT ELEVATION



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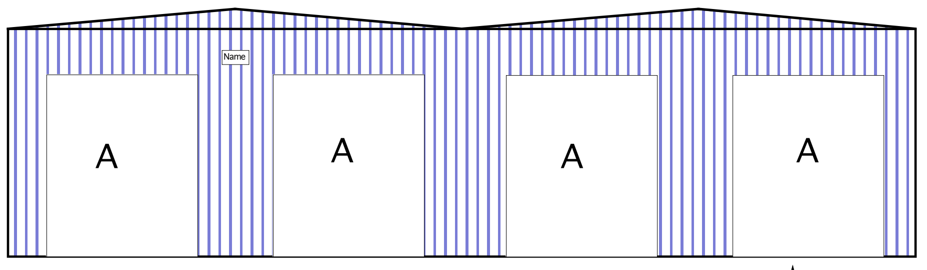

REAR ELEVATION

Notes

1. Portal Steel Frame
2. Box Profile Colour Coded, Insulate Wall, and Roof Cladding With 15% Roof Lights
3. Concrete Power Float Finish Slab

All dimensions In Metres

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title:
Storage Building D Elevations

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Contract No.

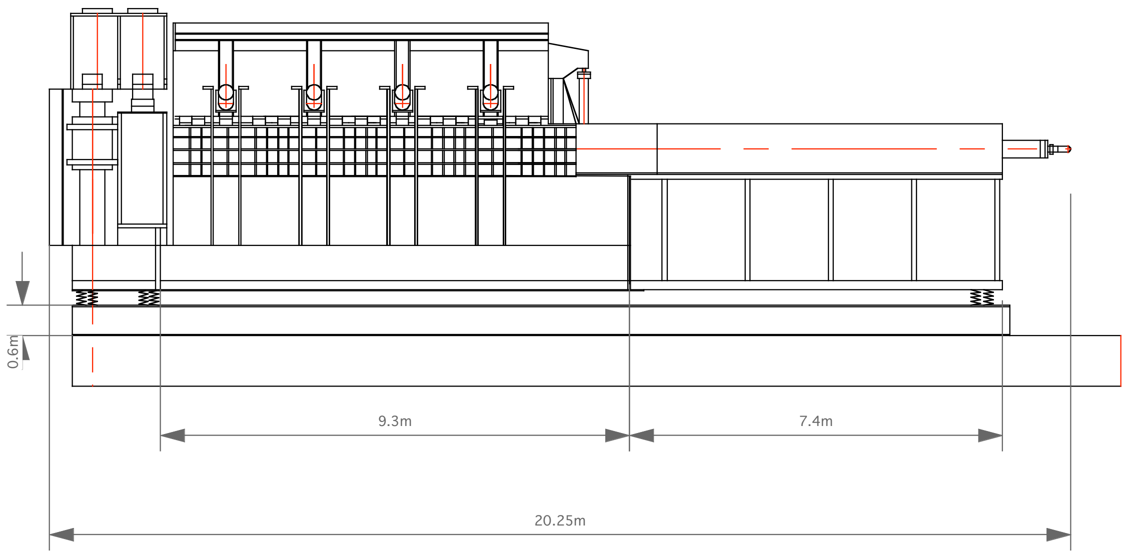
CAD Ref.

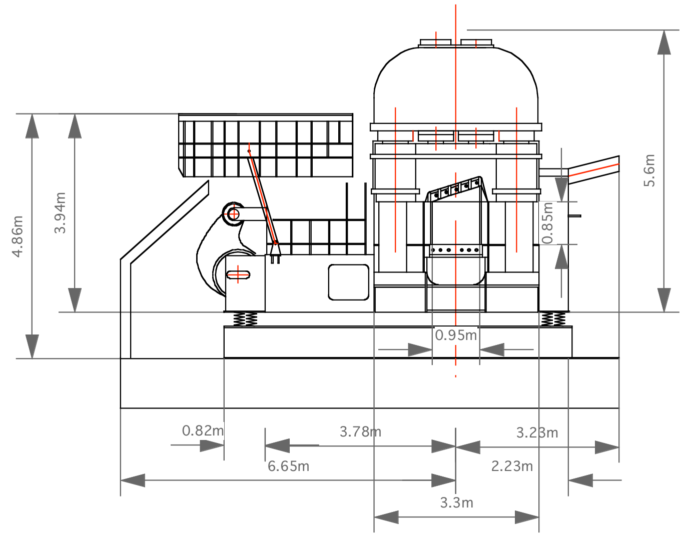
Scale	1:500	Drawn	Checked	Approved
		H.Garland	S.Hughes	M.Hopkins
	Date	14/12/04	14/12/04	21/12/04

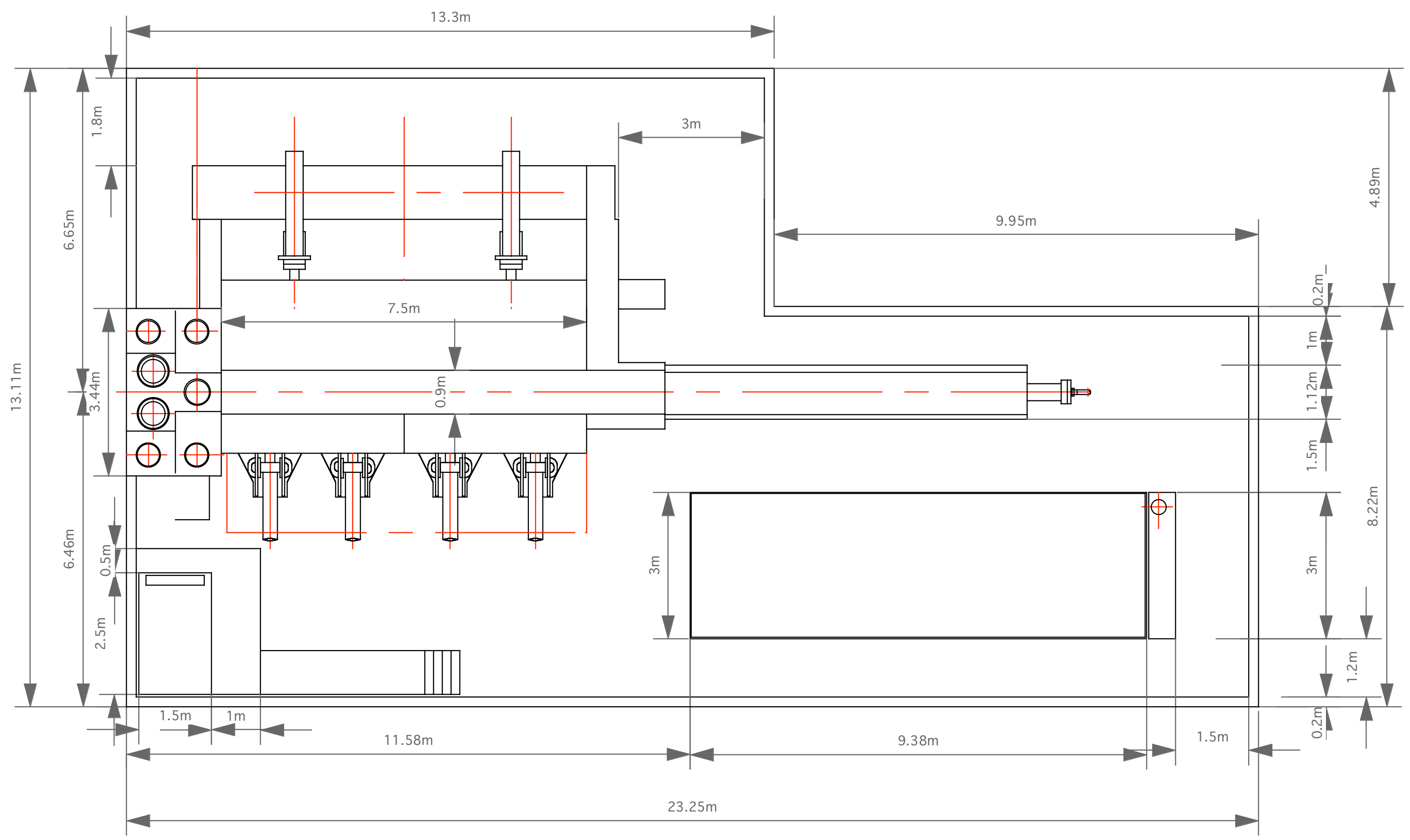
Drg. No. SP/GH/0/04/12/114

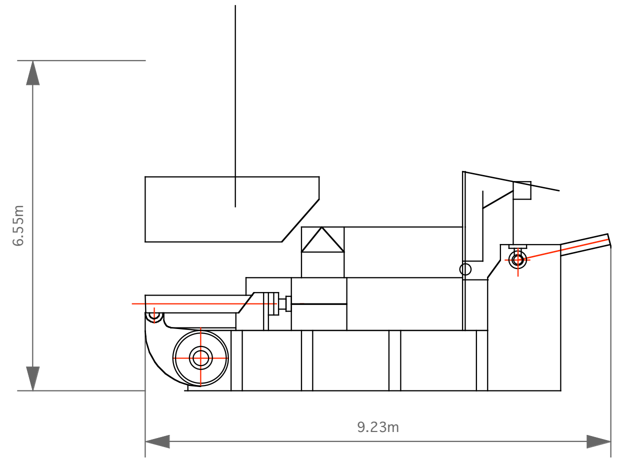
Sheet No. 02 of 02

Rev. 1









Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title:
Shear Plan and Elevations

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email: info@ableuk.com
www.ableuk.com

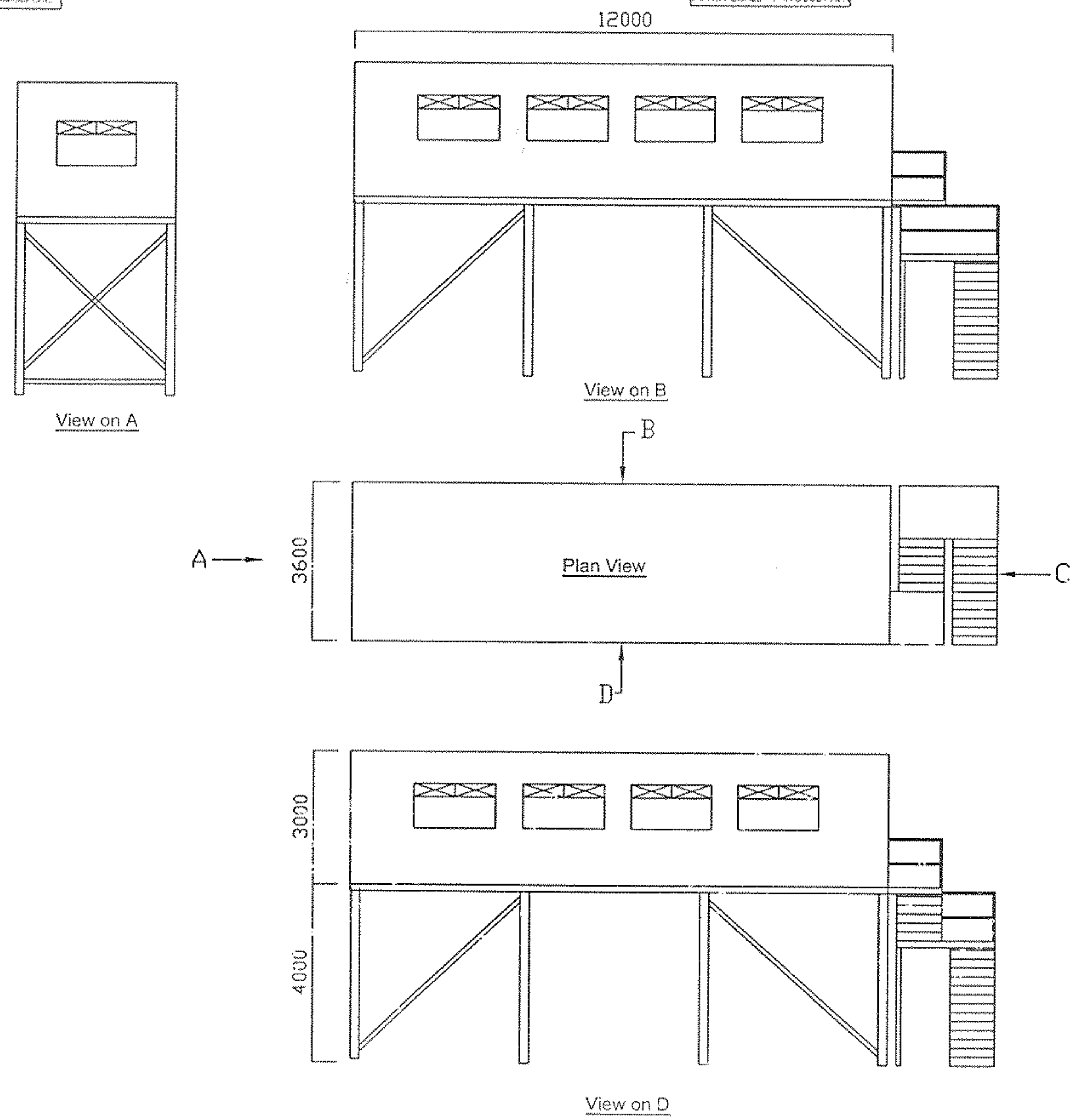
Contract No.

CAD Ref.

Scale	Drawn	Checked	Approved
1:150	H.Garland	G.Wolfenden	M.Hopkins
Date	14/12/04	14/12/04	21/12/04

Drg. No.	Sheet No.	Rev.
SP/GH/0/04/12/115	01 of 02	0

DO NOT SCALE - IF IN DOUBT ASK



EUROPEAN METAL RECYCLING LIMITED
SIRIUS HOUSE, DELTA CRESCENT
WESTBROOK, WARRINGTON WA5 7NS
TEL: 01925-715 400
FAX: 01925-713 470

SCALE	DRAWN	DATE	File
150 : 1	S.B.	Aug 2003	Proj/HartB/Pcabin

TITLE
Proposed Portacabin, Terc Site, Hartlepool

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\ Location:
Seaton Port TERRC Facility

Title:
Shear Accommodation

Able UK Ltd
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email: info@ableuk.com
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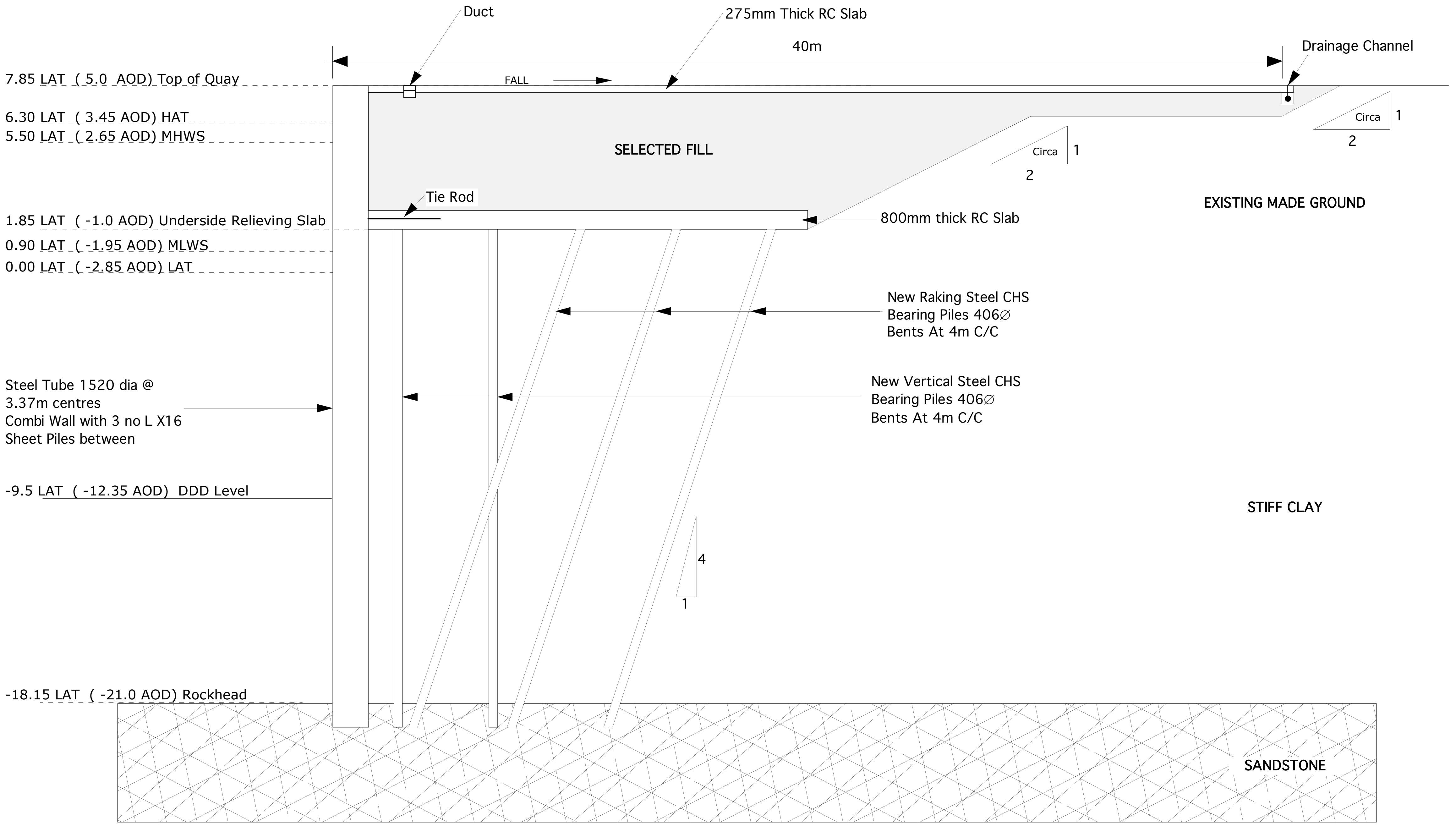
Scale:	Drawn	Checked	Approved
	H Garland	G Wolfenden	M Hopkins
Date	14/12/04	14/12/04	21/12/04

Drg. No.	Sheet No.	Rev.
SP/GH/0/04/12/116	02 of 02	0



Typical cross section showing new construction for Quay 1

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title:
Quay 1 Cross Section

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Fax: +44-(0)1642 655655
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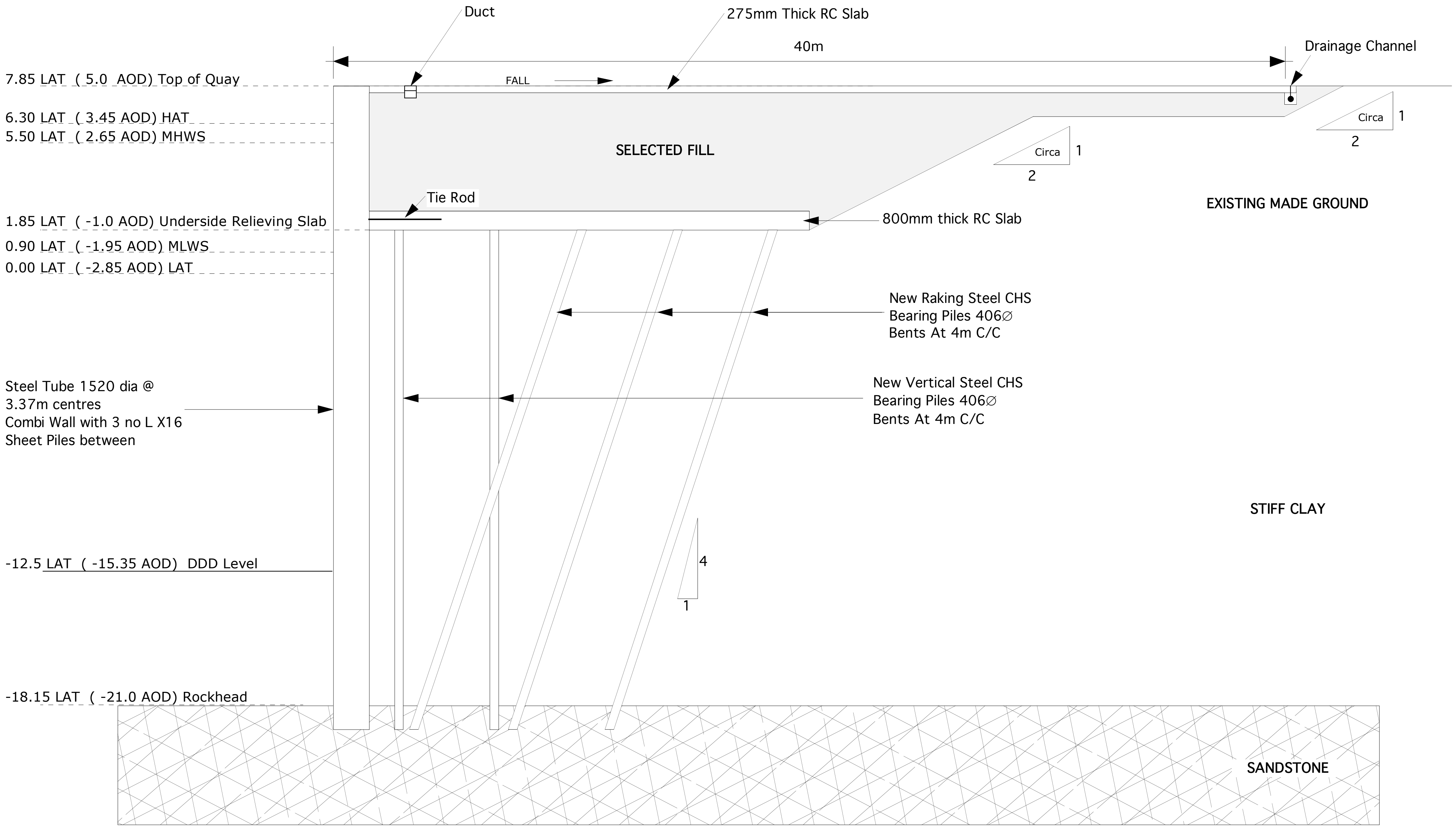
www.ableuk.com

Contract No.	CAD Ref.		
Scale	Drawn	Checked	Approved
1:200	H.Garland	G.Wolfenden	MCH
Date	25/11/04	30/11/04	3/12/04

Drg. No.	Sheet No.	Rev.
SP/GH/0/04/12/117	01 of 01	0



Typical cross section showing new construction for Quays 10 & 11

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title:
Quay 10 & 11 Cross Section

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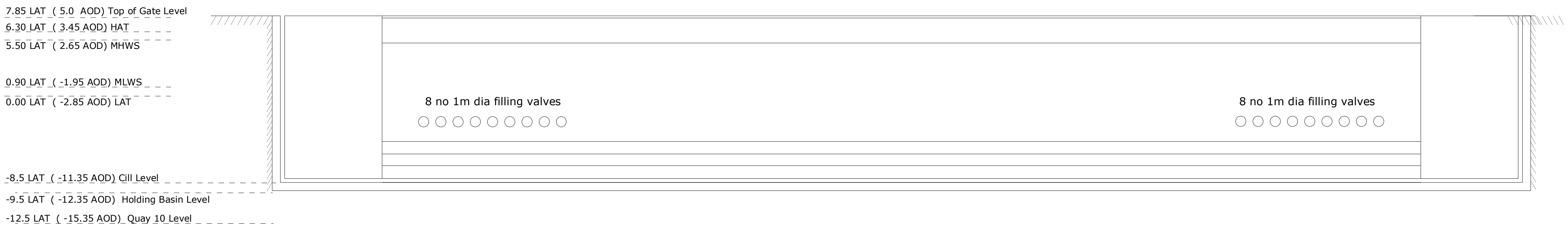
Fax: +44-(0)1642 655655
email: info@ableuk.com
www.ableuk.com

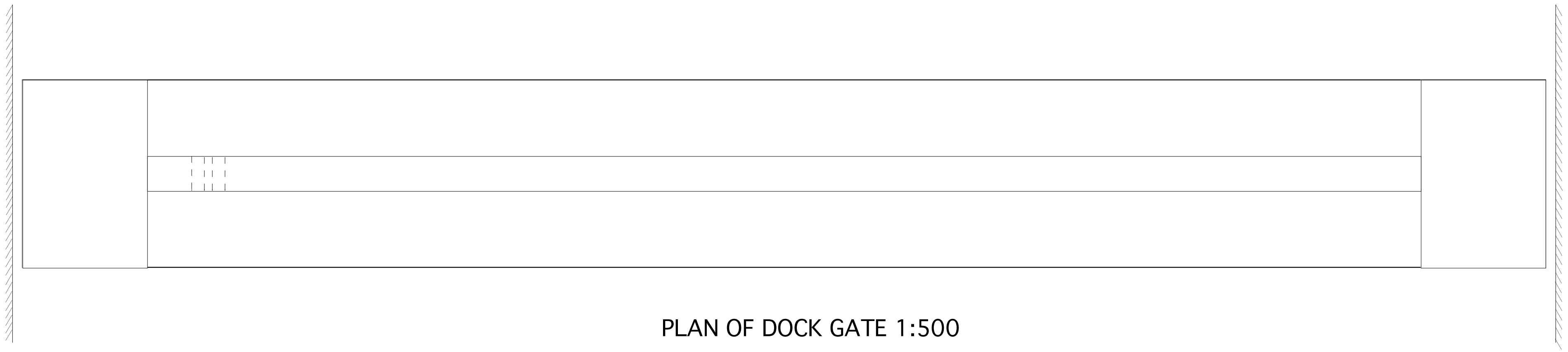
Contract No. | CAD Ref.

Scale	Drawn	Checked	Approved
1:200	H.Garland	G.Wolfenden	MCH
Date	23/11/04	26/11/04	1/12/04

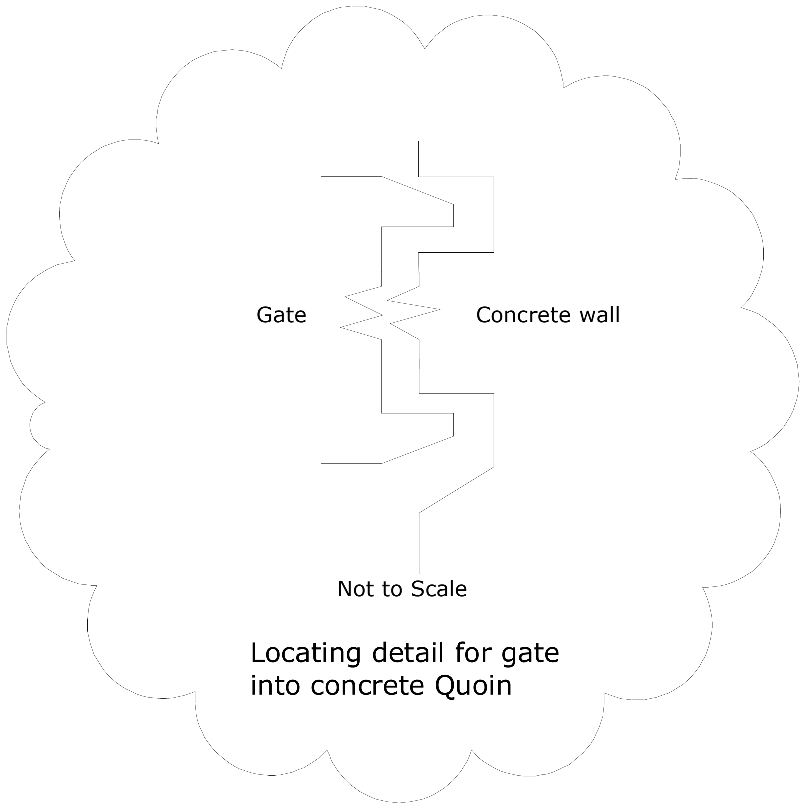
Drg. No.	Sheet No.	Rev.
SP/GH/0/04/12/118	01 of 01	0



ELEVATION OF DOCK GATE FROM SEAWARD 1:500



PLAN OF DOCK GATE 1:500



Locating detail for gate into concrete Quoin

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title:
New Dock Gate Elevation & Plan

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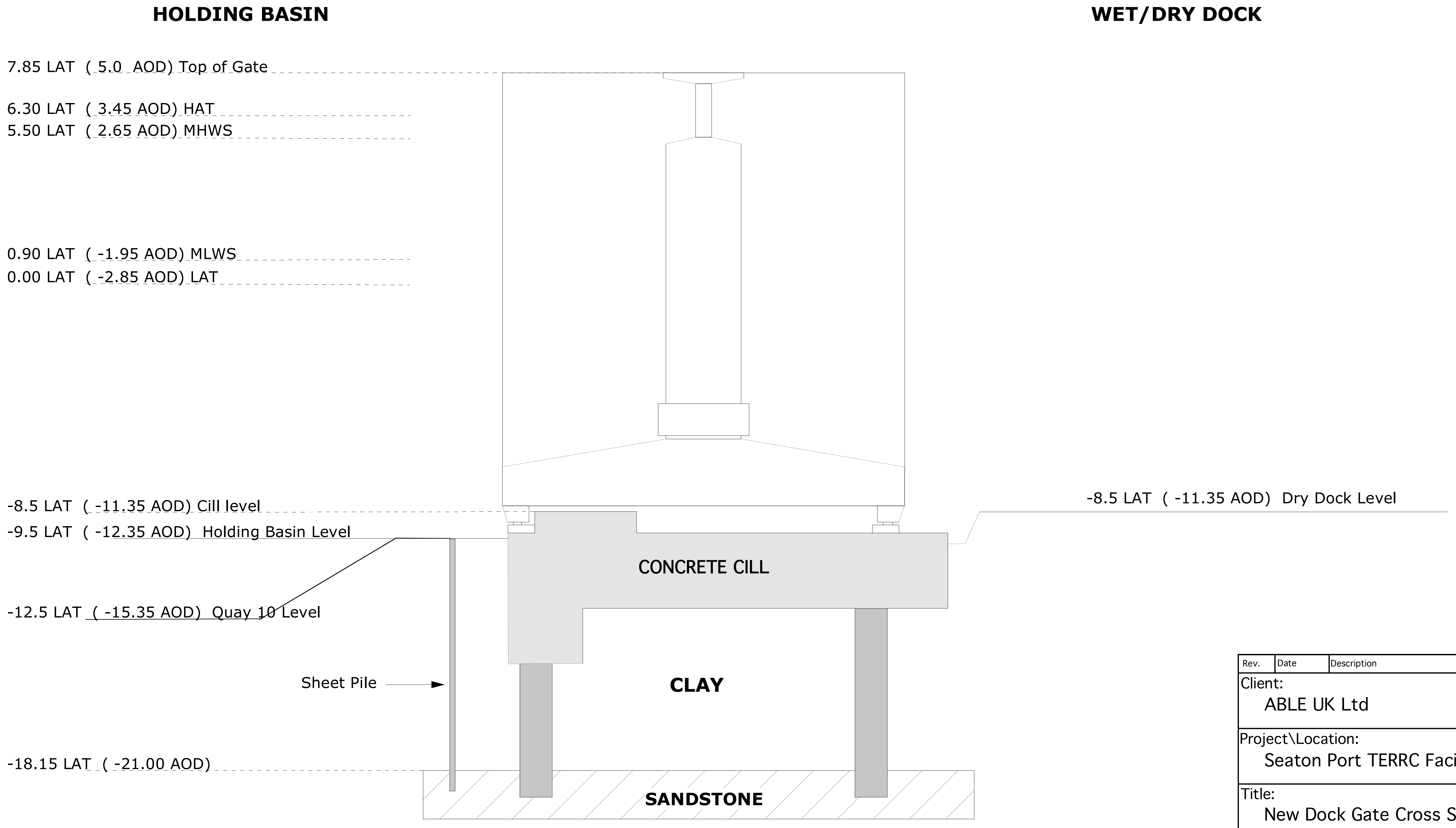
Contract No.

CAD Ref.

Scale	Drawn	Checked	Approved
1:500	H.Garland	G.Wolfenden	MCH
Date	15/12/04	15/12/04	17-12-04

Drg. No.	Sheet No.	Rev.
SP/GH/0/04/12/119	01 of 01	0



TYPICAL CROSS SECTION THROUGH NEW DOCK GATE 1:150

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title:
New Dock Gate Cross Section

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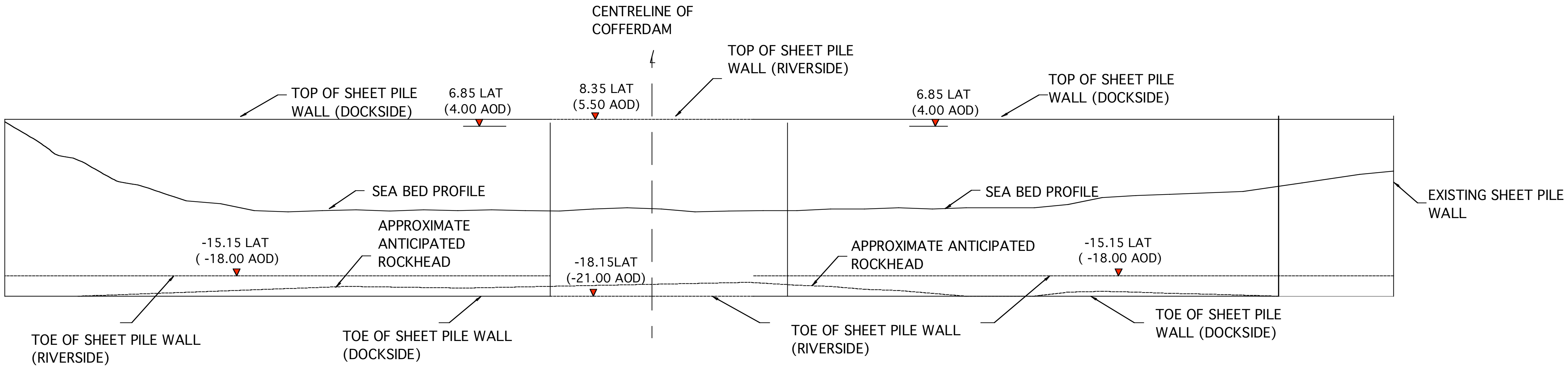
Fax: +44-(0)1642 655655
email: info@ableuk.com
www.ableuk.com

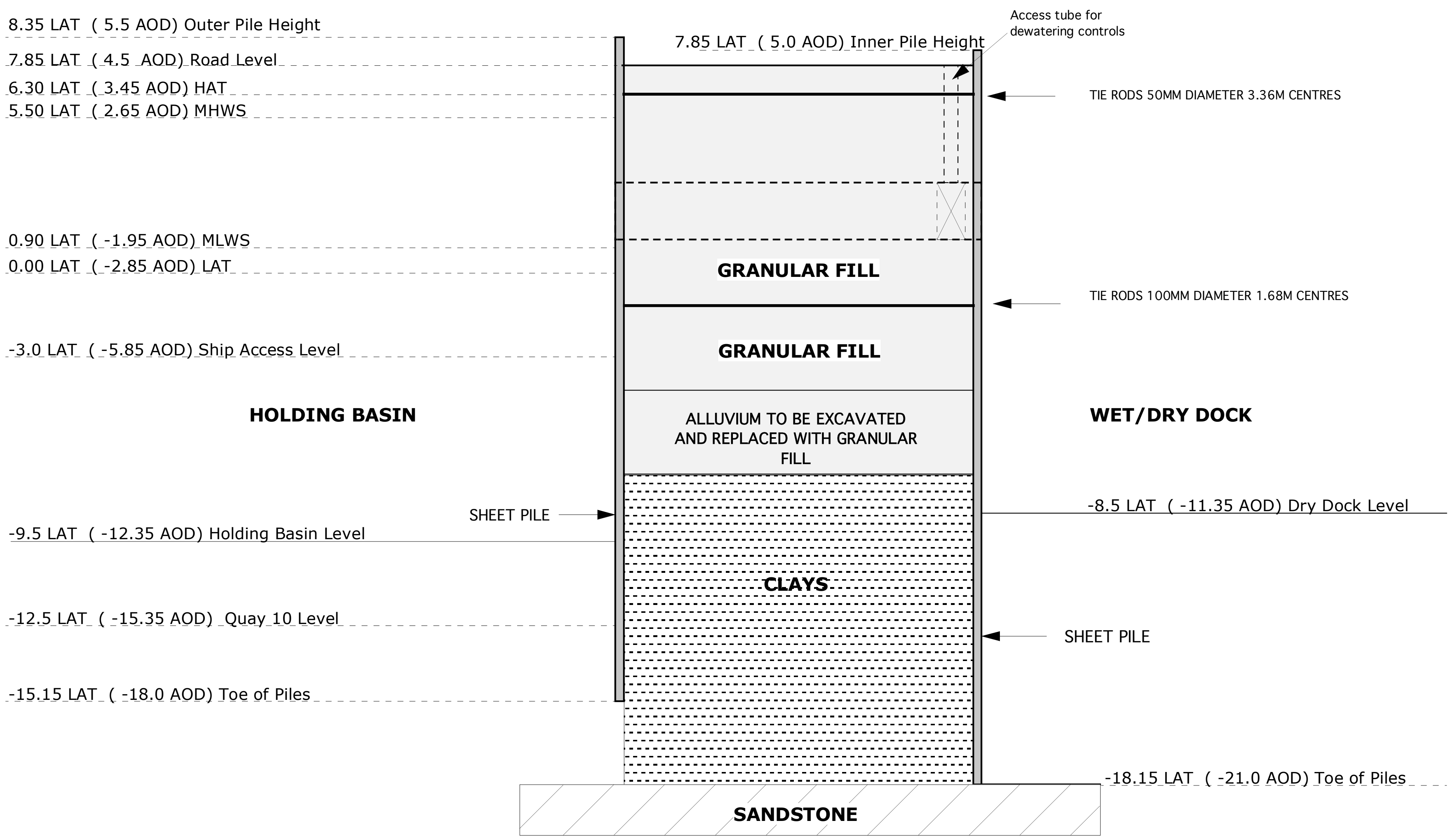
Contract No.	CAD Ref.

Scale	Drawn	Checked	Approved
1:150	H.Garland	G.Wolfenden	MCH
Date	15/12/04	15/12/04	20-12-04

Drg. No.	Sheet No.	Rev.
SP/GH/0/04/12/120	01 of 01	0



ELEVATION OF SEA BED AND COFFERDAM (REPRESENTATIONAL ONLY: DO NOT SCALE)



TYPICAL CROSS SECTION THROUGH TWIN WALLED
COFFERDAM 1:200

Rev.	Date	Description	BY	CHD	APP

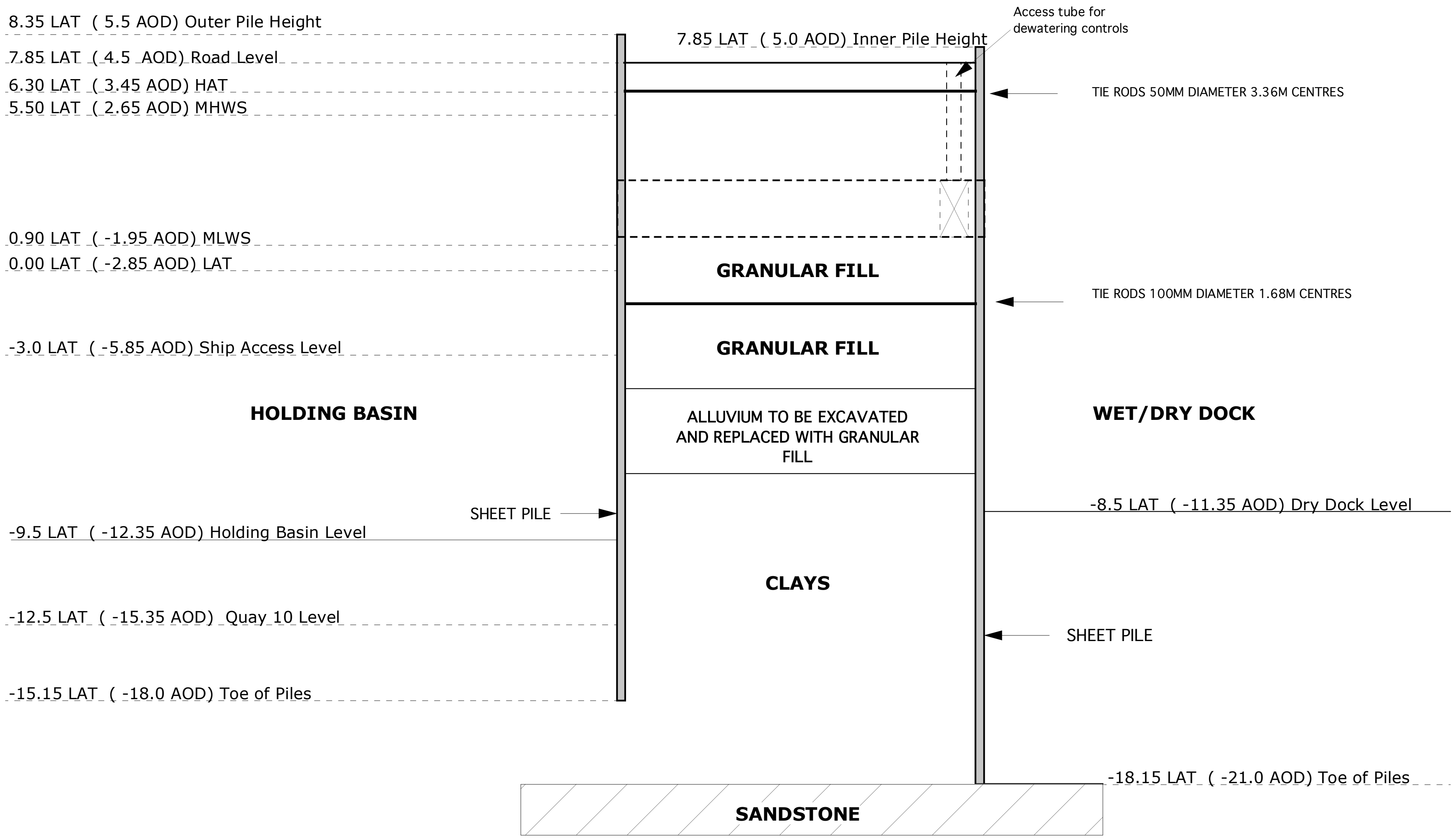
Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title:
Cofferdam Main Cross Sections

AbleUK Ltd
Able House
Billingham
Teesside UK
TS23 1PX
Tel: +44-(0)1642 806080
Fax: +44-(0)1642 655655
email: info@ableuk.com
www.ableuk.com

Contract No.		CAD Ref.	
Scale 1:200	Drawn H.Garland	Checked G.Wolfenden	Approved MCH
Date	15/12/04	15/12/04	21/12/04
Drg. No. SP/GH/0/04/12/121		Sheet No. 01 of 01	Rev. 0



TYPICAL CROSS SECTION THROUGH TWIN WALLED COFFERDAM 1:200

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

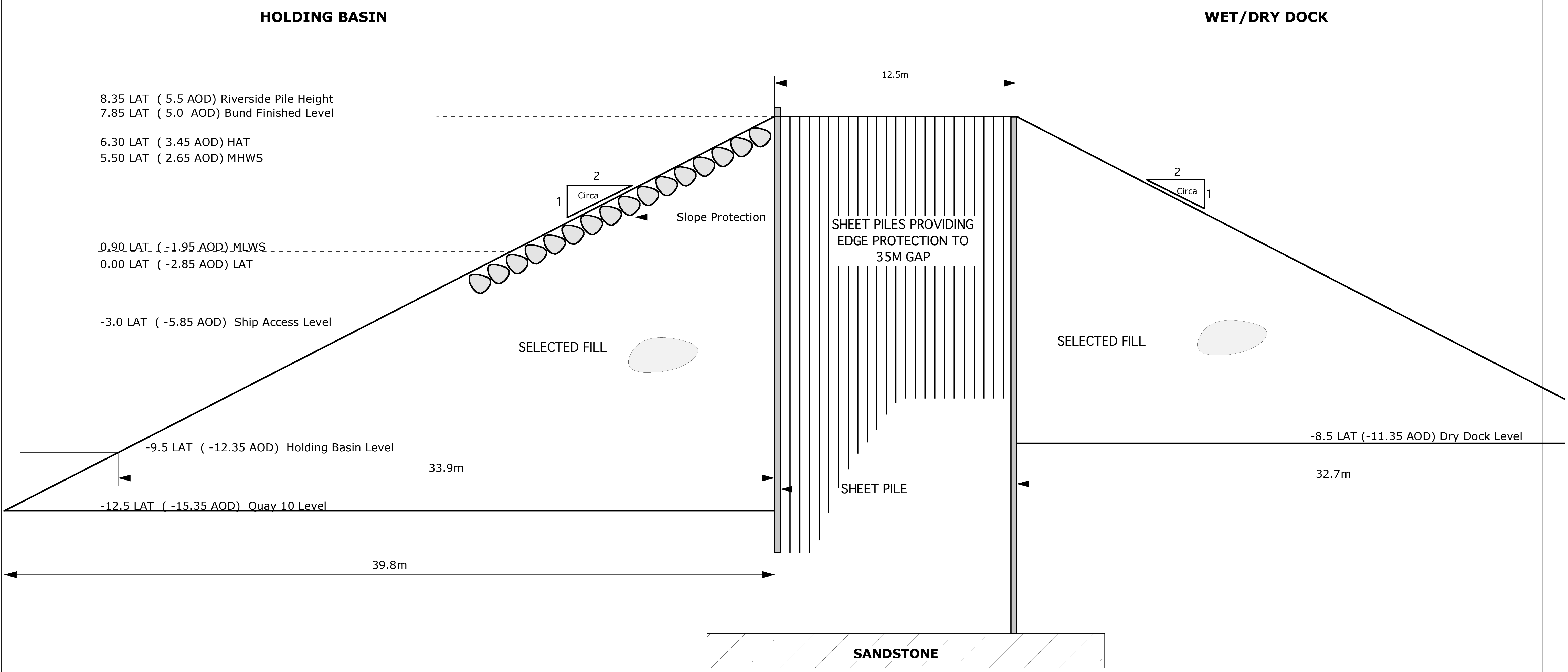
Title:
Cofferdam Alternative 1 Cross Section

AbleUK Ltd
Able House
Billingham
Teesside UK
TS23 1PX
Tel: +44-(0)1642 806080
Fax: +44-(0)1642 655655
email: info@ableuk.com
www.ableuk.com

Contract No. | CAD Ref.

Scale	Drawn	Checked	Approved
1:200	H.Garland	G.Wolfenden	MCH
Date	15/12/04	15/12/04	18-12-04

Drg. No.	Sheet No.	Rev.
SP/GH/0/04/12/122	01 of 01	0



TYPICAL CROSS SECTION THROUGH COFFERDAM
AT 35M FUTURE GAP LOCATION 1:200

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title:
Cofferdam Alternative 1 Bund Cross Section

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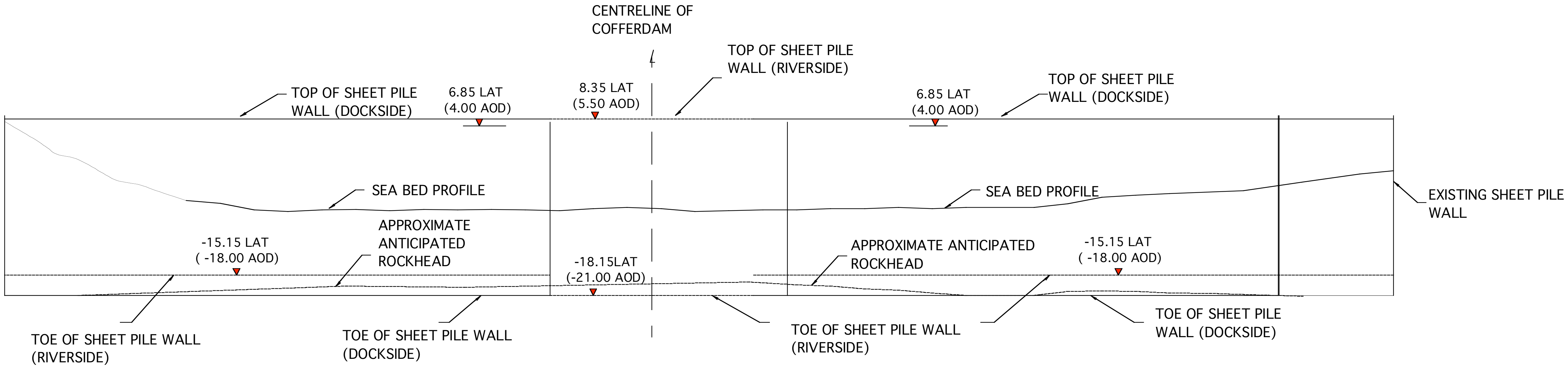
email: info@ableuk.com
www.ableuk.com

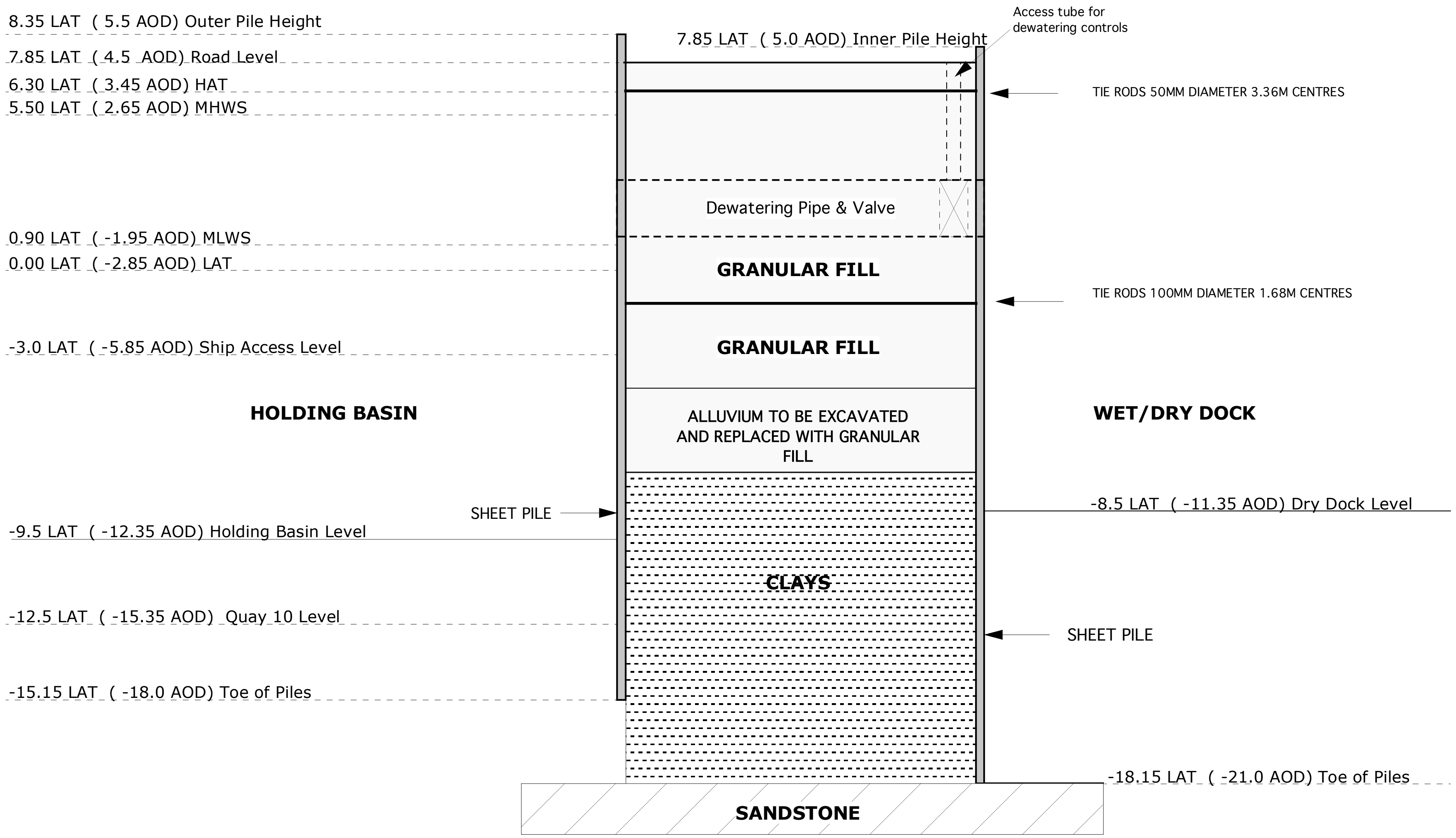
Contract No.	CAD Ref.

Scale		Drawn	Checked	Approved
1:200		H.Garland	G.Wolfenden	MCH
	Date	15/12/04	15/12/04	19/12/04

Drg. No.	Sheet No.	Rev.
SP/GH/0/04/12/123	01 of 01	0



ELEVATION OF SEA BED AND COFFERDAM (REPRESENTATIONAL ONLY: DO NOT SCALE)



TYPICAL CROSS SECTION THROUGH TWIN WALLED
COFFERDAM 1:200

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\Location:
Seaton Port TERRC Facility

Title:
Cofferdam Alternative 2 Cross Sections

AbleUK Ltd
Able House
Billingham
Teesside UK
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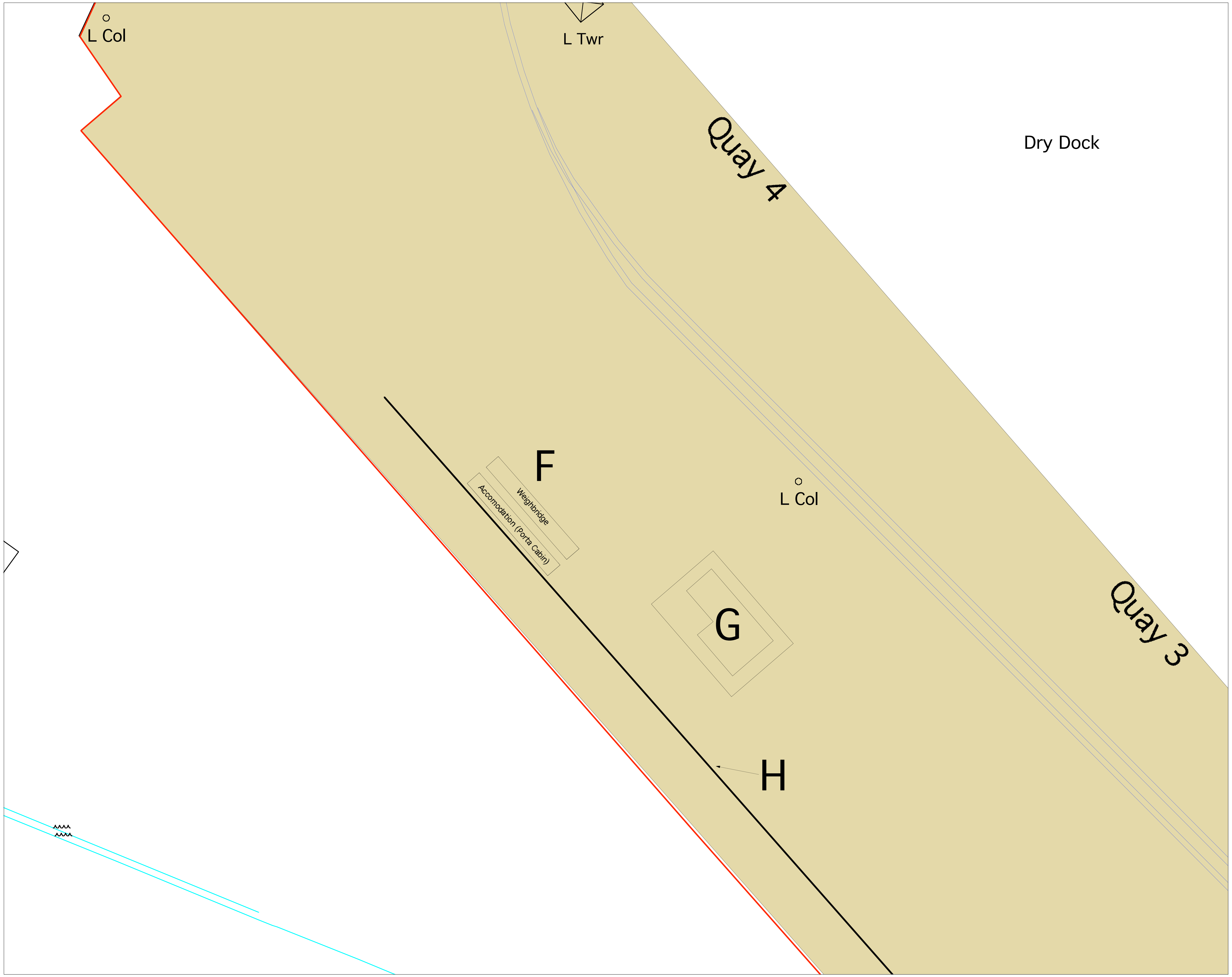
Contract No.	CAD Ref.		
Scale	Drawn	Checked	Approved
1:200	H.Garland	G.Wolfenden	MCH
Date	15/12/04	15/12/04	20/12/04
Drg. No. SP/GH/0/04/12/124	Sheet No. 01 of 01	Rev. 0	



Planning Application Legend

F	Accomodation & Weighbridge
G	Metal Shear
H	Acoustic Barrier

Rev.	Date	Description	BY	CHD	APP

Client:
ABLE UK Ltd

Project\ Location:
Seaton Port TERRC Facility

Title:
Shear Accomodation Location

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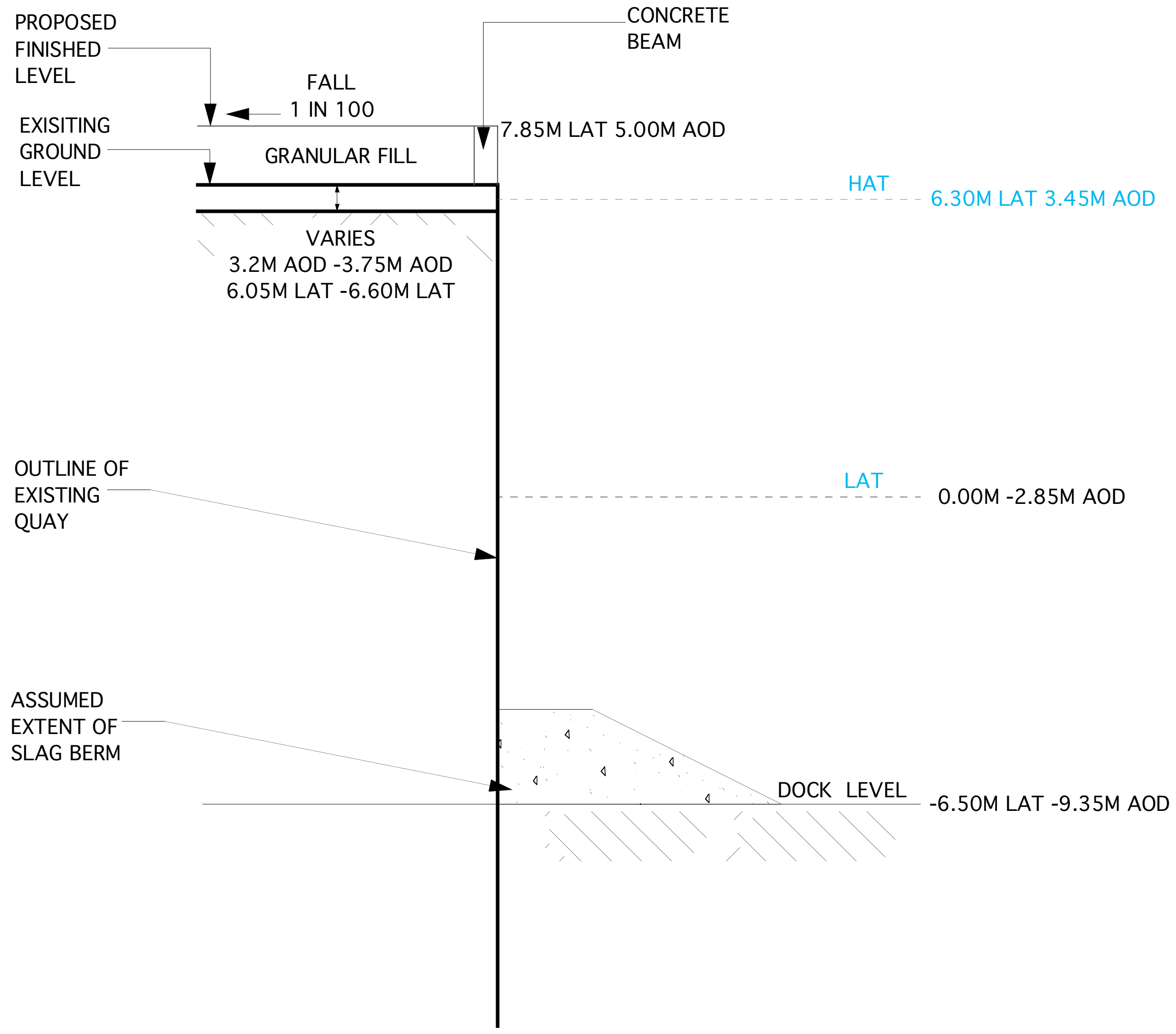
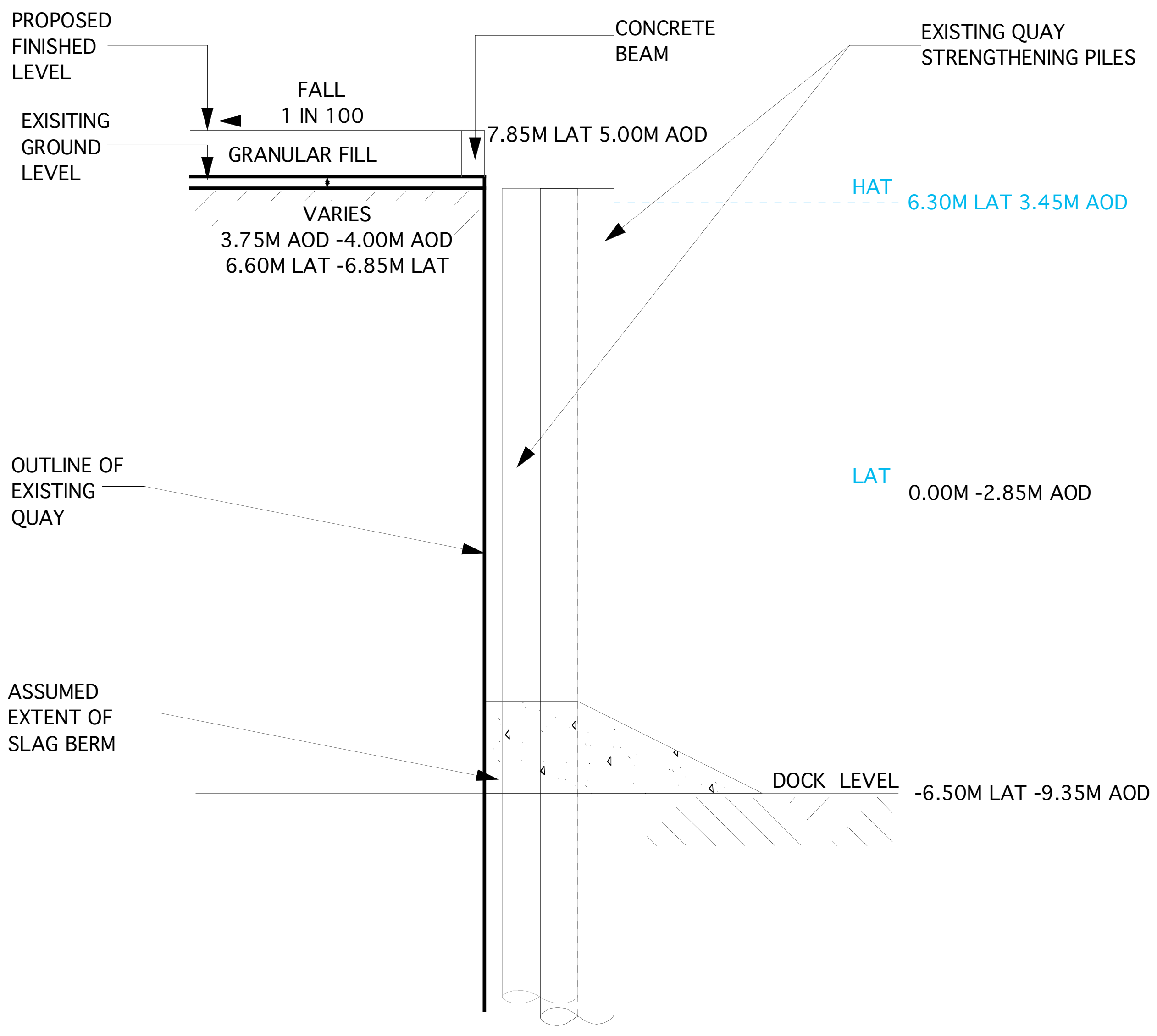
Scale: 1:1000	Drawn	Checked	Approved
	H Garland	G Wolfendon	MCH
Date	01/12/04	17/12/04	21/12/04

Drg. No. SP/GH/0/04/12/125



Typical Cross Section Of Quay 9 1:150



Typical Cross Section Of Quay 8 1:150

Rev.	Date	Description	BY	CHD	APP

Client: ABLE UK Ltd

Project: Seaton Port TERRC Facility

Title: Typical Cross Sections of Quays 8 & 9

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Contract No.

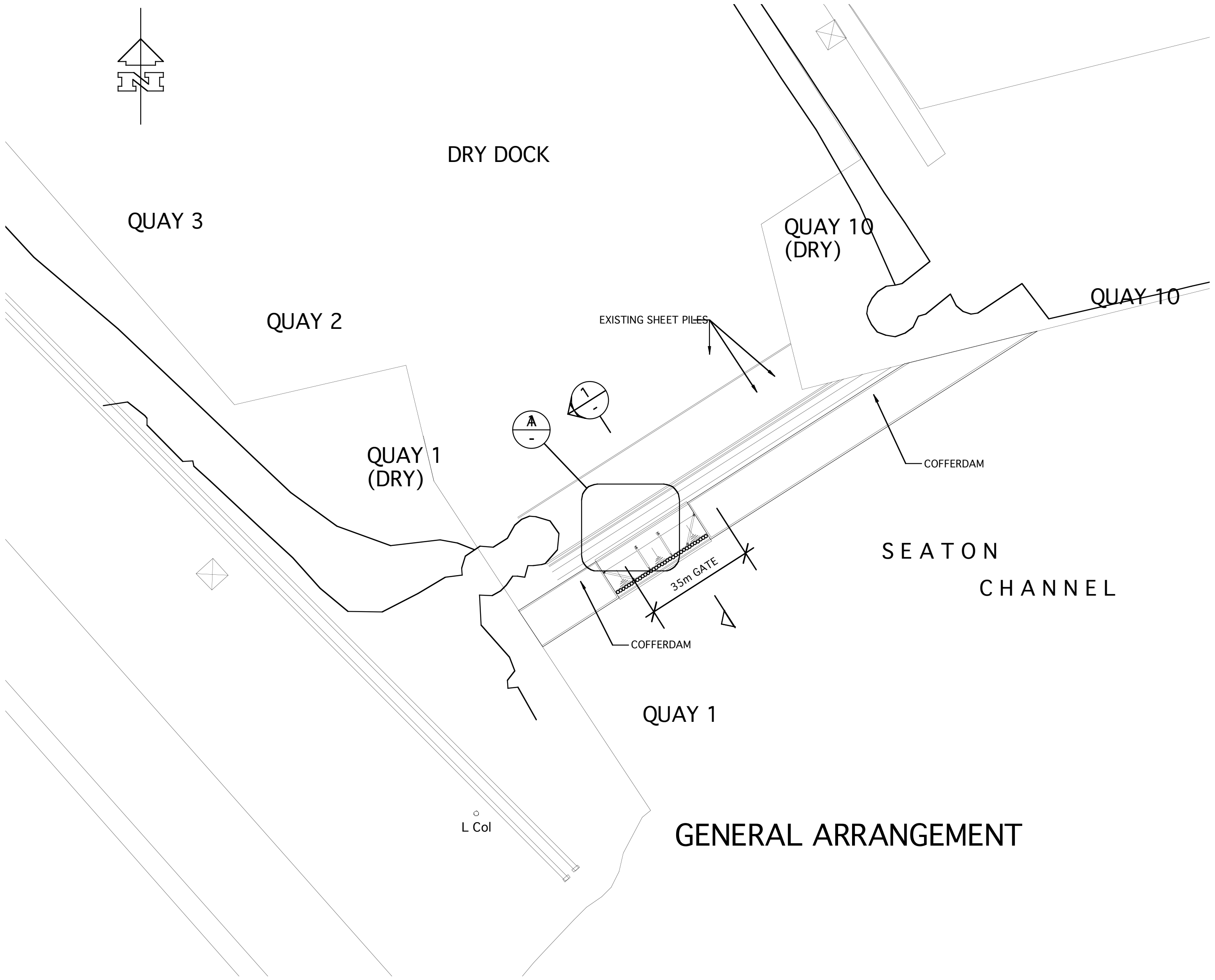
CAD Ref.

Scale	Drawn	Checked	Approved
1:150	H. Garland	G. Wolfenden	G. Wolfenden
Date	27/01/05	27/01/05	27/01/05

Drg. No. SP/GH/0/04/12/126

Sheet 01 of 01

Rev. 0



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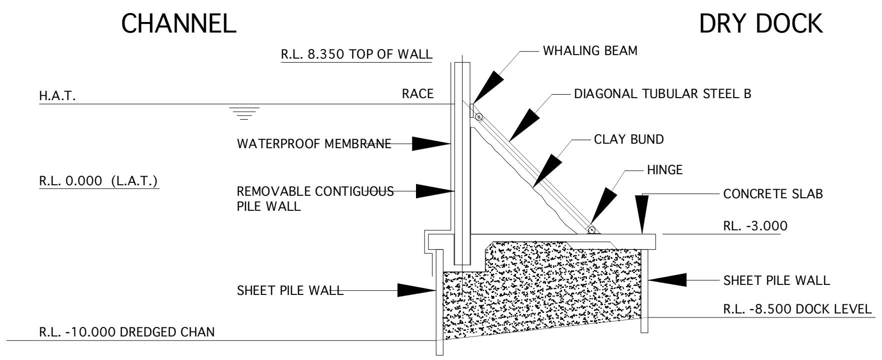

SECTION 1
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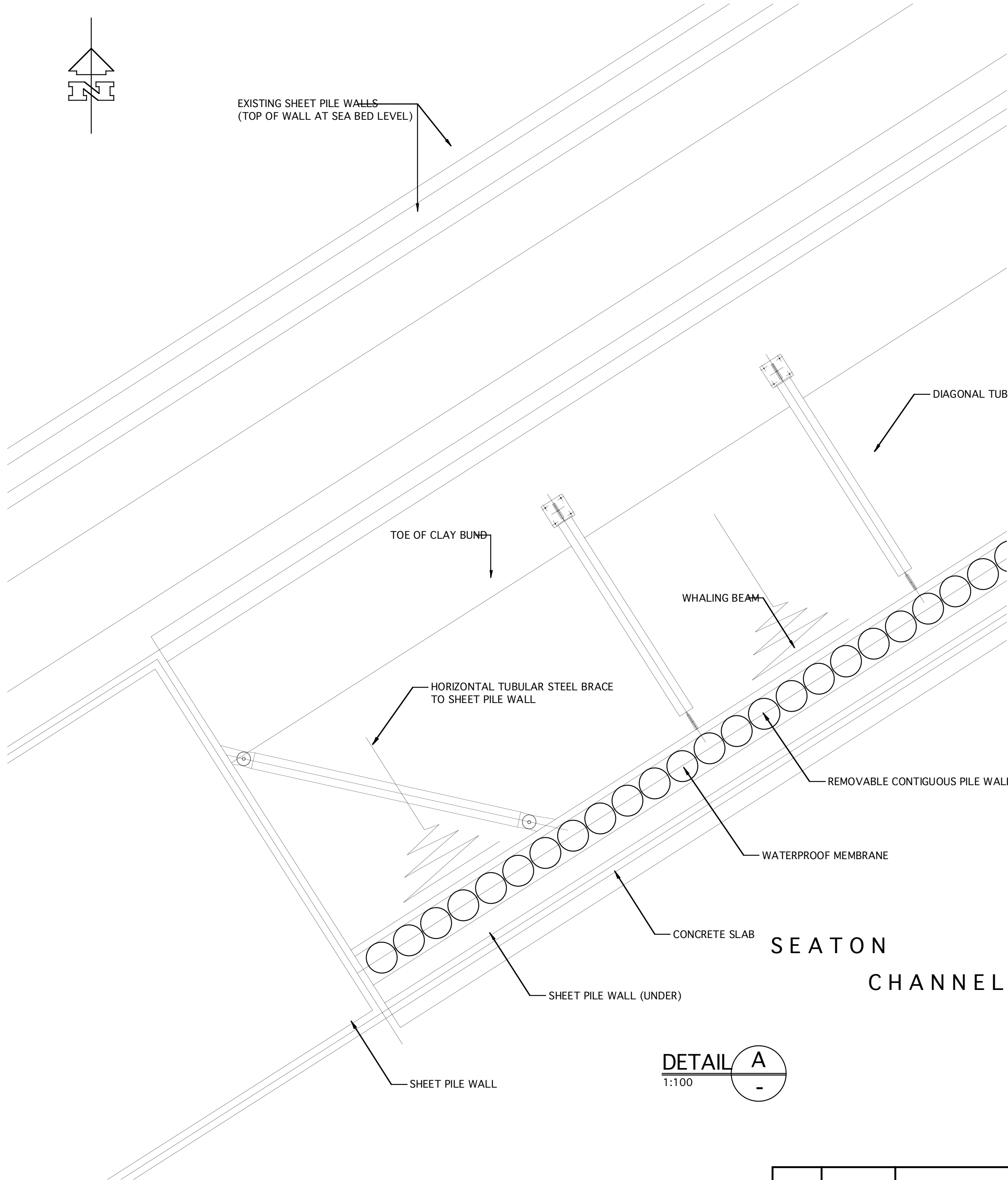

DETAIL A
1:100

Rev.	Date	Description	BY	CHD	APP

Client: ABLE UK

Project: Seaton Port TERRC Facility

Title: Indicative Concept For Cofferdam Opening

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Contract No.	CAD Ref.	
Scale 1:250 / 1:100	Drawn	Checked	Approved

Scale	Drawn	Checked	Approved
1:250 / 1:100	H. Garland	G. Wolfenden	MCH
Date	27/01/05	27/01/05	27/01/05

Drg. No. SP/GH/0/04/12/127 — Rev. 1

Appendix 1.2

Hartlepool Borough Council Formal Scoping Opinion

SCOPING OPINION IN RELATION TO PROPOSED PROJECT FOR:-

1. **Application No 1 for change of use to include all types of structures that may be delivered to TERRC either on a floating vessel such as a barge or delivered under its own power or delivered by being towed including ships, Salm's (**a large steel cylinder either floating vertically or moored to the sea being used mostly in the oil & gas industry offshore normally for mooring ships)**, Buoys, submarines, aircraft carriers, tankers, crane ships, cargo ships, Tension leg platforms, jackets, topsides, Mobile production Units, Navy Ships, Ro-Ro Ships, Barges, Drilling Rigs, Gravity Base structures, Jack Ups (**a type of platform that jacks itself up from the sea bed) **etc. This permission is to allow construction, repairs, refurbishment and decommissioning.**

2. **Application No 2 for a bund in the same location as per Laing application which was approved Oct 1997 (plan ref: TDC/95/010)**

3. **Application No 3 for a bund in the same location as per our last application (received 20 August 2003) which was withdrawn (17 September 2003), this is in front if the existing gate location.**

Issues that are required to be encompassed within Environmental Statement for the proposed developments.

A. **Actions related to the extended usage of the site (application 1) considered to give rise to impacts requiring assessment:-**

i. Transportation of the various structures to the site (Transfrontier impacts are required to be assessed).

ii. Storage of the structures at the site and potentially outside the bund area e.g. in Tees Bay or within the Tees Estuary. The maximum dimensions of the various structures specified need to be stated.

iii. Dismantling, refurbishment, repair and construction of structures in both wet and dry dock conditions or on land (this should include description of the different processes involved in relation to each type of structure where relevant). Wet dock working is a key risk area.

iv. Processing of materials including breaking, salvage, storage and removal of recyclable materials and the temporary presence, handling, extraction and removal of waste materials (in both wet and dry dock conditions or on land). Such materials include Bilge water; Ballast water; Ballast sediments; Invasive plant / animal material; Sewage and domestic waste; Hydrocarbon oils; Oily sludges; Oil and fuel; Chemicals and gases; Asbestos; Non ferrous metals; Paints, including TBT and other organotin compounds; Materials containing

PCBs; Refrigerants; Acids; Solvents; Antifreeze; Dust; Radioactive substances; and Other liquids.

v. Land reclamation / changes to land surface required to accommodate processes listed at (iv).

vi. Transportation of waste and recyclable materials from and within the site.

vii. Disposal of all waste materials (including any nuclear related materials) whether by landfill, chemical treatment or incineration.

viii. Recycling of recyclable materials both at and beyond the site.

B. Bund (application 2) / cofferdam (application 3) related actions considered to give rise to impacts requiring assessment: -

i. Construction and removal of proposed bund / cofferdam including transportation of constituent materials to and from the site, preliminary dredging work and steel piling operations. Assessment should also consider the necessary upkeep and maintenance of the bund /cofferdam. Assessment of the combined implications of carrying out construction work on and removal of both the bund and cofferdam should be covered if both structures could be installed. The repeated impacts of constructing and deconstructing the bund / cofferdam should also be considered.

ii. Erection of new dock gates (if proposed).

iii. Dredging operations in order to ‘finish’ the dry dock and to allow for the berthing of vessels.

iv. The use(s) to which the dry dock created by the bund / cofferdam and / or dock gates will be put.

v. Repeated dewatering and re-flooding of the dock basin.

Each of the aforementioned actions in sections A and B will need to be assessed in terms of their impacts in combination with one another and with existing, approved and proposed uses and activities e.g. the nearby power station and any proposed nearby windfarm construction.

Potential impacts (Actions likely to cause the following impacts are denoted in brackets. Many of the following overlap and interrelate)

1. Human Health

a) During all operations and processes, including ancillary operations such as post operation cleansing units and due to inadvertent transfer of contaminated material for example on footwear and clothes. The assessment should cover the quality or toxicity of air, water, foodstuffs and other products consumed by humans. **(Ai-viii) (Bi-v)**

b) Vulnerability of communities in the short, medium and longer term to disease and any abnormal mortality rate as a result of exposure to pollution with particular regard to the proximity between the waste disposal sites and residential areas should be assessed. **(Ai-viii) (Bi-v)**

2. Ecology

a) General impacts on marine, estuarine and terrestrial life

During all stages of a project from importation of structures to recycling and disposal of the associated waste. Particular focus is required on release of toxic, persistent or endocrine disrupting substances such as anti-foulants during dismantling operations or re-flooding of the basin. The assessment should cover the presence of toxic heavy metals within flaking paints including indicative quantities of such substances. **(Ai – viii) (Bi-v)**

b) **Waterbird populations.**
The extent and magnitude of any adverse effects including potential contamination of the food chain, noise and visual disturbance impacts and how such effects might vary throughout the year should be examined in relation to the Seal Sands Site of Special Scientific Interest (S.S.S.I.), The Teesmouth and Cleveland Coast Special Protection Area (S.P.A.) and Ramsar site. **(Ai – viii) (Bi – v)**

c) Seal populations
The extent and magnitude of any adverse effects including potential contamination of the food chain, noise and visual disturbance impacts and how such effects might vary throughout the year should be examined in relation to the Seal Sands Site of Special Scientific Interest (S.S.S.I.), The Teesmouth and Cleveland Coast Special Protection Area (S.P.A.) and Ramsar site. **(Ai – viii) (Bi – v)**

d) Introduction of alien species and pathogens. For example from fauna encrusted on ships and present within ballast water. The potential for importing non-native species is a risk, from within ballast/bilge/waste waters, ballast sediment and on the hull (especially significant if vessels are in a poor state of repair and are untreated with anti-fouling substances). Assessment must be made of the provisions in place for dealing with ballast water in particular. **(Ai – viii) (Biv – v)**

e) Hydrological and Hydrodynamic effects
The effect of the developments in terms of changes in tidal currents, local wave climate, sediment transport potential, patterns of sediment erosion and accretion and contaminant transport particularly that brought about by the exclusion of tidal waters from Graythorp dock. These effects all need to be considered in combination with existing discharge consents. The assessment should include the current proposal to remove 616,000 cubic metres of

sediment from in front of adjacent Quays 10 and 11 and the effects of any proposal to deepen Seaton Channel. This is relevant as the current channel depth is not deep enough to permit passage of large vessels such as aircraft carriers, therefore a capital dredge is implied by this application. A properly modelled assessment of the likely hydrological and hydrodynamic effects of a capital dredge capable of allowing their safe passage and the consequential impacts on the subtidal and intertidal habitats should be provided. This would then have to be related to any consequential impacts on the qualifying interests of the Seal Sands SSSI and the SPA/Ramsar site. **(Bi - v).**

f) **Re-suspension of contaminated sediment**
Its transport to intertidal areas during dredging operations. **(Ai-vi) (Bi - v).**

3. Water and ground condition

a) **Construction / fill material of bund / cofferdam.** The source of the material should be identified and any impacts associated with its procurement investigated. The potential for fill material to contain contaminants and for those contaminants to be leached away should be scrutinised. Measures to ensure contamination of Seaton Channel is avoided on removal of the bund / cofferdam should be set out. **(Bi)**

b) **Dewatering and reflooding of the dock basin.** Potential contamination to tidal waters in general and those overlying statutory nature conservation sites (Seal Sands SSSI and the SPA / Ramsar site) in particular resulting both from the controlled dewatering and reflooding processes and also through escaping via any weaknesses in the dock gates (if proposed) and / or bund / cofferdam should be investigated. The potential conflict with estuarine birds (especially ground nesting terns) from any scavenging animals drawn as a result of the dewatering process should be assessed. Further advice should be sought from English Nature. **(Ai-vi)(Bi, iv and v)**

c) **Airborne matter**. Including any impacts on air, land, water and local ecology and human health from the transfer of any airborne matter arising as a result of the transportation, storage of structures, any of the processes taking place within the dock whether in wet or dry conditions, during the breaking of dismantled material, during the period of transfer of the material from the site to its place of disposal or following disposal and arising from the construction presence and removal of the bund / cofferdam. **(Ai-viii) (Bi – v).**

d) **Surface water drainage run off.** Any impacts on land, water, local ecology and human health. Assessment must be made for the potential for seepage from the yard, from surface water run-off and contaminants. Safety measures in place to deal with this should also be detailed. An assessment of the robustness of existing and proposed flood defence measures in relation to both water ingress and subsequent water run-off should be made. **(Aii-viii) (Bi – v).**

e) Site flooding. Any impacts on land, water, local ecology and human health due to flooding of the application site and waste disposal site taking account of the predicted rises in sea level. **(Aii-viii) (Bi – v).**

f) Disposal of waste material. Potential contamination of groundwater and migration of gas and any other leachate resulting from the disposal of wastes including hazardous wastes. **(Avii)**

4. Condition of dock basin and entrance sill

a) **Dredging.** The disposal of potentially contaminated dredged sediments overlying both the footprint of the bund / cofferdam, the dock basin and to enable access to any of the berths prior to any operations being undertaken in the dock whether in wet or dry conditions will need to be addressed. Dredging will need careful planning and monitoring to avoid problems with the intakes by the Power Station and the contamination of the Seal Sands SSSI and the SPA / Ramsar site. Any capital and maintenance dredging required should be assessed for its impact on water turbidity (see below), local ecology including increased disturbance to seals and birds, and contaminated sediment re-suspension.

From a marine perspective, this represents the most significant risk to the environment. Thorough assessment needs to be made of the degree of historical contaminants (heavy metals, pesticides, PCBs, TBT, PAHs) present in the sediment within and outside the dock area. This must include assessment of both contaminant levels and potential impacts of any such contaminants. Re-suspension of contaminants caused by dredging could affect interest features in the area such as estuarine birds and marine mammals via bioaccumulation through the food web. It is essential that any sediment sampling examines deep, underlying sediment (deep coring required).

As mentioned above dredging will also increase water turbidity and the effects of this (such as reduced primary productivity) need to be assessed. Increased turbidity will cause the smothering of benthic infauna, leading to a reduction in food availability to estuarine birds. Loss of invertebrates is also undesirable as they play a role in burying contaminated sediment and reducing its bioavailability.

Dredging activities in the area are regulated in conjunction with English Nature so as to disturb birds as little as possible. Further advice on suitable dredging times should be sought from English Nature.

The assessment of methods to reduce the impact of dredging is essential, e.g. silt screens. A realistic dredging volume should be sought from PD Teesport.
(Ai-vi)(Bi-v)

b) **Impacts on sediments within dock**. This should be examined both within the context of exclusion of tidal waters in itself and taking account of the impact of any operations within or affecting the dry dock. The disposal of potentially contaminated sediments will need to be addressed. **(Ai-vi) (Bi-v)**

c) **Leachate from contaminated sediments** – The potential for any sediment pollutants in the dock basin emanating from any operations in the dock whether in wet or dry conditions to be conveyed to the Seaton Channel via weaknesses in any dock gates and / or the bund / cofferdam. **(Ai-vi) (Bi-v)**

5. Noise and vibration impacts

a) Impact of noise and vibration on human health and on environmentally sensitive sites (Seal Sands SSSI and the SPA / Ramsar site) having particular regard to sensitive periods. **(Ai – Aviii) (Bi-v)**

6. Odour impacts

a) Impact of odour on human health and on environmentally sensitive sites (Seal Sands SSSI and the SPA / Ramsar site). **(Ai – Aviii) (Bi-v)**

7. Traffic Impacts including (road, rail and sea).

a) Impacts in terms of noise and other forms of pollution **(Ai-Aviii) (Bi-v)**

8. Risk of accidents occurring.

a) From explosions, spillages e.g. oil and ballast discharge, fires or from the failure of pollution control systems both within and outside the bund areas. The impact of oil spillage near Hartlepool power station (particularly its relationship with cooling water) must be assessed in liaison with British Energy. **(Ai-Aviii) (Bi-v)**

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9. Visual impacts

a) Visual impact of proposed development on the surrounding area. **(Ai – Aviii) (Bi – ii)**

10. Waste Management Capacity

a) What impact will proposal have on long-term waste disposal requirements? Would the project bring forward the need for additional landfill site provision? **(Avii).**

11. Cradle to Grave

a) Assessment should be made of the life span of the dock and the ecological implications for its removal. Assessment should look at levels of contaminants predicted to be present within the dock at the end of its working life.

Assessment should also look at the necessary upkeep and maintenance of the bund / cofferdam. **(Ai-Aviii) (Bi-v)**

12. Economic Regeneration

a) Direct and indirect employment creation and safeguarding associated with construction operations and later processes. **(Ai-Aviii) (Bi-v)**

b) Any detrimental economic impact relating to the visitor economy **(Ai-Aviii) (Bi-v)**

13. Archaeology.

a) An assessment should be made of the impact on undisturbed prehistoric peat deposits which may lie beneath the existing dock. **(Ai-Aviii) (Bi-v)**

Informatives

i. All of the above need to be assessed in relation to baseline data which should be clearly identified within the Environmental Statement.

ii. The Environmental Statement will be expected to indicate the extent and content of monitoring programmes necessary to facilitate ongoing assessment of the impacts referred to.

iii. The preparation of the Environmental Statement should have full regard to the requirements of both Parts I and II of Schedule 4 of the Town and Country Planning (Environmental Impact Etc.) Regs. 1999.

Appendix 4.1

House of Commons Environment Food and Rural Affairs Committee, Eighteenth Report of Session 2003 – 2004

"Dismantling Defunct Ships in the UK. 3 November 2004"

House of Commons
Environment, Food and Rural Affairs Committee

Dismantling Defunct Ships in the UK

Eighteenth Report of Session 2003–2004

HC 834

House of Commons

Environment, Food and Rural Affairs Committee

Dismantling Defunct Ships in the UK

Eighteenth Report of Session 2003–2004

Report, together with formal minutes, oral and written evidence

Ordered by The House of Commons to be printed 3 November 2004

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Environment, Food and Rural Affairs Committee

The Environment, Food and Rural Affairs Committee is appointed by the House of Commons to examine the expenditure, administration, and policy of the Department for Environment, Food and Rural Affairs and its associated bodies.

Current membership

Mr Michael Jack (*Conservative, Fylde*) (Chairman)
Ms Candy Atherton (*Labour, Falmouth and Camborne*)
Mr Colin Breed (*Liberal Democrat, South East Cornwall*)
David Burnside (*Ulster Unionist, South Antrim*)
Mr David Drew (*Labour, Stroud*)
Patrick Hall (*Labour, Bedford*)
Mr Mark Lazarowicz (*Labour/Co-op, Edinburgh North and Leith*)
Mr David Lepper (*Labour, Brighton Pavilion*)
Mr Ian Liddell-Grainger (*Conservative, Bridgwater*)
Mr Austin Mitchell (*Labour, Great Grimsby*)
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A list of Reports of the Committee in the present Parliament is at the back of this Report.

Committee staff

The current staff of the Committee are Matthew Hamlyn (Clerk), Fiona Mclean (Second Clerk), Jonathan Little and Dr Antonia James (Committee Specialists), Marek Kubala (Inquiry Manager), Louise Combs and Jim Lawford (Committee Assistants) and Anne Woolhouse (Secretary).

Contacts

All correspondence should be addressed to the Clerk of the Environment, Food and Rural Affairs Committee, House of Commons, 7 Millbank, London SW1P 3JA. The telephone number for general enquiries is 020 7219 5774; the Committee's e-mail address is: efracom@parliament.uk.

Contents

Summary

Ships have a finite working life, at the end of which they need to be dismantled. Much of the material, such as the steel, that makes up a ship can be recycled. Indeed, the scrap value of the metal means that, whilst the ship owner can sell on defunct vessels, the owner loses direct control over how the vessels are dismantled. However, the ships that are now reaching the end of their lives now also contain hazardous materials such as asbestos, PCBs and waste oils which need to be disposed of safely.

Most large ships are currently dismantled in Asia, but health and safety protection for workers and environmental protection standards there are, by the standards of the developed world, often unacceptable. However, there are few, if any, facilities in the developed world that are capable of dismantling the largest ships. Recent experience in Hartlepool, England showed that strong objections might be raised to the development of such facilities.

The regulatory framework that applies to ships as waste, advocated principally by the International Maritime Organisation, is complex and difficult to apply and enforce. Although some welcome first steps have been taken, including the development of voluntary guidelines and the establishment of an international working group, much still needs to be done to create a coherent and effective international regime.

The Government has an important role to play in ensuring this issue receives the necessary international attention and priority, particularly during the United Kingdom's forthcoming EU Presidency and chairmanship of the G8. At that time, the Government will have a significant opportunity to ensure that greater priority is given to this issue and to help to determine a workable set of rules governing the safe dismantling of ships.

At home, the Government must also do everything it can to persuade UK-based ship owners to arrange for their vessels to be disposed of responsibly. It is imperative that, as a first step, it ensures that all naval and other publicly-owned vessels are dismantled to the highest health, safety and environmental standards.

1 Introduction

1. Ships have a finite, albeit long, working life, at the end of which they need to be dismantled. Much of the material they are made from, such as the steel, can be recycled, but many of the ships that are reaching the end of their lives now also contain hazardous materials, such as asbestos, PCBs and waste oils, which need to be disposed of safely.

2. It is estimated that, world-wide, about 700 large commercial vessels are scrapped every year.[1] In addition, a number of naval vessels and smaller coastal transport and fishing vessels are also scrapped. In this inquiry we focussed on the disposal of larger vessels capable of international voyages. The recent decision by the International Maritime Organisation to phase out all single-hulled tankers by 2015 at the latest will increase the number of vessels which will need to be dealt with over the next few years.[2]

3. There has been growing concern about the health and environmental impacts of ship dismantling: Greenpeace, for example, has been campaigning against the dismantling of ships in poor conditions in Asia.[3] There have also been concerns about ship dismantling in England. In 2003, the Committee examined the case of a British company, Able UK Ltd, which had intended to dismantle and recycle redundant ships from the US auxiliary fleet.[4] The company had entered into an agreement with the ships' owner, the United States Maritime Administration (MARAD) and was granted a trans-frontier shipment permit to import the ships by the Environment Agency. A number of the ships were brought across the Atlantic to Able UK's facility in Hartlepool, County Durham.

4. Objections from the public and environmental groups led to two judicial reviews of the decisions to permit Able UK to take the ships. The reviews ruled that Able UK did not have the necessary permits to carry out the work. Able UK must now conduct further environmental assessments and seek planning permission before it can go ahead. Both the Environment Agency and Defra have conduced reviews of the lessons learned from the Hartlepool situation. It is clear that, although it remains the company's responsibility to ensure that it has all the relevant permits to carry out the work, the regulatory structure governing ship dismantling is highly complex and perhaps little understood.

5. The evidence we heard about Able UK's proposal to dismantle the US ships suggested that a more detailed examination of the wider issues of ship dismantling was necessary. So, on 25 March 2004 we announced a new inquiry with the following terms of reference:

> In light of the issues surrounding the dismantling of US Navy vessels on Teesside, the phasing out of single-hulled tankers, and the need to dispose of defunct UK naval vessels, the Committee is undertaking an inquiry into the environmental impacts of dismantling defunct ships in the United Kingdom, and the methods of disposal to be used. In particular the Committee will consider:

[1] Q9

[2] Ev 69 [International Maritime Organisation], para 4. Most have to be scrapped by 2010 and some—the oldest—by 2005.

[3] http://www.greenpeace.org/international_en/campaigns/intro?campaign_id=3990

[4] Environment, Food and Rural Affairs Committee, *US 'Ghost Ships'*, Minutes of Evidence and Memoranda, HC 1336 Session 2002–03, Ev 39

- what facilities and expertise are already in place in England and Wales to dismantle defunct ships safely
- what is the likely demand for such facilities and what would be the likely economic and environmental impacts of meeting such a demand
- what is the legal status of importing such vessels for dismantling (the Committee will particularly seek to clarify what are the implications for the industry of the Stockholm Convention on Persistent Organic Pollutants), and
- how defunct United Kingdom vessels are currently dealt with, and what plans have been made to cope with their disposal.[5]

6. In response to our call for written evidence, we received 15 memoranda. We took oral evidence in June and July 2004 from: the Chamber of Shipping; Friends of the Earth; Greenpeace; Able UK Ltd; the Environment Agency, and Elliot Morley MP, Minister for Environment and Agri-Environment, Department for Environment, Food and Rural Affairs. We also discussed the matter informally with European Commission officials during a Committee visit to Brussels in July 2004. We are most grateful to all those who submitted evidence or otherwise helped us during the inquiry.

2 How are defunct ships currently dealt with?

7. Most ships from developed countries are sold on before they need scrapping.[6] Defra told us that:

> vessels often change flag and ownership over their lifetime. As a result of UK flag pressure many companies are investing in new tonnage and environmentally friendly/benign technology, whilst selling on older vessels as trading entities. Thus, in practice there are very few vessels going direct from the UK register to dismantling facilities.[7]

8. A similar situation applies to vessels owned by the Ministry of Defence (MOD). Defra told us that the MOD estimated that over the next decade 44 vessels will come out of operation, but said:

> once vessels are declared as surplus, MOD policy is to sell ships for continued operation to a new owner, (either to a foreign government or a commercial

[5] Environment, Food and Rural Affairs Committee, Press Notice 41, Session 2003–04, 25 March 2004

[6] Ev 1 [Chamber of Shipping], para 3

[7] Ev 59 [Defra], para 7

> customer) wherever this is possible. Thus, only a few vessels are dismantled immediately, with a majority being sold on as operational vessels.[8]

The MOD does intend to dismantle one ship, HMS Intrepid, and has sought bids from UK yards but has had little interest.[9]

9. Most of those ships owned by UK companies that are scrapped are sold for breaking outside Europe, mainly in India, Pakistan, Bangladesh and China.[10] Ship owners often sell vessels to a broker who then arranges the dismantling, usually by selling the vessel on to a dismantling company.[11]

Concerns about the way ships are dismantled at present

10. The International Maritime Organisation (IMO) note that there had been "growing concerns about environmental safety, health and welfare matters in the ship recycling industry".[12] These concerns had arisen, in large part, from investigations into conditions at ship breaking yards in Asia.

11. Greenpeace has conducted a number of such investigations in India and China.[13] It told us that disposal in poorly regulated facilities in Asia, which lack dry dock facilities and other environmental protection measures and have inadequate health and safety procedures, results in "serious damage to the environment and human health".[14] It described workers removing material, including asbestos, by hand with no protective clothing, using gas torches for cutting metal even where fuel is present, burning cables in the open air with no breathing apparatus and oils and liquid wastes draining directly into the sea.[15]

12. Concern about conditions is not confined to environmental organisations. BP Shipping sent one of its very large crew carriers to Pakistan for dismantling but "were so disturbed by what [they] saw there that [they] were determined that [they] would not do it that way in future".[16] As a result, the company now uses sites in China, where it believes the health, safety and environmental conditions are acceptable. It sends members of its own staff to supervise the dismantling and says it is able to audit the way the hazardous waste that arises during the dismantling is dealt with. P&O Nedlloyd also uses yards in China for the same reasons.[17] Greenpeace told us that conditions in China were better than those in many other countries, but still "nowhere near" state of the art.[18]

13. Nor is concern confined to ship dismantling which takes place in Asia. Environmental organisations and local residents' groups have also raised concerns about

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8 Ev 60 [Defra], para 8

9 Q272

10 Ev 27 [Greenpeace], paras 21–22, Ev 1 [Chamber of Shipping]

11 Ev 27 [Greenpeace], para 21

12 Ev 69 [International Maritime Organisation], para 2

13 Ev 27 [Greenpeace], para 23

14 Ev 27 [Greenpeace], para 31

15 Ev 27 [Greenpeace], paras 25–28

16 Q3

17 Qq3 and 5

18 Q108

the environmental impact of ship dismantling in the United Kingdom. Hartlepool Friends of the Earth media group did not feel that "such large scale, waste generating and potentially hazardous ventures [as ship dismantling] should be located in areas already blighted by the negative effects of industrial pollution". [19]

Why are ships recycled in developing countries?

14. There are two main reasons why most ships are dismantled in Asia rather than in the west. First, it is much cheaper to do so.[20] Indeed, in Asia, the value of the scrap is such that dismantling yards pay to take the ships, whereas yards in developed counties require payment to do so. [21] The Maritime and Coastal Agency told us that:

> the ships imported for recycling in England (specifically the MARAD vessels) are special cases where the owners have decided on more stringent conditions for the recycling of their vessels whilst not capitalising fully on the scrap value … there is a financial disincentive for ships to be recycled in Western Europe as the steel in the vessel is worth $10 a ton to the owner in North West Europe, and has peaked at $390–410 a ton in India and Bangladesh.[22]

15. The second reason, which may in part arise from the first, is that there are few facilities in OECD counties that can handle the largest ships.[23] In particular, the evidence we received indicates that there are no facilities in England and Wales which have both the capacity to dismantle large ships and the licence to do so.[24] Able UK has experience in dismantling oil rigs, and its Hartlepool yard may be the closest to having the facilities and expertise. However, even if Able UK were to receive all the necessary permits to allow it to dismantle the US vessels, there is still doubt over whether it could take the largest tankers.[25]

16. Greenpeace was of the view that "there are currently no facilities in the UK that would meet all legal requirements and satisfactory health, safety and environmental standards" although there are some sites where such facilities could be developed.[26] And Defra told us that:

> there appears to be a gap in UK expertise in the dismantling of large vessels once they reach the end of their life. As far as the Government is aware, there are currently no facilities in England and Wales with the capacity and expertise to dismantle large defunct ships safely.[27]

17. The Maritime and Coastguard Agency pointed out that the lack of facilities in the United Kingdom and other developed counties presented difficulties for ship owners who wished to dismantle their defunct vessels responsibly:

[19] Ev 87 [Hartlepool Friends of the Earth Media Group], para 6
[20] Q24
[21] Q149
[22] Ev 82 [Maritime and Coastal Agency], paras 8 and 12
[23] Qq49–53
[24] Q7
[25] Qq42–43
[26] Ev 25 [Greenpeace], para 1
[27] Ev 59 [Defra], para 4

> the lack of ship-recycling facilities that can handle hazardous wastes or ship-decontamination facilities in OECD countries is a major problem for shipping and can cause significant delay for owners who wish to recycle in the developed world, resulting in significant associated financial costs (port dues, maintenance and crewing costs).[28]

18. **The lack of suitable dismantling facilities in developed countries is a significant barrier to responsible ship dismantling. At present, even if a ship owner based in the United Kingdom wished, or was required, to dismantle a ship here, appropriate facilities for larger vessels do not exist. Given the economic advantages of dismantling facilities in Asia, and the difficulties faced by companies such as Able UK, there is little incentive for companies here to develop ship dismantling facilities.**

3 Existing legislation and guidelines regulating ship dismantling

Legislation

19. Another important barrier to safe and responsible ship dismantling is the difficulties faced by national regulators in applying waste law to ships and the problem of enforcing the law.

The Basel Convention

20. The Chamber of Shipping told us that there is very little legislation that directly addresses ship dismantling.[29] There is, though, an international framework for dealing with waste and hazardous wastes in particular: the United Nations Environment Programme Basel Convention on the control of trans-boundary movements of hazardous wastes and their disposal was adopted in 1989 in response to concerns about hazardous wastes from developed countries being dumped in developing countries. The Convention imposes certain controls on the international movement of hazardous wastes and provides criteria for the environmentally sound management of such wastes. [30]

21. There is disagreement about whether the Basel Convention applies to ships at all. The Chamber of Shipping argued that it was never intended to do so and is inappropriate for application to the shipping industry, saying that the presence of some hazardous materials on board ships that are intended for recycling should not mean that the entire vessel is regarded as hazardous waste.[31] The Environment Agency agreed that the Convention was probably not drawn up with ships in mind:

[28] Ev 82 [Maritime and Coastal agency], para 10

[29] Q13

[30] 162 states have agreed to be bound by the Convention: www.basel.int.

[31] Ev 2 [Chamber of Shipping], Q31

> it is very clear that the original basis of the Basel Convention was to deal with the issues of the transboundary movements of waste that came from a land-based arising and were ending up at some other land-based point of destination.[32]

The Agency told us that applying the Convention's controls to ship recycling was "extremely problematic".[33]

22. Greenpeace accepted that the legal framework for ship recycling is complex and that there are practical difficulties in applying some aspects of waste law to ships. However, it argued that the Basel Convention ought to apply to ships:

> of all of the instruments currently in place that impact this issue, the Basel Convention is the only one that is a) legally binding, and b) is in a clear position to actually minimise the export of ships containing hazardous materials to developing countries, and thus is the only instrument well placed to quickly prevent more impoverished workers from being poisoned or otherwise killed from risks associated with hazardous wastes.[34]

23. In 1995 an amendment to the Convention was proposed which would ban hazardous wastes exports for final disposal and recycling from what are known as Annex VII countries (Basel Convention parties that are members of the EU, OECD, Liechtenstein) to non-Annex VII countries (all other parties to the Convention). The amendment has not entered into force: it has to be ratified by three quarters of the parties who accepted it in order to do so. At the time of writing, 49 of 82 parties had ratified the amendment.

The European Community Waste Shipments Regulation

24. The requirements of the Basel Convention are transposed into European law by the European Community Waste Shipments Regulation; in the UK the Transfrontier Shipment of Waste Regulations 1994 give full effect to the Waste Shipments Regulation in the UK. The Regulation also takes account of OECD decisions on wastes destined for recovery (that is, for some sort of re-use or recycling rather than for disposal). The Environment Agency explained that the regulation:

> provides for a system of 'prior informed consent' whereby transboundary movements of hazardous waste must be prenotified to, and consented by, the relevant competent authorities. Contracts also have to be in place between the notifier and the consignee with a financial guarantee and insurance to cover foreseeable eventualities, including repatriation of the waste.[35]

25. The European regulation also transposes the as yet unratified amendment to the Basel Convention which forbids the movement of hazardous waste from developed to developing countries.[36]

[32] Q208

[33] Ev 57 [Environment Agency supplementary evidence]

[34] http://greenpeaceweb.org/shipbreak/analysisinconsistencies.pdf

[35] Ev 47 [Environment Agency], para 5.3

[36] Ev 46 [Environment Agency], para 5.3

26. In informal discussions, European Commission officials were clear that the Commission considered that the Basel Convention and the European waste shipment Community Waste Shipments Regulation did apply to ships that the owners intended to dismantle. **Since the European Community Waste Shipments Regulation includes a ban on export of hazardous wastes to developing countries, the regulation forbids the export of ships that are classified as hazardous waste to developing countries. We welcome this development.**

Enforcing legislation

27. Aside from arguments about the applicability of waste legislation to ships there are clear problems, acknowledged by all our witnesses, in enforcing that legislation. First, there is the vexed question of when a ship becomes waste. The European waste framework directive defines waste as anything that the holder discards or intends to discard.[37] As long as a ship is still seaworthy and the owner has not declared his or her intention to dispose of it, it is very difficult to determine when it could be regarded as waste.[38] It is vital to be able to do this because it is only when a ship is waste that the various national and international waste regulations apply.

28. A second, related, issue is that of which states or bodies have jurisdiction over the ship in order to enforce waste regulations once a ship is deemed to be waste. The Maritime and Coastguard Agency commented on difficulties raised by discrepancies between the ways in which national and international legislation are applied:

> a major difficulty lies with the difference in the perceived roles and responsibilities of the state, with … all shipping related legislation being applied through the state only to the state's flagged ships, whilst the Basel Convention would apply to the exporting state—in this case to vessels leaving UK ports regardless of flag or state of ownership … there has been the threat of abandonment of ships following potential detentions under trans-frontier shipment of waste controls in UK ports.[39]

29. National and European law does not apply on the high seas, so there is the possibility that a ship's owner could circumvent waste legislation by delaying the declaration of its intention to dispose of the ship until the vessel had left national waters. The IMO, as a United Nations body, is the only body with the power to regulate ships regardless of where they are registered, docked and dismantled.

30. **The Government, as a member of the International Maritime Organisation and in its role as upcoming president of the G8 and the European Union, should work to ensure that the International Maritime Organisation gives priority to producing an internationally binding agreement which sets out how ships should be dismantled. Such an approach must avoid the difficulties associated with the current tortuous arguments which try to determine when a ship becomes waste. We urge the Government to encourage the International Maritime Organisation to concentrate its work on a best practice agreement which applies at the point of dismantling. The Government should seek to ensure that the International Maritime Organisation does**

[37] Council Directive 75/442/EEC on waste, as amended by Council Directive 91/156/EEC

[38] Qq206, 213, 257

[39] Ev 84 [Maritime and Coastguard Agency], paras 25, 29 and see Ev 61 [Defra], para 16

not allow itself to be side-tracked into the difficulties of agreements which try to adjudicate on how international waste transfer arrangements affect the way in which ship dismantling is conducted.

Voluntary guidelines

31 In response to the growing concerns about the environmental and health and safety impacts of ship recycling, the IMO adopted guidelines on ship recycling in December 2003.[40] These drew on an earlier industry code of practice produced by the International Chamber of Shipping in conjunction with a number of other shipping organisations.[41]

32. The IMO guidelines set out the roles of the state where the ship is flagged, where it is docked and where it is intended to be recycled as well as those of the commercial bodies involved—the ship owners and dismantling companies.[42] They recommend that each ship should have a 'green passport', which sets out what hazardous materials are on board and where they are. For new ships, this passport should be prepared by the shipbuilder and kept up to date by its owners. For existing ships, ship owners should prepare a passport to the best of their knowledge.

33. The guidelines recommend that, when choosing where to send a ship for recycling, the ship owner should take account of the facility's ability to handle and dispose of hazardous wastes safely and should:

> make every effort to minimize the amount of potentially hazardous materials on board the ship [and] continuously seek to minimize hazardous waste generation and retention during the operating life of a ship and at the end of a ship's life.[43]

34. The guidelines also recommend that the ship owner should remove hazardous materials from the ship before sending it for recycling, where this is consistent with the safe operation of the ship.

35. There is some difference of opinion over whether the IMO guidelines should be converted into a binding regulation. The Chamber of Shipping opposed such a conversion, at least for the moment, arguing that, since the guidelines were adopted only recently, it is too early to say how effective a voluntary regime will be and whether it needs the force of law.[44] Both Friends of the Earth and Greenpeace argued that an international regulatory framework for ship dismantling was necessary.[45] The Environment Agency and Defra said that, at least, a clearer international agreement about the definition of ships as waste was necessary and that tighter international regulation may also be desirable.[46]

36. Whatever the merits of voluntary or regulatory regimes, there does appear to be an international consensus that the way in which the international waste regime applies to

[40] Ev 69 [International Maritime Organisation], paras 2–3

[41] Ev 1 [Chamber of Shipping], Q17

[42] IMO Assembly Resolution A.962(23), *IMO Guidelines on Ship Recycling*

[43] IMO Assembly Resolution A.962(23), *IMO Guidelines on Ship Recycling*

[44] Qq16 and 30

[45] Qq102 and 106

[46] Qq209 and 253

ships needs to be reviewed. To this end, the IMO, the International Labour Organisation (ILO) and the parties to the Basel Convention have agreed to form a joint working group which will:

> act as a platform for consultation, co-ordination and co-operation in relation to the work programme and activities of ILO, IMO and the Conference of Parties to the Basel Convention with regard to issues related to ship recycling.[47]

37. The Minister for Environment and Agri-Environment told us that the working group was a technical, rather than ministerial, group and was not likely to start work until February 2005. He hoped that the United Kingdom would be appointed to the group.[48]

38. **Given the international nature of the shipping industry, any action or regulation to address ship dismantling will be effective only if it is agreed at an international level. Furthermore, if an initiative is really to work, it would have to be taken under the aegis of the International Maritime Organisation in order to circumvent the problems associated with ships changing flag and owners declaring their intention to dismantle a vessel only once it is on the high seas.**

39. **We therefore warmly welcome the decision to form a joint working group of the Conference of the Parties to the Basel Convention, the International Maritime Organisation and the International Labour Organisation. We urge the Government to ensure that it has meaningful input into the deliberations of the working group. We hope that the working group will clarify when a ship is to be regarded as waste and how best to apply the principles of international waste legislation to those parts of a defunct vessel that cannot be re-used or recycled.**

40**. We note the Minister's hope that the United Kingdom will be included in the working group and urge the Government to seek to play as active a role as possible in it.**

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[47] Ev 1 [International Maritime Organisation], para 6

[48] Qq264–5

4 Principles of responsible ship recycling

Who should be responsible for the way a ship is recycled?

41. The IMO guidelines make a number of recommendations to ship owners and acknowledge that they have a responsibility to address the issues involved. However, they also:

> accept that the obligation for environmental and worker protection in ship recycling facilities must rest with the recycling facility itself and with the regulatory authorities of the country in which the recycling facility operates. [49]

42. The Chamber of Shipping accepted that a company that was disposing of a ship at the end of its working life, whether by sending it directly to a dismantler or going through a third party, had a responsibility to sell the ship to a yard that could dismantle it safely. However, it took the view that it remained the responsibility of the yard to ensure that the dismantling was done properly. Moreover, if a ship was sold on with a significant number of years' working life left, then the original owner could not be expected to follow its fate until disposal.[50]

43. The Chamber also told us that it was difficult for ship owners to assess which dismantling facilities were able to handle potentially hazardous wastes safely, although government certification schemes, such as one recently launched by the Chinese Government, could make it easier.[51]

44. Environmental organisations, on the other hand, argued that the 'polluter pays' principle should apply and the owner of the ship should ensure that the ship's dismantling did not harm people or the environment.[52] Greenpeace believes that the IMO guidelines represent:

> an effort to deflect responsibility away from the shipping industry (the polluter in this case) to its victims (developing countries and communities).[53]

Greenpeace argued that the Government should be responsible for naval ships and that for commercial vessels, responsibility should lie with:

> the country receiving the lion's share of the economic benefit during the life of that ship.[54]

45. **We take the view that is would be extremely difficult to assign responsibility for the way in which a ship is dismantled to any but the current owner. However, the current owner, regardless of how long they have owned the ship and regardless of whether they bought the ship as a going concern or with the intention of selling it for**

[49] IMO Assembly Resolution A.962(23), *IMO Guidelines on Ship Recycling*

[50] Qq26–27, 65

[51] Qq17 and 57

[52] Qq81–83, 86, 111, 137

[53] http://greenpeaceweb.org/shipbreak/analysisinconsistencies.pdf

[54] Q137

scrap, should be responsible for ensuring that the ship is dismantled to internationally acceptable standards of health, safety and environmental protection.

46. **We accept that it may be difficult for smaller ship owning companies to assess the quality of dismantling facilities and we therefore recommend that the Government consider how an international standard could be developed, which could be used to certify qualifying dismantling yards.**

Where should ships be dismantled?

47. Our witnesses all agreed that ships should be dismantled to high standards of workforce health and safety and environmental protection. However, they disagreed over whether, in order to meet these standards, ships should be dismantled only in developed countries. Friends of the Earth and Greenpeace argued that the proximity principle should apply and that, as far as possible, developed countries should dismantle their own ships. Where this was not possible, dismantling should be done in the same region.[55] Friends of the Earth said:

> it is a matter of principle and it is about countries taking responsibility for the waste that they generate. [The proximity principle] should incentivise countries to minimise the waste they generate and to put in place facilities to look after [it] … If you are having to deal with you own mess at home you will take it more seriously than if it is sailing over the horizon to be disposed of where nobody can see it.[56]

48. The Chamber of Shipping argued that the most important factor in choosing where to send a ship for dismantling was whether the dismantling facility could meet the required health, safety and environmental standards; after that the decision was an economic one.[57] It also emphasised the global nature of the shipping industry, saying that it was very difficult to say which country should be regarded as 'home' for any particular ship. BP Shipping, a Chamber member, said:

> we are a UK-based shipping organisation of the [international] BP group. We have ships that we were recycling that were built in Japan, they spent their entire lives trading around the world. If they had ever come to this country, they would only have come on a few occasions and were then finally dismantled in China. Where is 'home' for that ship?[58]

49. It may also be the case that a greater proportion of the ship can be re-used if it is dismantled in Asia: scrap metal prices are higher there and items such as computers and even light bulbs can be re-used whereas in Europe they would be more likely to be disposed of.[59]

50. Greenpeace argued that, although facilities in Asia varied in their standards of health, safety and environmental protection, none were satisfactory:

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55 Qq 81–83, 111, 129
56 Q86
57 Q4
58 Q6
59 Qq21–22

> China, I would say, is improving and at least the dismantling is done on the quayside rather than simply on a beach … [but] it is by no means approaching what we would call high environmental or health and safety standards … what happens to [the] hazardous wastes is far from certain.[60]

51. The Chamber of Shipping told us that facilities in China were investing in raising environmental standards in order to attract socially responsible ship owners and that the Chinese government was in the process of certifying yards and only allowing those that met a certain standard to import vessels for dismantling.[61] It said that suitable facilities for the larger ships do not exist in developed countries and that the companies in China that its members dealt with not only met the required environmental standards but also treated their staff properly and paid them properly "in relation to their own economy".[62]

52. Greenpeace has called for the development of ship scrapping facilities in the UK and Europe, partly in order to apply the proximity and polluter pays principles to ship dismantling and partly because:

> the UK has the regulatory infrastructure, the health and safety infrastructure and the medical infrastructure to be best placed, or one of the best placed, countries to make sure that environmental impacts are minimised. We have the technology and we have the know-how.[63]

53. **For us, the most important consideration in deciding where a ship should be dismantled is that the level of health and safety protection for the workers and the environmental protection at ship dismantling facilities meet the highest standards; as stated above, we believe that such standards should be stated in an internationally binding agreement which sets out a clear statement of minimum standards of ship dismantling, regardless of where the dismantling takes place. The Government should work to ensure that the International Maritime Organisation gives priority to producing such an agreement. It is clear that the majority of large vessels are dismantled under wholly inadequate conditions on beaches in Pakistan, India and Bangladesh; it is unacceptable that OECD-based companies, who are also members of the International Maritime Organisation, should continue to permit their vessels to be dismantled in this way.**

54. **As regards ship dismantling in the United Kingdom, the decision to grant or deny permission for ship dismantling facilities is clearly for the planning authority concerned and the environmental and health and safety regulators. However, it seems to us that the UK has the potential to establish an industry in ship dismantling which can be done safely and offer economic benefits to the communities in which is it carried out.**

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60 Q108
61 Q57
62 Q53
63 Q111

5 Action at the United Kingdom level

The Government's ship recycling strategy

55. The Government announced in response to our request for evidence that it will produce a ship recycling strategy:

> [the strategy] will consider, in detail, the economic and environmental impacts of establishing high quality facilities in the UK and look at potential means (economic and/or regulatory) to encourage the establishment of such facilities in the UK. It will also set out the Government's policy on the dismantling of UK government vessels.[64]

56. **We welcome the Government's decision to produce a ship recycling strategy. The strategy's scope, as outlined by Defra, is commendable. We recommend that it also set out how UK Government policy will interact with and push forward the international agenda.**

57. **The need to eradicate irresponsible ship dismantling is urgent, all the more so because all remaining single-hulled tankers must be dismantled before 2015, many before 2010 and the oldest by the end of 2005. In this context, the Government should tell us how it will use its forthcoming presidency of the European Union and chairmanship of the G8 to encourage rapid international action to ensure these tankers are dismantled in a responsible way.**

A United Kingdom ship recycling industry

58. **Government has most direct control over the ships it owns, namely naval vessels. These should be dismantled in a way that does not harm the environment or people. We would welcome the development of a thriving ship dismantling industry in the United Kingdom, which dismantled all defunct state-owned vessels to the highest standards of health, safety and environmental protection.**

59. **We expect that the presence of such facilities would act as a catalyst to enable UK-based ship owners to have their commercial vessels dismantled here. However, we recognise that responsible recycling will impose a cost on ship owners and recommend that the Government explore ways of mitigating that cost.**

60. **We recommend that, pending greater international regulation of ship recycling, the Government consider how best to persuade UK-based ship owners to adhere to the IMO guidelines and ensure that their vessels are dismantled, and seen to be dismantled, with the minimum impact on human health and the environment.**

[64] Ev 62 [Defra], para 27

Conclusions and recommendations

How are defunct ships currently dealt with?

1. The lack of suitable dismantling facilities in developed countries is a significant barrier to responsible ship dismantling. At present, even if a ship owner based in the United Kingdom wished, or was required, to dismantle a ship here, appropriate facilities for larger vessels do not exist. Given the economic advantages of dismantling facilities in Asia, and the difficulties faced by companies such as Able UK, there is little incentive for companies here to develop ship dismantling facilities. (Paragraph 18)

Existing legislation and guidelines regulating ship dismantling

2. Since the European Community Waste Shipments Regulation includes a ban on export of hazardous wastes to developing countries, the regulation forbids the export of ships that are classified as hazardous waste to developing countries. We welcome this development. (Paragraph 26)

3. The Government, as a member of the International Maritime Organisation and in its role as upcoming president of the G8 and the European Union, should work to ensure that the International Maritime Organisation gives priority to producing an internationally binding agreement which sets out how ships should be dismantled. Such an approach must avoid the difficulties associated with the current tortuous arguments which try to determine when a ship becomes waste. We urge the Government to encourage the International Maritime Organisation to concentrate its work on a best practice agreement which applies at the point of dismantling. The Government should seek to ensure that the International Maritime Organisation does not allow itself to be side-tracked into the difficulties of agreements which try to adjudicate on how international waste transfer arrangements affect the way in which ship dismantling is conducted. (Paragraph 30)

4. Given the international nature of the shipping industry, any action or regulation to address ship dismantling will be effective only if it is agreed at an international level. Furthermore, if an initiative is really to work, it would have to be taken under the aegis of the International Maritime Organisation in order to circumvent the problems associated with ships changing flag and owners declaring their intention to dismantle a vessel only once it is on the high seas. (Paragraph 38)

5. We therefore warmly welcome the decision to form a joint working group of the Conference of the Parties to the Basel Convention, the International Maritime Organisation and the International Labour Organisation. We urge the Government to ensure that it has meaningful input into the deliberations of the working group. We hope that the working group will clarify when a ship is to be regarded as waste and how best to apply the principles of international waste legislation to those parts of a defunct vessel that cannot be re-used or recycled. (Paragraph 39)

6. We note the Minister's hope that the United Kingdom will be included in the working group and urge the Government to seek to play as active a role as possible in it. (Paragraph 40)

Principles of responsible ship recycling

7. We take the view that is would be extremely difficult to assign responsibility for the way in which a ship is dismantled to any but the current owner. However, the current owner, regardless of how long they have owned the ship and regardless of whether they bought the ship as a going concern or with the intention of selling it for scrap, should be responsible for ensuring that the ship is dismantled to internationally acceptable standards of health, safety and environmental protection. (Paragraph 45)

8. We accept that it may be difficult for smaller ship owning companies to assess the quality of dismantling facilities and we therefore recommend that the Government consider how an international standard could be developed, which could be used to certify qualifying dismantling yards. (Paragraph 46)

9. For us, the most important consideration in deciding where a ship should be dismantled is that the level of health and safety protection for the workers and the environmental protection at ship dismantling facilities meet the highest standards; as stated above, we believe that such standards should be stated in an internationally binding agreement which sets out a clear statement of minimum standards of ship dismantling, regardless of where the dismantling takes place. The Government should work to ensure that the International Maritime Organisation gives priority to producing such an agreement. It is clear that the majority of large vessels are dismantled under wholly inadequate conditions on beaches in Pakistan, India and Bangladesh; it is unacceptable that OECD-based companies, who are also members of the International Maritime Organisation, should continue to permit their vessels to be dismantled in this way. (Paragraph 53)

10. As regards ship dismantling in the United Kingdom, the decision to grant or deny permission for ship dismantling facilities is clearly for the planning authority concerned and the environmental and health and safety regulators. However, it seems to us that the UK has the potential to establish an industry in ship dismantling which can be done safely and offer economic benefits to the communities in which is it carried out.. (Paragraph 54)

Action at the United Kingdom level

11. We welcome the Government's decision to produce a ship recycling strategy. The strategy's scope, as outlined by Defra, is commendable. We recommend that it also set out how UK Government policy will interact with and push forward the international agenda. (Paragraph 56)

12. The need to eradicate irresponsible ship dismantling is urgent, all the more so because all remaining single-hulled tankers must be dismantled before 2015, many before 2010 and the oldest by the end of 2005. In this context, the Government should tell us how it will use its forthcoming presidency of the European Union and chairmanship of the G8 to encourage rapid international action to ensure these tankers are dismantled in a responsible way. (Paragraph 57)

13. Government has most direct control over the ships it owns, namely naval vessels. These should be dismantled in a way that does not harm the environment or people. We would welcome the development of a thriving ship dismantling industry in the United Kingdom, which dismantled all defunct state-owned vessels to the highest standards of health, safety and environmental protection. (Paragraph 58)

14. We expect that the presence of such facilities would act as a catalyst to enable UK-based ship owners to have their commercial vessels dismantled here. However, we recognise that responsible recycling will impose a cost on ship owners and recommend that the Government explore ways of mitigating that cost. (Paragraph 59)

15. We recommend that, pending greater international regulation of ship recycling, the Government consider how best to persuade UK-based ship owners to adhere to the IMO guidelines and ensure that their vessels are dismantled, and seen to be dismantled, with the minimum impact on human health and the environment. (Paragraph 60)

Formal minutes

Wednesday 3 November 2004

Members present:

Mr Michael Jack, in the Chair

Mr David Burnside	Austin Mitchell
Mr Colin Breed	Joan Ruddock
David Drew	Diana Organ
Mr Mark Lazarowicz	Alan Simpson
Mr David Lepper	Paddy Tipping

The Committee deliberated.

Draft Report [*Dismantling Defunct Ships in the UK*], proposed by the Chairman, brought up and read.

Ordered, That the draft Report be read a second time, paragraph by paragraph.

Paragraphs 1 to 60 read and agreed to.

Summary read and agreed to.

Resolved, That the Report be the Eighteenth Report of the Committee to the House.

Ordered, That the Chairman do make the Report to the House.

Ordered, That the provisions of Standing Order No. 134 (Select committees (reports)) be applied to the Report.

Several papers were ordered to be appended to the Minutes of Evidence.

Ordered, That the Appendices to the Minutes of Evidence taken before the Committee be reported to the House.–(*The Chairman*).

Several memoranda were ordered to be reported to the House.

[Adjourned till Wednesday 10 November at half past Two o'clock.

Witnesses

Wednesday 30 June 2004

Wednesday 14 July 2004

Wednesday 21 July 2004

List of written evidence

Reports from the Committee since 2001

Session 2003–04

Seventeenth Report	Agriculture and EU Enlargement	HC 421
Sixteenth Report	Climate Change, Water Security and Flooding	HC 558
Fifteenth Report	The Departmental Annual Report 2004	HC 707
Fourteenth Report	Sites of Special Scientific Interest	HC 475
Thirteenth Report	Bovine TB (*Reply, HC 1130*)	HC 638
Twelfth Report	Reform of the Sugar Regime (*Reply, HC 1129*)	HC 550-I
Eleventh Report	GM Planting Regime (*Reply, HC 1128*)	HC 607
Tenth Report	Marine Environment: Government reply to the Committee's Report	HC 706
Ninth Report	Milk Pricing in the United Kingdom (*Reply HC 1036*)	HC 335
Eighth Report	Gangmasters (follow up) (*Reply*, HC 1035*)*	HC 455
Seventh Report	Implementation of CAP Reform in the UK (*Reply*, HC 916)	HC 226-I
Sixth Report	Marine Environment (*Reply, HC 706)*	HC 76
Fifth Report	The Food Standards Agency and Shellfish (*Reply, HC 601*)	HC 248
Fourth Report	Environmental Directives (*Reply, HC 557*)	HC 103
Third Report	Caught in the net: Cetacean by-catch of dolphins and porpoises off the UK coast (*Reply, HC 540*)	HC 88
Second Report	Annual Report of the Committee 2003	HC 225
First Report	Water Pricing (*Reply, HC 420*)	HC 121

Session 2002–03

Eighteenth Report	Conduct of the GM Public Debate (*Reply HC 443 Session 2003-04*)	HC 220
Seventeenth Report	Biofuels (*Reply, HC 88 Session 2003-04*))	
	HC 929-I Sixteenth Report Vets and Veterinary Services	HC 703
Fifteenth Report	New Covent Garden Market: a follow-up (*Reply, HC 123 Session 2003-04*)	HC 901
Fourteenth Report	Gangmasters (*Reply, HC 122 Session 2003-04*)	HC 691
Thirteenth Report	Poultry Farming in the United Kingdom (*Reply, HC 1219*)	HC 79-I
Twelfth Report	The Departmental Annual Report 2003 (*Reply, HC 1175*)	HC 832
Eleventh Report	Rural Broadband (*Reply, HC 1174*)	HC 587
Tenth Report	Horticulture Research International (*Reply, HC 1086*)	HC 873
Ninth Report	The Delivery of Education in Rural Areas (*Reply, HC 1085*)	HC 467
Eighth Report	The Future of Waste Management (*Reply, HC 1084*)	HC 385
Seventh Report	Badgers and Bovine TB (*Reply, HC 831*)	HC 432
Sixth Report	Rural Payments Agency (*Reply, HC 830*)	HC 382
Fifth Report	The Countryside and Rights of Way Act 2000 (*Reply, HC 748*)	HC 394
Fourth Report	Water Framework Directive (*Reply, HC 749*)	HC 130
Third Report	The Mid-term Review of the Common Agricultural Policy (*Reply, HC 615*)	HC 151
Second Report	Annual Report of the Committee 2002	HC 269
First Report	Reform of the Common Fisheries Policy (*Reply, HC 478*)	HC 110

Session 2001–02

Tenth Report	The Role of Defra (*Reply, HC 340, Session 2002-03*)	HC 991
Ninth Report	The Future of UK Agriculture in a Changing World (*Reply, HC 384, Session 2002-03*)	HC 550
Eighth Report	Hazardous Waste (*Reply, HC 1225*)	HC 919
Seventh Report	Illegal Meat Imports (*Reply, HC 1224*)	HC 968
Sixth Report	Departmental Annual Report 2002 (*Reply, HC 1223*)	HC 969
Fifth Report	Genetically Modified Organisms (*Reply, HC 1222*)	HC 767
Fourth Report	Disposal of Refrigerators (*Reply, HC 1226*)	HC 673
Third Report	Radioactive Waste: The Government's Consultation Process (*Reply, HC 1221*)	HC 407
Second Report	The Countryside Agency (*Reply, HC 829*)	HC 386
First Report	The Impact of Food and Mouth Disease (Reply, HC 856)	HC 323

Appendix 8.1

Working Plan

Golder Associates (UK) Limited, 2004

The Working Plan has been prepared by ABLE for its own management purposes and for the submission to the EA in pursuant of an application for a Waste Management Licence.

At this stage, the Working Plan is in draft form and will be submitted to the EA with the Waste Management Licence Application. The Working Plan will then be held by the EA on publicly available record and maybe consulted at the offices of the EA.

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REPORT ON

TEESSIDE ENVIRONMENTAL RECLAMATION AND RECYCLING CENTRE (TERRC), HARTLEPOOL

WORKING PLAN, SUPPORTING DOCUMENTS AND WASTE MANAGEMENT LICENCE APPLICATION

Submitted to:

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DISTRIBUTION:

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Appendix 8.2

Noise Emissions

Appendix 8.2

Noise Emissions

1 Introduction

1.1 Noise emissions from the TERRC site have been calculated in accordance with BS 5228 Part 1 1997 “Noise and Vibration Control on Construction and Open Sites”. It has been assumed that noise generated on site will be between 125 and 2000Hz. Diesel engines would be in the 125 to 250Hz range while diamond-cutting saws would be around 2000Hz. Wherever possible, sound power levels for individual plant are taken from the B.S.

1.2 It is assumed also that all plant will be properly maintained and fitted with appropriate silencers.

1.3 Plant likely to be used in operations on the TERRC site, associated with the construction, repair, refurbishment or recycling of vessels marine structures and other craft is set out in Table A8.2.1.

Table A8.2.1 Plant and Sound Power Levels (SPL) for Operations Centred on the Dock

Operation	Equipment	Duration	B.S. Table No.	% Time	SPL dB
A. DOCK ENTRANCE AND ROCK REINFORCEMENT					
1. Cleaning Sill	Tracked Excavator	1 day	C3/95	100	110
2. Import stone and push into position.	Tipper Lorry Dozer	13 weeks 13 weeks	C3/112 C3/69	50 80	113 115
3. Piling	Sheet piling by drop hammer	6 weeks	C4/8	100	114
B. COFFER DAM CONSTRUCTION					
1. Dredging	Dredger	2-4 weeks	C3/95	100	110
2. Sheet piling.	Piling Rig	6-12 weeks	C4/8	100	114
3. Filling dam wall with stone.	Tipper lorry Dozer	4 weeks 4 weeks	C3/112 C3/69	50 80	110 115
4. Removing water from dam wall.	2 No. Water Pumps	4 weeks	C12/2	20	104
5. Sheet piling centre access.	Piling Rig	4 weeks	C4/8	100	114

Operation	Equipment	Duration	B.S. Table No.	% Time	SPL dB
6. Remove centre access section.	Piling Rig Tracked Excavator Dump Truck	4 weeks 4 weeks 4 weeks	C4/8 C3/95 C9/27	100 90 90	114 110 105
7. Rebuild centre access section.	Piling Rig Tracked Excavator Dump Truck	4 weeks 4 weeks 4 weeks	C4/8 C3/95 C9/27	100 90 90	114 110 105
C. SEDIMENT REMOVAL					
	Dozer 2.No. Tracked Loaders 6 No. Dump Trucks	2-4 weeks 2-4 weeks 2-4 weeks	C3/69 C3/54 C9/27	90 80 80	115 111 105
D. DISMANTLING IN WET CONDITIONS					
	3 No. Cranes 4 No. Cutters Metal Shearer Metal Recycling Facility	Ongoing Ongoing Ongoing Ongoing	C7/114 C8/32 C9/27	80 90 80 100	114 115 105 105
E. DISMANTLING IN DRY CONDITIONS					
	2 No. Tracked Excavators 4 No. Cutters 4 No. Dump Trucks Crane Metal Shearer Metal Recycling Facility	Ongoing Ongoing Ongoing Ongoing Ongoing Ongoing	C3/42 C8/32 C9/27 C7/117	90 90 80 90 100 100	116 115 105 110 110 105
F. OTHER OPERATIONS VESSELS ETC CONSTRUCTION, REFURBISHMENT AND REPAIR					
	Grit Blasting 2 No. Cranes Dump Truck	Infrequent Infrequent Infrequent	C10/5 C7/114 C9/27	5 5 5	120 114 105

1.4 Noise is of concern to those working on site, (Section 28) and by its potential effects on wildlife in the area. This primarily means birds on the SPA, and seals in or close to the channel.

1.5 For the purpose of this E.I.S., three locations have been identified on the SPA opposite the TERRC site (Figure A8.2.1). The impact of noise generated by the plant involved in the various operations on site has been calculated as it would be heard at each of these three noise sensitive locations.

1.6 Background ($L_{90,30}$) noise levels were measured at the mid-tide shoreline of the SPA and were found to average at 47.5dBA. The effects of noise emission from TERRC relative to the background levels is given in Table A8.2.2.

Table A8.2.2 Estimated Noise Levels on the SPA Resulting from Dock Activities

Phase	Duration	Noise Level (dBA) at Location		
		1	2	3
Opening/Closing Coffer Dam				
Opening *	2-4 weeks	61.2	57.9	50.5
Closing *	2-4 weeks	61.2	57.9	50.5
Coffer Dam Construction				
Dredging *	2-4 weeks	57.0	52.4	52.0
Piling *	6-12 weeks	60.0	56.4	54.0
Infilling with stone	4 weeks	61.0	57.4	55.0
Removal of water inside dam walls	4 weeks	50.5	48.5	48.5
Form dam entrance	4 weeks	58.4	56.1	52.7
Opening/Closing Dam	4 weeks	62.4	59.1	56.7
Removal of Sediments from Dock Floor	4 weeks	50.5	50.5	49.5
Dismantling Vessels in Wet	Ongoing	63.0	61.3	61.0
Dismantling Vessels in Dry	Ongoing	57.9	57.1	56.0

Note: Operations marked * may be quickened by doubling up on plant and labour. This would increase noise levels at Locations 1, 2 and 3 by up to 3dB compared with those shown in the above table.

1.7 In the above table it is assumed that decommissioning work would be proceeding on up to a total of eight vessels simultaneously. If one such unit was being repaired or refurbished (using a section being fabricated on shore) the sound levels from these operations perceived at locations 1, 2 and 3 on the SPA would be.

Table A8.2.3 Estimated Noise Levels on the SPA Resulting from Construction Repair and Refurbishment of One Unit

SPA Location	Sound Level Derived From Construction, Repair or Refurbishment Operations
1	44.0 dB
2	42.3 dB
3	41.3 dB

1.8 The main operations going on simultaneously on the TERRC site, i.e. dismantling procedures are at least 13.9 dB noisier. The net effect of using space in the dock, tidal or dry, for repair, refurbishing or construction instead of using it for decommissioning works would result in no change in the level of noise reaching the SPA.

1.9 The other operations addressed in Table A8.2.3 on site will involve the construction of vessels etc (though this is more likely to apply to the building of replacement sections or modules during the refurbishment and repair of vessels etc) repair and refurbishment of vessels marine structures and other craft. Noisy operations involved will be the cleaning of hulls by grit blasting, and movement of sections by dump truck and crane. No hammering or riveting is envisaged in these operations. The cleaning of hulls will take place in dry dock conditions where there is both distance and barrier attenuation. Sound power levels from these operations are shown in Section F of Table A8.2.1.

1.10 In October 2001 RPS submitted to Hartlepool Borough Council a report “Teesside Environmental Reclamation and Recycling Centre, Graythorp, Hartlepool. Environmental Monitoring”. This report provided information for an assessment to be made as required by Regulation 48 of the Conservation (Natural Habitats &c) Regulations 1994. Included within the report were details of noise levels created by various industrial activities on site.

1.11 Some of the noisiest operations related to loading and unloading rock armour at Quay 10. The noise monitoring equipment at 100m distance registered a noise level of 66.5dB. Given a distance attenuation 48dB, the noise level at source on the quayside must have been 114.5dB. Emissions at this sound power level would therefore be perceived at the three noise sensitive locations (used in these calculations) as follows:

Table A8.2.4 Noise Levels at the SPA Estimated from the 2001 Noise Measurements

Noise Sensitive Location on the SPA	Noise Level dBA
1	56.4
2	55.9
3	54.7

1.12 These values are similar with the estimated values in Table A8.2.2.

1.13 During the 2001 noise monitoring operation which was carried out for 24 hours per day for an 8-day period, pressure discharge events were noted associated with the adjacent power station. These events averaged 92.6dB at the site noise monitoring station on the east of the dock entrance. Given the distance from the noise source it is estimated that the sound power level at the pressure discharge point would have been 153.7dBA. This would have been perceived at the SPA as a short very noisy event.

1.14 The impact and significance of these estimated noise emissions is assessed in Section E of this Environmental Impact Statement.

Table A8.2.5 Estimated Noise Levels at the SPA Resulting from Pressure Discharge from the Power Station

Noise Sensitive Location on the SPA	Noise Level dBA
1	88.7

2	87.6
3	90.9

1.15 These events are for a very short duration, a matter of seconds or minutes, but are 25-30dB greater than noise levels generated by TERRC. They still occur and are expected to continue intermittently into the future.

1.16 In addition to the work within the dock and on the surrounding land for which noise levels have been predicted, it is proposed to carry out a capital dredge of the Channel. This is described in Appendix 9.1.

1.17 The dredging works would take place if possible during the summer period when the SPA is in least sensitive use, no works will be carried out during the months of November, December, January and February except between the times of two hours after a low tide and two hours before the next low tide (unless the agreement of the Local Planning Authority has first been obtained in writing to any variation to this restriction). The Channel is currently subject to maintenance dredging and would continue to be so after it is deepened by a capital dredge next year.

1.18 The dredging operations are expected to generate a sound power level of 110dB (Table A8.2.1) and operate at 100% on-time. Background noise levels on the SPA, at its shoreline with the Seaton on Tees Channel have been measured (L_{90}) at 47.5dBA. Using this information a noise map has been produced and is shown in Figure A8.2.2. The predicted noise levels are the maximum noise levels which will be encountered when dredging operations are immediately opposite each section of the SPA shoreline. So for example, if the dredger were at Location 3, the noise levels on the SPA directly opposite Location 3 would be as shown. At the same time, the noise levels opposite Locations 1 and 2 would be less than those shown on the figure.

1.19 In addition to dredging, construction of Quays 1, 10 and 11 will generate noise which could affect the SPA. BS5228 ascribes a power level of 110dBL_{WA} to pile driving. Taking the noise sensitive locations into account as shown on figure A8.2.1 the noise impact from pile driving alone will be:-

Location	Noise Impact for Pile Driver dBA
1	64.1
2	46.6
3	46.6

1.20 The background noise level on the SPA has been measured at 47.5dB so that there is a marked effect at location No.1, with noise levels increasing by 16.6dBA. At locations 2 and 3 the incoming noise at 46.6dBA will combine with the background to rise by 3dB to 50.5dB.

1.21 Pile driving may not be carried out as a solo operation but may at least for part of the time, be done concurrently with dredging. A noise map is provided in figure A8.2.2. The noise emanating from piling is far less than that attributable to dredging. There is therefore no additive effect and noise levels on the SPA will remain generally as shown despite piling being carried out. The one exception is in the horn shaped section of the SPA projecting up towards Quay 1. Here noise emissions from dredging would be the same as these from piling if concurrently at Quay 1. There would be an additive effect such that noise levels within the SPA horn (Location No.1 on figure A8.2.1) would be 67.1dBA. It should be noted that dredging is anticipated to take 12 weeks. Channel dredging close to Location 1 is estimated to last for 1 week after which noise levels at location 1 will diminish significantly. The dredging works would take place if possible during the summer period when the SPA is in least sensitive use, no works will be carried out during the months of November, December, January and February except between the times of two hours after a low tide and two hours before the next low tide (unless the agreement of the Local Planning Authority has first been obtained in writing to any variation to this restriction).

1.22 Noise emissions have also been estimated from operations to erect the five industrial buildings. The equipment likely to be used is shown in Table A8.2.5.

Table A8.2.5

Plant Likely to be Used for Ground Preparation, Building Erection and Track Work

Plant	SPL - dB	On-time - %	Adjustment	On-time dB
Tracked Excavator	108	75	1.5	106.5
Dump Truck 50T	109	100	0	109
Lorry Mounted Crane	90	50	3	87
Wheeled Loader	102	90	0.5	101.5
Lorry Unloading Aggregate	113	25	6	107
Vibratory Roller	106	25	6	100

1.23 The aggregate of all these sources of noise is 113dB. Buildings D and E (see Figure 1.1) are closest to the SPA. Noise generated by this group of plant working on the footprint of these two buildings has been calculated in respect of Locations 1, 2 and 3 (see Figure A8.2.1) as follows. The same plant is assumed to be the maximum to be used in preparing the ground for the rail track.

Table A8.2.6

Impact of Construction Noise on the SPA

Noise Source	Noise Receptor on the SPA Location No.	Resulting Noise Level Relative to Background (47.5dB)
Building D	1	+ 10.5 dB
Building E	2	+ 2 dB
Building E	3	+ 3 dB
Rail Head	1	+ 10.5 dB
Buildings A, B and C	2 and 3	+ 1 dB

1.24 When operational there will be activities within the buildings but it is not expected that noise emissions will be sufficient to be perceptible at the SPA. However, there may be external noise, for example a heavy lorry 96dB delivering or collecting from each building. A locomotive pulling or pushing wagons on the rail track will also generate noise 96dB, although at the estimated rail traffic of two trains per day, yield a low on time. Noise levels attributable to delivery lorries and the rail locomotive are estimated below. A comment is made on what effect this would have relative to background noise levels on the SPA.

Table A8.2.7

Operational Noise

Noise Source Delivery Lorry, Locomotive	Noise Receptor on the SPA Location No.	Noise Reaching the SPA	Relative to Background (47.5dB)
Building D	1	27 dB	Nil
Building E	2	14.4 dB	Nil
Building E	3	16.6 dB	Nil
Rail Head	1	27 dB	Nil
Buildings A, B and C	2 and 3	11.7 dB	Nil

2 Definitions

2.1 Noise events from very high pitch to low pitch, some of these frequencies are inaudible to the human ear. Noise monitoring equipment normally registers only those frequencies which are detected by the human ear. This is termed “A” weighted sound.

2.2 Sound is measured on a logarithmic scale in units of decibels (dB). A measurement on a noise meter will therefore normally be given as dBA.

2.3 The average noise L_{eq} level measured over a period of time, T, is given as $dBAL_{eqT}$.

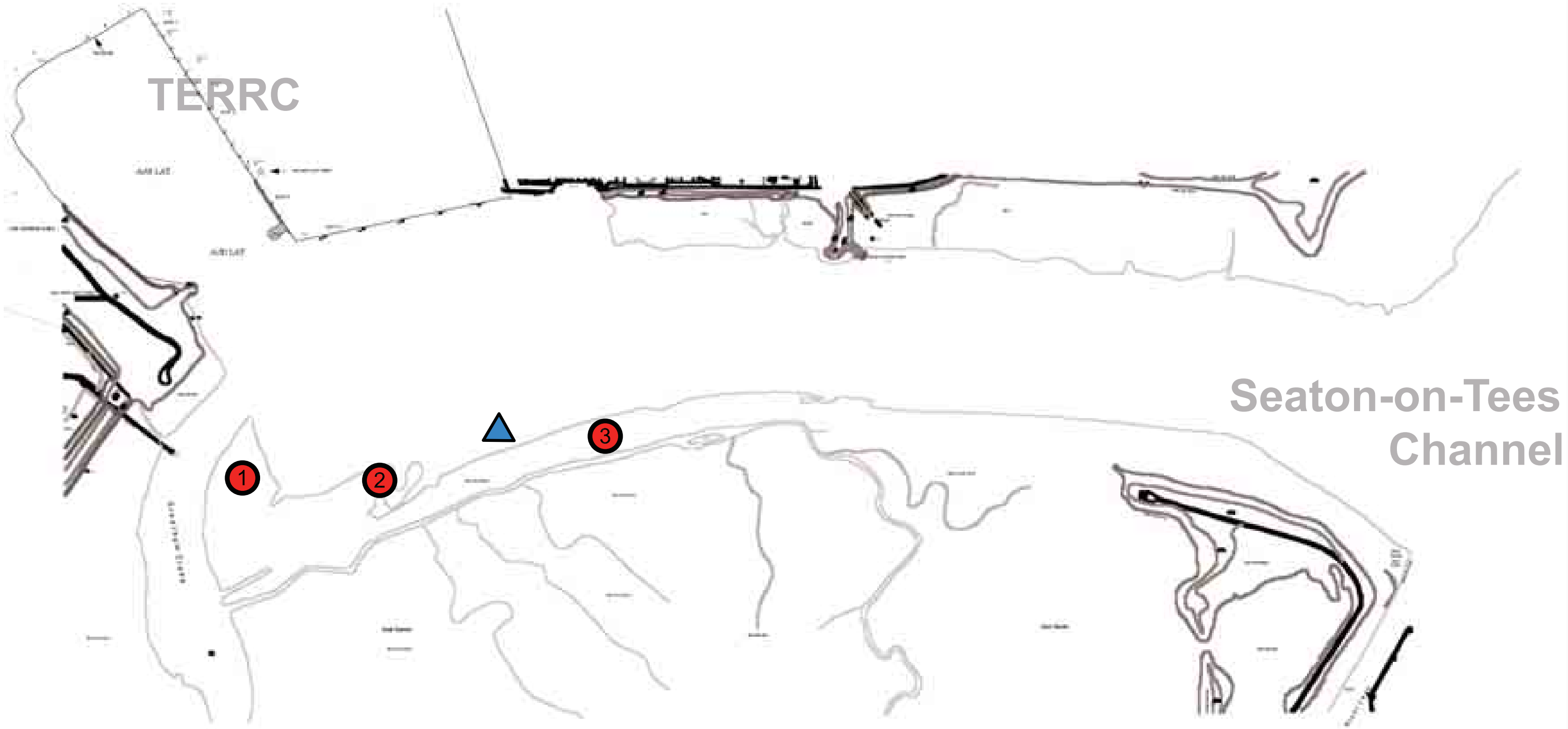
2.4 L_{90T} is the noise level in dBA, exceeded for 90% of the monitoring period T. This is normally taken to be the background noise level.

2.5 L_{maxT} is the maximum noise pressure level recorded in the period of time T. It relates to a brief single event, not to be confused with L_{peak} which is the highest sound pressure level measured during the period T, albeit possibly for instantaneous events. L_{peak} is higher than L_{max}.

Table A8.2.6 TERRC Noise Monitoring Data – Seal Sands Mud Flats 26th March 2004

Measurement Period	Lpeak dB(A)	Lmax dB(A)	L10 dB(A)	L50 dB(A)	Leq dB(A)	L90 dB(A)	Lmin dB(A)	Comments
07.30 – 08.00	91.8	65.8	52.0	50.5	50.9	49.5	48.0	Distant Pipe Mill noise
08.05 – 08.35	91.1	65.2	50.0	49.0	49.2	47.5	45.7	Aircraft
08.40 – 09.10	96.6	62.8	50.0	48.5	48.8	47.0	44.7	
09.15 – 09.45	99.6	75.8	51.5	49.0	54.4	47.5	44.5	Power Station & noisy aircraft
07.30 – 09.45	99.6	75.8	51.5	49.5	51.4	47.5	44.0	

Weather Notes: Weather at the time of monitoring was cool approximately 6 - 7°C, overcast with light rain towards during the final hour of measurement. Wind was variable north to north-west and light. There was only minimal wave motion on the Seaton Channel



Key / Notes

Noise Monitoring Point

Noise Assesment Location

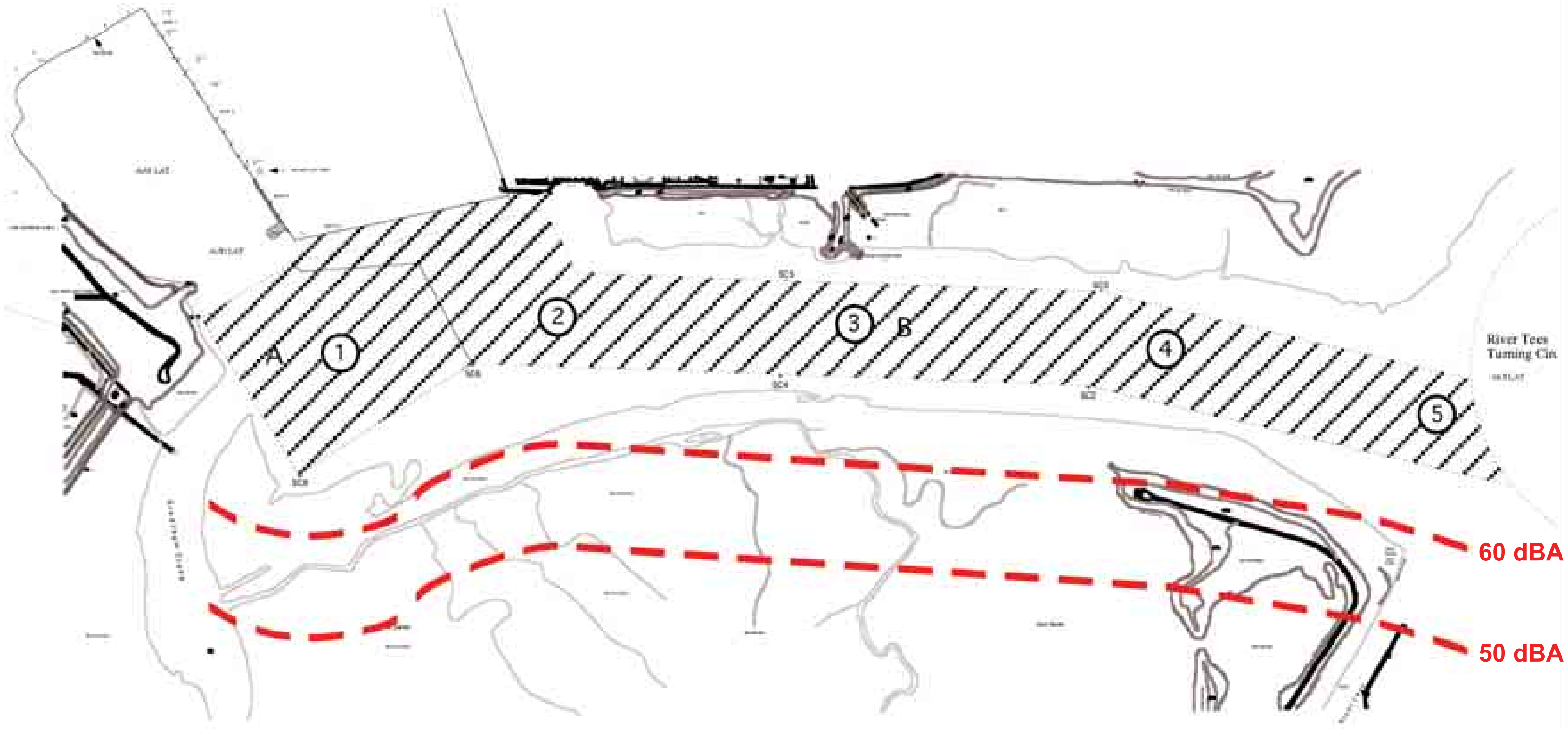
RPS Planning, Transport and Environment

able

PROJECT
Seaton Port TERRC Facility
Environmental Impact Statement

TITLE
Noise Monitoring and Assesment Locations

SCALE	DRAWN BY
NTS	NA
DATE	CHECKED
02.12.04	SL/GD
PROJECT NUMBER	DRAWING NUMBER
DE0295	Figure A8.2.1



Background L_{90} noise level
on north side of SPA measured
at 47.5 dBA

Key / Notes

Co-ordinates
1. X 452879 Y 526324
2. X 453175 Y526345
3. X 453607 Y526356
4. X454051 Y526301
5. X454454 Y526234

Dredge Areas
A. Holding Basin
B. Seaton Channel

Proposed Dredging Area

RPS Planning, Transport and Environment

Able

THIS DRAWING IS NOT TO BE SCALED. ALL DIMENSIONS TO BE CHECKED ON SITE. DISCREPANCIES, AMBIGUITIES AND/OR OMISSIONS BETWEEN THIS DRAWING AND INFORMATION GIVEN ELSEWHERE MUST BE REPORTED IMMEDIATELY TO THIS OFFICE FOR CLARIFICATION BEFORE PROCEEDING.

PROJECT
Seaton Port TERRC Facility
Environmental Impact Statement

TITLE
MAXIMUM SOUND LEVELS PERCIEVED ON THE SPA & RAMSAR SITE, ATTRIBUTABLE TO CHANNEL DREDGING ACTIVITIES

SCALE	DRAWN BY
NTS	NA
DATE	CHECKED
02.12.04	SL/GD
PROJECT NUMBER	DRAWING NUMBER
DE0295	Figure A8.2.2

Appendix 14.1

Phase 1 Habitat Survey and Ecological Interest of the Surrounding Area

Appendix 14.1

Phase 1 Habitat Survey and Ecological Interest of the Surrounding Area

14.1 Introduction

14.1.1 RPS Ecology were commissioned to carry out a Phase 1 Habitat Survey and scoping study of the Able UK TERRC site at Hartlepool.

14.1.2 The objective was to complete a Phase 1 Habitat Survey, mapping the main habitats on site, identify any potential habitat for protected species or species of conservation importance and identify requirements for additional surveys.

14.2 Methods

Background Data Search

14.2.1 Information on the interest associated with the adjacent sites of International, National and Local Importance was obtained from English Nature. Citations and maps identifying the boundaries of Special Protection Areas (SPA), RAMSAR Sites, National Nature Reserves and Sites of Special Scientific Interest (SSSI) were obtained. Consultations were made with the Tees Valley Wildlife Trust and Hartlepool Borough Council county ecologist to obtain any information on protected species on the site and within a 2km surrounding area.

14.2.2 Data on the seal populations was obtained from the Industry and Nature Conservation Association (INCA, 2004). The data was based on direct seal counts taken daily at low tide during June, July and August. Observations of the seals using the Seal Sands mudflats were made from the Tioxide Hide, adjacent to the Able UK site.

Phase 1 Habitat Survey and Scoping Survey

14.2.3 A Phase 1 Habitat survey was carried out on 29th March 2004 in accordance with the standard methodology (Nature Conservancy Council, 1990). This comprised walking over the site and mapping the habitat types present within the boundary of the site. The nomenclature for the flora is that of Stace (1997). In addition, the habitats on the site were scoped for their potential to support protected species.

14.3 Results

Background Data

Sites of National and International Importance

14.3.1 The TERRC site lies in the vicinity of several areas of International conservation importance, which together form part of the Teesmouth and Cleveland Coast Ramsar Site and Special Protection Area (SPA) (Figure A14.1). The boundary of the SPA and Ramsar Site is mid channel of the Seaton-on-Tees Channel, which flows into the Teesmouth. These areas are also of national conservation significance and have been designated a National Nature Reserve (NNR) (Teesmouth NNR). These sites are important for the large numbers of migratory waterfowl and wading birds which visit the mudflats to feed in winter. Other features of interest include a representative range of sand dunes and saltmarsh communities with three nationally scarce plant species, Rush-leaved Fescue, Stiff-leaved Saltmarsh Grass and Brackish Water Crow-foot. It also supports a population of Lyme Grass Moth, which is of National importance.

14.3.2 Six Sites of Special Scientific Interest (SSSI) are immediately adjacent to the site or nearby (Figure A14.2). The Hartlepool Submerged Forest SSSI is important for organic and inorganic deposits, including a peat bed located in the intertidal area south of Hartlepool. The site provides important evidence for sea-level changes over the last 5,000 years.

14.3.3 Seaton Dunes and Common SSSI, an area of sand dunes and grazing marsh, is approximately 0.5 km north and east of the TERRC Site. The site is important for its flora, invertebrate fauna and bird life. The range of habitats includes a range of sandy, muddy and rocky foreshore, dunes, dune slacks and dune grassland as well as relict saltmarsh, grazed freshwater marsh with dykes, pools and sea walls. In addition to an interesting and rich flora including the nationally rare Rush-leaved Fescue and the uncommon plants such as Strawberry Clover, Wild Celery and Adder's Tongue Fern. The SSSI is the northernmost limit for the snail *Hydrobia ventrosa*, and supports two nationally rare species of beetle *Hydnobius perrisi* and *Philonthus atratus* and a rare spider *Silometopus incurvatus*. The area also provides important winter feeding grounds and roost sites for wading birds.

14.3.4 The water in the basin on the site mixes with the Seaton-on-Tees Channel, which joins the River Tees just to the south west of Teesmouth. The channel borders an extensive area of inter-tidal mud flats forming the Seal Sands SSSI, which attracts large numbers of migratory wildfowl and wading birds in winter. Large areas of the estuary have been reclaimed for industrial development making the remaining mudflats particularly important. The boundary of the Seal Sands SSSI lies immediately adjacent to the south eastern side of the site, and covers the whole of the channel and the mud flats on the other side of the Seaton-on-Tees Channel. As the name suggests the area is also an important breeding area for Harbour Seals (also known as Common Seals). The area is also used by Grey Seals.

14.3.5 The wetlands on the western side of the site, and the wetlands further south towards Billingham, form part of the Tees and Hartlepool Foreshore and Wetlands SSSI. Part of the area, Greenabella Marsh, is managed by Cleveland Wildlife Trust on behalf of the landowners, Tioxide. It comprises several coastal areas which form an integral part of the complex of wetlands, estuarine and maritime sites supporting the internationally important population of wildfowl and waders of the Tees Estuary.

14.3.6 Cowpen Marsh SSSI consists of two units, located south west of the TERRC Site. Unit 1 is located along Greatham Creek and unit 2 is the area of saltmarsh south of Greatham Creek.

14.3.7 On the opposite side of the Teesmouth Channel is the South Gare and Coatham Sands SSSI. The SSSI's in the Tees Estuary together are important feeding and roosting sites for wintering wildfowl.

14.3.8 The successive reclamation and development of the Tees Estuary has resulted in the loss of most of the upper shore as feeding and roosting areas for waterfowl. At high tide the birds have to disperse to inland wetlands or more distant coastal locations. The birds move in regular patterns around the estuary utilising different sites at different stages of the tide.

Protected Species

14.3.9 Consultations with the county ecologist and local Wildlife Trust revealed that there were no records of protected species in the TERRC site, although there were some records of protected species occurring within the 2km search area as follows.

Amphibians

The most recent record for protected amphibians is in 2003 for a sighting of Great Crested Newt on the Philip Tank Farm site approximately 1.5km from the TERRC site (Ian Bond pers. comm). Prior to this an extensive survey of Greenabella Marsh, adjacent to the TERRC site, was carried out in 1993 by Tees Valley Wildlife Trust, and no specimens of Great Crested Newt were recorded.

Mammals

Greenabella Marsh, adjacent to the TERRC site, previously supported a population of water vole (Tees Valley Wildlife Trust pers. comm). However, since the last sighting in 2002 mink have increased in this area and may have caused the local water vole population to decline or disappear through predation.

Birds

The main wildlife interest of the TERRC site lies in the birds of the adjacent Special Protection Area and Ramsar site. This is extensively covered in Section 17 of this Environmental Impact Statement.

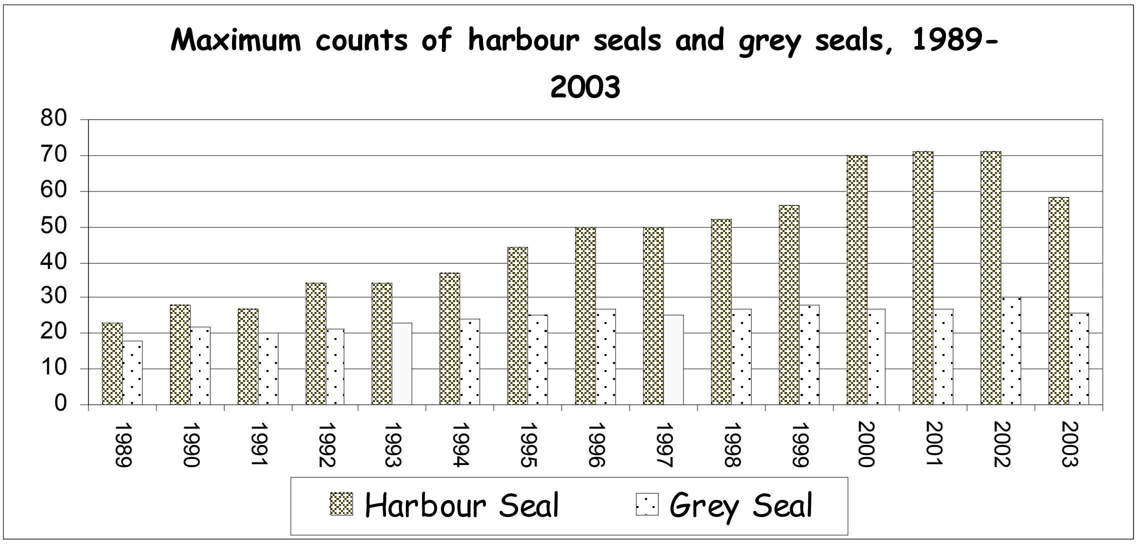
Current Seal Populations of the Tees Estuary

14.3.10 The INCA data show a steady increase in the maximum number of Harbour Seals on Seal Sands mudflats counted in one day from 23 individuals in 1989 to 71 in 2001 (Figure A14.3;

source INCA, 2004). The latest figures available for the number of individuals recorded on Seal Sands mudflats in one day was 58 seals, recorded on the 19th June, 2003.

14.3.11 Grey seals are not resident or breeding on Seal Sands. Smaller increases in numbers seen in one day were observed over the 15 year period from 18 individuals in 1989 to 30 in 2002. The most recent figures for the maximum numbers counted on one day, was 26 recorded on the 18th July, 28th July and 3rd August 2003.

Figure A14.3: Seal Data from INCA



Phase 1 Habitat and Scoping Survey

Phase 1 Habitat Survey

14.3.12 Vernacular names are used throughout the text for flora present. Scientific names are recorded in Addendum A14. The time of year at which this survey was carried out places limitations on the identification of detailed floristic interest associated with the site. It is not possible separate many species of plant in the early phases of growth as they often have similar growth forms.

14.3.13 Phase 1 habitats present on the site were Bare Ground (J4), Ephemeral/Short Perennial (J1.3), Scattered Scrub (A2.2), Neutral Grassland (B2), Swamp (F1), and Standing Water (G1), with Buildings (J3.6) and boundary features including Fences (J2.4), Walls (J2.5) and Earth Banks (J2.8). The habitats and associated target notes were mapped at a scale of 1:5,000 (Figure A14.4). These habitats are described in more detail below.

Bare Ground and Ephemeral / Short Perennial Habitats

14.3.14 The site comprises mainly levelled and gravelled areas. The largest area surrounds a deep basin. A tarmac access road and a car park area were located adjacent to the entrance of the site.

14.3.15 Patchy ephemeral vegetation dominated by Common Mouse-ear, Procumbent Pearlwort, Groundsel and Scentless Mayweed was found along the base of the fences, and on some of the levelled areas.

14.3.16 The concrete areas adjacent to the basin on the east side were dominated by mosses (Target Note 10).

14.3.17 Several buildings and portacabins were present on the site.

14.3.18 The southern boundary of the site, which borders the Seaton-on-Tees Channel, and the west side of the basin has been protected by large rocks that are covered at high tide (Target Note 1). The tidal vegetation on these rocks included a narrow band of Green Algae with Bladder Wrack below.

Scattered Hawthorn Scrub

14.3.19 The main area of scattered scrub, dominated by Hawthorn, was on the bank-side adjacent to the road and beside the car-park. Scattered Elder, Hawthorn, Brambles and Rose bushes were present around the site.

Neutral Grassland

14.3.20 Neutral grassland has developed on the less disturbed areas beside the road, on the bank-side west of the basin, where the piles of aggregate are stored east of the basin and on the margins of the site.

Standing Water and Swamp

14.3.21 The area east of the basin was graded to three levels using earth banks and drained into an area of standing water on the eastern margin of the site. There was a break in the earth bank at Target Note 11 allowing water to drain north, from the levelled area into the wet area. The bank-side adjacent to the pond was dominated by rank grasses with Hawthorn, Rose and Brambles rare. There was no marginal vegetation typical of permanent ponds, but there was a small Reedmace swamp north of the pond.

14.3.22 A shallow ditch with steep sided banks drains from a culvert on the western boundary of the site. Southwest of the site was a mosaic of neutral grassland, Reedmace swamp and lagoons.

Target Notes

1. Protective boulders covered by the tide support littoral algae.

2. Eroding earth bank dominated by rank grasses including species such as Creeping Bent, and Cock's-foot. Species typical of coastal areas, including Red Fescue, Scentless Mayweed, and Wild Carrot, and ruderal species typical of waste ground, including Annual Wallrocket, Rosebay Willowherb, Broad-leaved Dock, Teasels, Groundsel, Weld and Common Mouse-ear were also present.

3. Neutral grassland (Plate 1).

4. Lichens were present on top of the concrete structures at the southern end of the basin. Brambles and Sea Couch Grass were found at the base of these structures.

5. Sparse ephemeral vegetation dominated by Common Mouse-ear, Procumbent Pearlwort, Groundsel and Scentless Mayweed.

6. Ditch outside the boundary fence (Plate 2). Beyond the ditch was a mosaic of neutral grassland, Reedmace swamp and lagoons (Plate 3).

7. All the fences have ephemeral vegetation including Common Mouse-ear, Procumbent Pearlwort, Groundsel and Scentless Mayweed at the base.

8. Small area with Elder bushes.

9. Vegetated pile of aggregate with calcareous interest including Carline Thistle and Bird's-foot Trefoil (Plate 4).

10. Moss growing on the concrete.

11. Area east of the basin was divided into smaller areas with earth banks and bunds. A break in the bund allows the levelled ground to drain north into the standing water.

12. Bank-side slopes down towards the standing water. The main vegetation type was neutral grassland dominated by rank grasses with a few small Hawthorn, Rose and Brambles. There was no marginal vegetation around the standing water. An area of Reedmace swamp vegetation was present (Plate 5).

13. Vegetated and non-vegetated piles of aggregate were present on the area east of the basin. The neutral grassland was predominantly of rank grasses including species such as Creeping Bent, and Cock's-foot. Species typical of coastal areas, including Red Fescue, Scentless Mayweed, and Wild Carrot, were occasionally present. Ruderal species typical of waste ground, including Annual Wallrocket, Rosebay Willowherb, Broad-leaved Dock, Teasels, Groundsel, Weld and Common Mouse-ear were frequent. A small patch of Daffodils and Marram were present on the vegetated piles of aggregates.

14. The neutral grassland was encroaching onto the pile of sand beside the car-park (Plate 6), where Common Ragwort, Annual Wall-rocket and Scentless Mayweed were frequent and Wild Carrot rare.

15. Small area of scattered scrub.

16. The neutral grassland and scrub under-storey beside the road was dominated by grasses including False Oat-grass, Red Fescue, Cock's-foot, Creeping Bent and Yorkshire-fog. Species frequent within the sward included Common Knapweed, Daisy, Cow Parsley and Hogweed.

17. Scattered scrub with neutral grassland under-storey on bank-side beside the road (Plate 6).

18. Neutral grassland. Species present within the sward included Yarrow, Dandelion, White Clover, Daisy, Cow Parsley and Creeping Cinquefoil.

19. Adjacent to the railway line was a wet ditch that contains stands of Sea Club-rush that forms a corridor east towards the Nuclear Power Station (Plate 7). There were no saltmarsh plants present.

20. Neutral grassland borders the playing fields of the Nuclear Power Station.

21. Pile of bare earth.

22. The majority of this area has been levelled (Plate 8). A little short vegetation has started to colonise the area, including Common Chickweed, Groundsel and Scentless Mayweed.

Protected Species Scoping Survey

Invertebrates

14.3.23 Due to the nature of the habitats on site, the site is considered unlikely to provide habitat for rare or protected invertebrates. Brown Lipped Snails were frequent in the grassland on the margins of both site areas.

Amphibians

14.3.24 The water bodies of the site provided only limited potential to support Great Crested Newt during the breeding season. The standing water described in paragraph 14.3.21 had little of the marginal vegetation that is required by newts for laying eggs. Likewise, the shallow ditches described in paragraph 14.3.21 are steep-sided which makes access for newts difficult.

14.3.25 In addition, whilst Great Crested Newts are often found on industrial sites, where piles of rocks provide suitable refuge for individuals to hide, this site was unsuitable due to the present level of disturbance of people and vehicles using the site.

Reptiles

14.3.26 There was little potential habitat for reptiles on site. However, it is possible that reptiles may use the small patches of scrub and neutral grassland to the north of the railway line, particularly along the earth banks. Common Lizard has been recorded in the sand dunes north of Hartlepool by Tees Valley Wildlife Trust and therefore occurs in the wider area.

Badger

14.3.27 No evidence of Badgers was recorded on site, and no potential setts were located.

Water Vole

14.3.28 No suitable habitat for Water Voles was located within the site boundaries.

Bats

14.3.29 No habitat considered likely to support roosting bats was located on site – although there are a number of buildings, they are not considered suitable roosting habitat. In addition, the site is considered unlikely to provide high quality foraging habitat on account of its open, exposed location and lack of extensive areas of semi-natural vegetation, particularly woodland and hedges.

Birds

14.3.30 The site itself is considered unlikely to support birds of conservation significance in any significant numbers, although it is possible that small numbers of JNCC Red or Amber List species and/or UK BAP priority species (such as Starling, House Sparrow and Song Thrush) may occur. However, as detailed above the site is adjacent to areas of significant importance for a variety of bird species.

14.4 Discussion

Ecological Interest of the Surrounding Area

14.4.1 The TERRC site lies within an area that supports nationally and internationally important habitats, which attracts approximately 25,000 visitors annually (www.english-nature.org.uk). The surrounding wetlands, dunes and foreshores are of international importance as feeding and roosting areas for wintering wildfowl and are protected with SPA and Ramsar Site status. Protected habitats listed in Annex 1 of the EC Habitats Directive included estuaries, mudflats, saltmarsh and sand dunes.

Ramsar Sites

14.4.2 There are 119 Ramsar sites in the UK including swamp and marsh, lakes, rivers, artificial, marine and estuary habitats. The Teesmouth and Cleveland Coast Ramsar is important for supporting substantial numbers of waterfowl, with about 1% of the British population. The nearest Ramsar site to the north is the Firth of Forth and to the south the Humber Estuary. Other Ramsar sites on the east coast are the Wash, the Norfolk Broads and Thames Estuary.

SPA

14.4.3 The Teesmouth population of Sanderling exceeds internationally important levels and up to half of the 1200 birds (5.7% of the European population) feed and roost on Seaton Sands, North Gare Sands and Seaton Snook. Similarly, large populations of Knot winter at Teesmouth, with up to 10,000 birds (3% of the Western European population) may roost on Seaton Dunes Snook Dunes at high tide. Other important species include up to 200 ringed Plover (about 1% of the western European population) and approximately 250 turnstone (2.4% of the UK wintering population).

Saltmarsh and Grazing Marshes

14.4.4 Cowpen Marsh SSSI (116.8ha) includes the largest salt marsh between Lindisfarne and the Humber Estuary and together with the adjacent coastal grazing marshes and mudflats is important for wintering wildfowl and waders. The extent of grazing marsh in the UK is thought to be around 300,000ha of which 200,000ha are found in England. Only approximately 5,000ha in England is semi-natural with a high diversity of native species.

14.4.5 Trampling by animals on grazing marshes provide the bare ground needed for the Stiff-leaved Saltmarsh Grass, which is at the northern edge of its range. The local population has declined from a presence in 16x10 km squares pre- 1970 to presence in only 1x10km square (Preston et al., 2002) The Brackish Water Crow-foot is decreasing slowly. It has been lost from the North Yorkshire coast, but is present in the Humber Estuary and on the Northumberland Coast. Strawberry Clover is declining and has been introduced in Durham. Adjacent sites are North Yorkshire and the Firth of Forth. Wild Celery is decreasing due to loss of coastal marshes. The northern limit of its range is on the Northumberland Coast.

14.4.6 *Hydnobius perrisi*, now known as *Trichohydnobius sutralis* is a very rare red data book species. *Philonthus atratus* is a Rove Beetle at the northern limit of its range.

Sand Dunes

14.4.7 The Sand Dune Survey of Great Britain (1993-1995) gives the total area of sand dunes as 11,897 ha in England and 8101 ha in Wales. Major dune systems are widely distributed within the UK, being found on all English and Scottish coasts except the English Channel and the Thames Estuary. Large sand dune systems are found along the Northumberland Coast. Smaller dune systems are found on the Durham Coast and both sides of the Tees Estuary. In the last 20 years about 2% of the dune habitat in England has been lost through erosion, increasing the importance of the remaining dunes. Seaton Dunes and Common SSSI covers 312.1ha.

14.4.8 *Silometopus incurvatus* is a money spider only found in three other locations in Britain, the nearest being the south side of the Firth of Forth.

The Seal Population of the Tees Estuary

14.4.9 The Tees Estuary supports a small population of Harbour Seals and Grey Seals numbering approximately 58 and 26 individuals respectively. The seals returned to the estuary in the 1960’s after an absence of about 100 years, with Harbour Seals breeding successfully since 1994. They represent the only breeding seal population between Lindisfarne and the Wash.

14.4.10 The seal population on Seal Sands has been studied since 1989 by INCA based on observations at Seal Sands. The maximum number of Harbour Seals observed on Seal Sands on any one day was 23 in 1989 and 71 in 2001. Last year the maximum number of harbour seals counted has declined to 58 seals, recorded on the 19th of June, 2003.

14.4.11 Grey seals are not resident or breeding on Seal Sands and therefore their numbers are not considered as important as the monitoring of the harbour seals. The maximum number of grey seals observed on Seal Sands mudflats on any one day was 18 in 1989, increasing to 30 by 2002. The maximum numbers decreased last year to 26 grey seals on the 18th July, 28th July and 3rd August.

Ecological Interest of the Site

14.4.12 The site is of limited wildlife interest, with the most important areas being the scattered scrub, neutral grassland and swamp areas on the margins of the site. These are not protected habitats and no protected species were found on the site.

Habitats

14.4.13 The Sea Club-rush swamp adjacent to the railway is a relict saltmarsh dyke, locally known as a stell. It is of limited ecological interest as it is isolated from any larger areas of similar habitat, but is of local importance and it should be retained if possible within the development masterplan. Habitats with continuous links to similar habitats usually have a greater diversity and therefore are of higher conservation importance.

14.4.14 Lime loving plants, found on the concrete rubble on the east side of the basin, are often associated with derelict industrial sites where concrete waste is left undisturbed for a number of years, and are not unique to the site.

Protected Species

14.4.15 The site itself was of low ecological significance for protected species. There were no existing records of protected species known to use the site and the site was deemed to be of low suitability for any protected species.

14.4.16 However, given the occurrence of water bodies on site, and the record of a Great Crested Newt found within 2km, the developer is advised that should any newts be found on site this must be reported immediately.

14.4.17 Great Crested Newts are listed on Schedule 5 of the Wildlife and Countryside Act 1981, which affords them protection under Section 9, as amended by the Countryside and Right of Way Act (2000). This makes it an offence to:

- intentionally or recklessly kill, injure or take (capture etc.);
- possess;
- intentionally or recklessly damage, destroy, obstruct access to any structure or place used by a scheduled animal for shelter or protection, or disturb any animal occupying such a structure or place;
- sell, offer for sale, possess or transport for the purpose of sale (live or dead animal, part or derivative) or advertise for buying or selling such things.

14.4.18 In addition, Great Crested Newts are Schedule 2 species protected under Regulation 39 of the Conservation (Natural Habitats etc.) Regulations 1994. They are also listed on Annex II of the EC Habitats Directive and are UK Biodiversity Action Plan Species.

14.4.19 Although there were records of common lizard in the sand dunes north of Hartlepool the site itself provides little potential habitat for reptiles to occur. The only habitat that offers limited potential for reptiles is on the other side of the railway track, an area that is unlikely to be developed due to its isolation from the main site.

14.4.20 Common lizards are listed on Schedule 5 of the Wildlife & Countryside Act 1981 (as amended) with part of Section 9(1) and all of Section 9(5) applying. As such it is an offence to:

- Intentionally or recklessly kill or injure any individual; and
- Sell, offer for sale, possess or transport for the purpose of sale or publish advertisements to buy or sell individual reptiles.

14.4.21 This legislation effectively requires that mitigation take place at the time of the remediation works in order to prevent the killing or injuring of individual reptiles should they be discovered.

14.4.22 Whilst the site holds no records for birds of conservation concern nesting on site and there is little suitable habitat, there is strict legislation relating to disturbance of birds during the breeding season.

14.4.23 All nesting birds are protected under Section 1 of the Wildlife and Countryside Act (1981). It is an offence to intentionally take, damage or destroy the nest of any wild bird while that nest is in use or being built; or take or destroy an egg of any wild bird. Areas of natural vegetation, particularly scrub, at the site are likely to support nesting birds and therefore clearance of these areas during the bird-breeding season (mid March – end August) should be avoided. If removal during this period cannot be avoided all vegetation to be removed should be checked for nesting birds prior to clearance.

14.5 Conclusions

14.5.1 The site itself is not ecologically significant but given the sensitive nature of the surrounding area every care needs to be taken to mitigate potentially harmful impacts that may arise from the development itself or in any combination with the existing industry in the area.

14.6 Summary

14.6.1 RPS Ecology were commissioned to carry out a Phase 1 Habitat Survey and scoping study of the Able UK TERRC site at Hartlepool. The objective was to complete a Phase 1 Habitat Survey, mapping the main habitats on site, identify any potential habitat for protected species or species of conservation importance and identify requirements for additional surveys.

14.6.2 The TERRC site lies in the vicinity of several sites of international conservation importance, which together form part of the Teesmouth and Cleveland Coast Ramsar Site and Special Protection Area.

14.6.3 Six Sites of Special Scientific Interest are immediately adjacent to, or nearby the site, including The Hartlepool Submerged Forest, Seaton Dunes and Common, Seal Sands, Tees and Hartlepool Foreshore and Wetlands, Cowpen Marsh and South Gare and Coatham Sands. The SSSI's in the Tees Estuary together are important feeding and roosting sites for wintering wildfowl. The birds move in regular patterns around the estuary utilising different sites at different stages of the tide.

14.6.4 The INCA data show a steady increase in the maximum number of Harbour Seals on Seal Sands mudflats counted in one day from 23 individuals in 1989 to 71 in 2001. The latest figures available for the number of individuals recorded on Seal Sands mudflats in one day was 58 seals, recorded on the 19th of June, 2003. Grey seals are not resident or breeding on Seal Sands. Numbers counted in one day have increased from 18 individuals in 1989 to 30 in 2002. The most recent figures for the maximum numbers counted on one day, was 26 recorded on the 18th July, 28th July and 3rd August 2003.

14.6.5 Phase 1 habitats present on the site were Bare Ground (J4), Ephemeral/Short Perennial (J1.3), Scattered Scrub (A2.2), Neutral Grassland (B2), Swamp (F1), and Standing Water (G1), with Buildings (J3.6) and boundary features including Fences (J2.4), Walls (J2.5) and Earth Banks (J2.8). Lime loving plants, found on the concrete rubble on the east-side of the basin, are often associated with derelict industrial sites where concrete waste is left undisturbed for a number of years, and are not unique to the site.

14.6.6 The site is of limited wildlife interest, with the most important areas being the scattered scrub, neutral grassland and swamp areas on the margins of the site. These are not protected habitats although they may be suitable for breeding birds. For this reason any construction works that may alter potential breeding habitats should be done outside the breeding season.

14.6.7 The site is of limited interest with respect to protected species. However, the legislation relating to Great Crested Newts, common lizard and nesting birds should be noted as there may be a small chance of occurrence in the area based on the existing records of protected species in the vicinity of the TERRC site.

14.6.8 Whilst the site itself is not ecologically significant, given the sensitive nature of the surrounding area every care needs to be taken to mitigate potentially harmful impacts that may arise from the site itself or in any combination with the existing industry in the area.

REFERENCES

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www.english-nature.org.uk

Plate 1: Looking south west from the basin at target note 4. Neutral grassland and short perennial habitat.

Plate 2: Ditch on the western boundary of the site.

Plate 3: Greenabella Marsh from the boundary fence in the southern corner of the site.

Plate 4: The neutral grassland (target note 9) looking north with the piles of aggregates in the background.

Plate 5: The standing water looking north from target note 11 with the piles of aggregates on the left.

Plate 6: The scrub and neutral grassland adjacent to the road with the pile of sand in the foreground.

Plate 7: Sea Club-rush swamp looking east along the railway towards the nuclear power station.

Plate 8: View across the railway from target note 3.

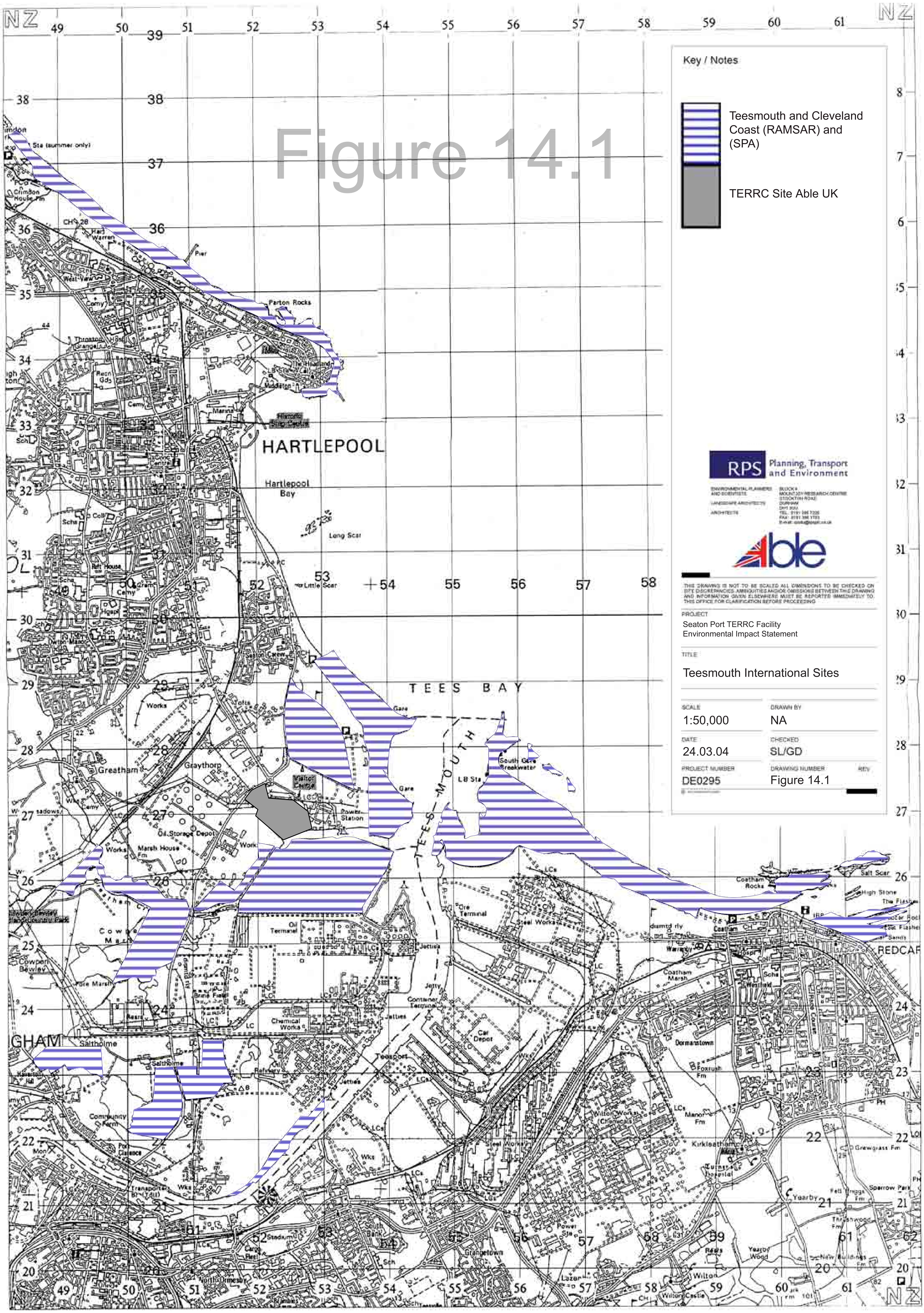

Figure 14.1
Key / Notes
Teesmouth and Cleveland Coast (RAMSAR) and (SPA)
TERRC Site Able UK
RPS Planning, Transport and Environment
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PROJECT
Seaton Port TERRC Facility
Environmental Impact Statement
TITLE
Teesmouth International Sites
SCALE
1:50,000
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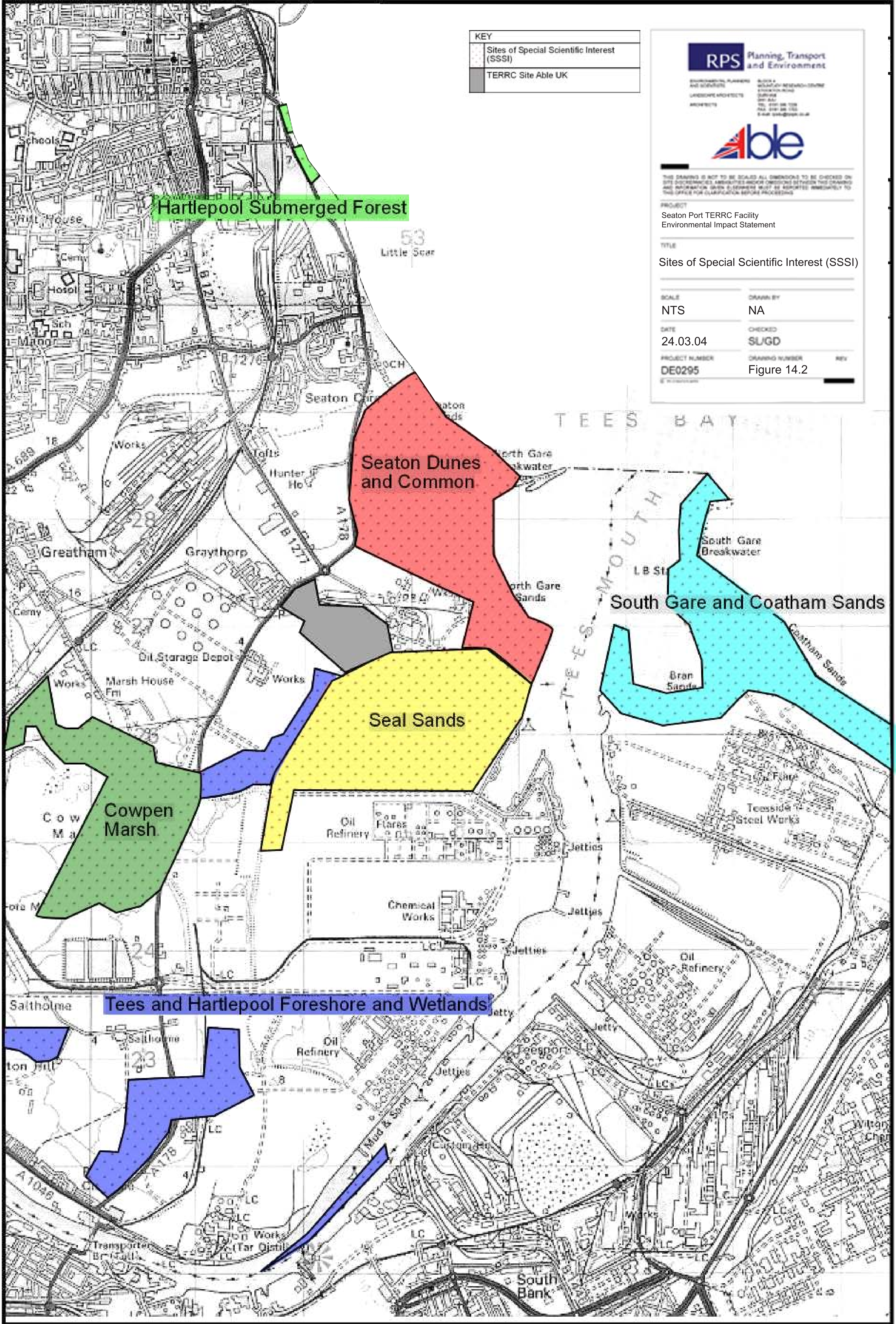
NA
DATE
24.03.04
CHECKED
SL/GD
PROJECT NUMBER
DE0295
DRAWING NUMBER
Figure 14.1
REV
HARTLEPOOL
Hartlepool Bay
TEES BAY
TEES MOUTH
REDCAR
Greatham
Graythorp
Saltholme
Seaton Carew
Dormanstown
Kirkleatham
Grangetown
Teesport
Coatham Marsh
Long Scar
Little Scar
Parton Rocks
South Gare Breakwater
Salt Scar
Coatham Rocks



KEY
Sites of Special Scientific Interest (SSSI)
TERRC Site Able UK
RPS Planning, Transport and Environment
PROJECT
Seaton Port TERRC Facility
Environmental Impact Statement
TITLE
Sites of Special Scientific Interest (SSSI)
SCALE
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DRAWN BY
NA
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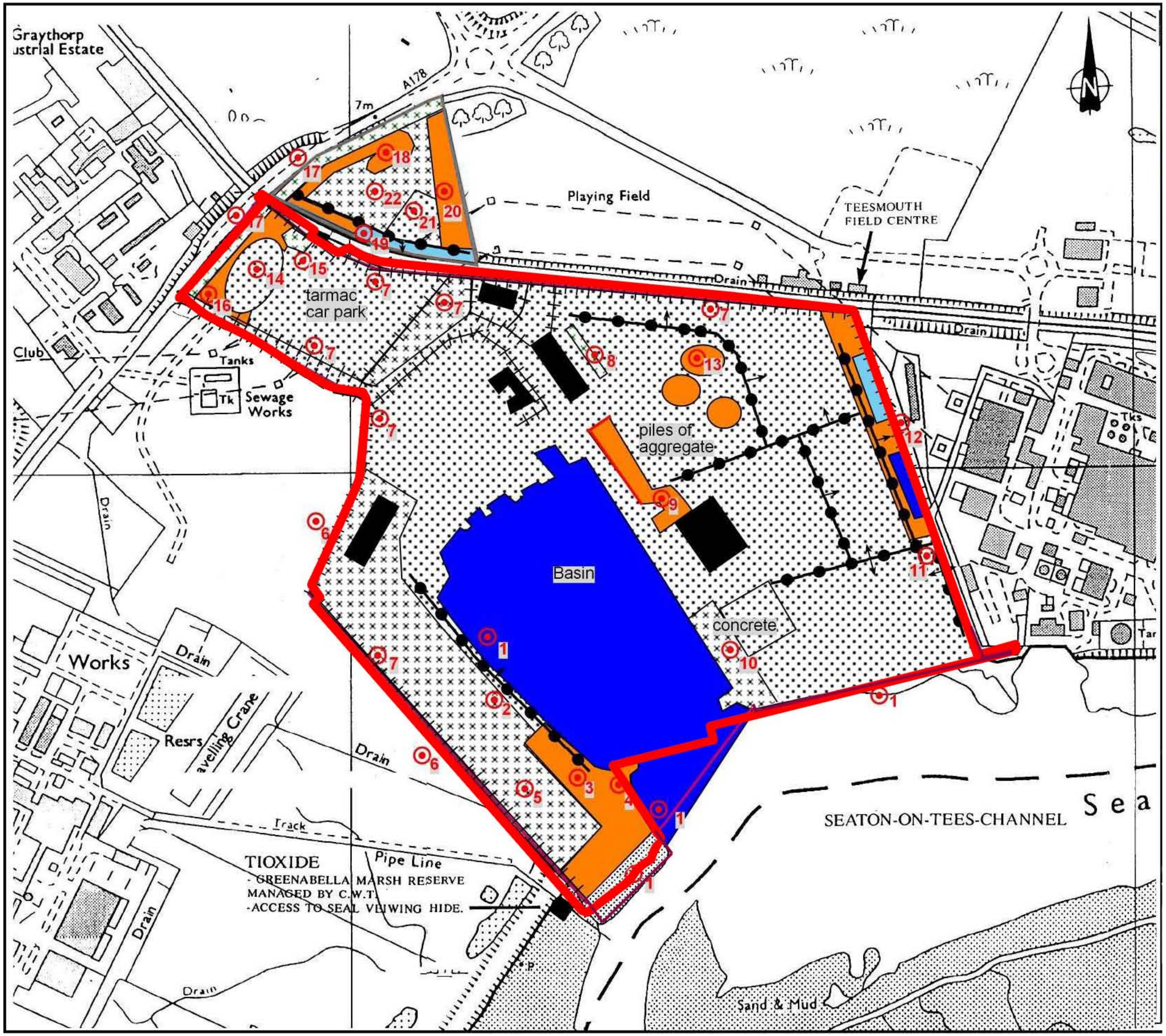
24.03.04
CHECKED
SL/GD
PROJECT NUMBER
DE0295
DRAWING NUMBER
Figure 14.2
Hartlepool Submerged Forest
Seaton Dunes and Common
South Gare and Coatham Sands
Seal Sands
Cowpen Marsh
Tees and Hartlepool Foreshore and Wetlands
TEES BAY
Greatham
Graythorp
Oil Storage Depot
Marsh House Fm
Oil Refinery
Chemical Works
Teesside Steel Works
Saltholme
Teesport
South Bank



Key / Notes

- Scattered Scrub (A2.2)
- Neutral Grassland (B2)
- Swamp (F1)
- Standing Water (G1)
- Ephemeral/Short Perennial (J1.3)
- Wall (J5)
- Buildings (J3.6)
- Bare Ground (J4)
- Fence (J2.4)
- Earth Bank(J2.8)
- Target Notes
- Boundary of Site

RPS Planning, Transport and Environment

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PROJECT
Seaton Port TERRC Facility
Environmental Impact Statement

TITLE
Phase 1 Habitats

SCALE	DRAWN BY	
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DATE	CHECKED	
24.03.04	SL/GD	
PROJECT NUMBER	DRAWING NUMBER	REV
DE0295	Figure A14.4	

Addendum A14

Plant Species found in the Habitats Present on the TERRC Site

Addendum A14

Table 1: Flora of the Ephemeral Habitat

Common Name	Latin Name
Cleavers	*Galium aparine*
Common Chickweed	*Stellaria media*
Common Mouse-ear	*Cerastium holosteoides*
Dandelion?	*Taraxacum sect. Ruderalia*
Great Lettuce	*Lactuca virosa*
Groundsel	*Senecio vulgaris*
Ivy-leaved Speedwell	*Veronica hederifolia*
Procumbent Pearlwort	*Sagina procumbens*
Rosebay Willowherb?	*Chamerion angustifolium*
Scentless Mayweed	*Tripleurospermum inodorum*
Wavy Bitter-cress	*Cardamine flexuosa*
Weld	*Reseda luteola*

Table 2: Flora of the Neutral Grassland

Common Name	Latin name
Annual Wall-rocket	*Diplotaxis muralis*
Broad-leaved Dock	*Rumex obtusifolius*
Greater Burdock	*Arctium lappa*
Cock's-foot	*Dactylis glomerata*
Colt's-foot	*Tussilago farfara*
Common Bent-grass	*Agrostis stolonifera*
Common Mallow	*Malva sylvestris*
Common Ragwort	*Senecio jacobaea*
Cow Parsley	*Anthriscus sylvestris*
Creeping Bent-grass	*Agrostis stolonifera*
Creeping Buttercup	*Ranunculus repens*
Creeping Cinquefoil	*Potentilla reptans*
Daffodils	*Narcissa sp.*
Daisy	*Bellis perennis*
False Oat-grass	*Arrenatherum elatius*
Hogweed	*Heracleum sphondylium*
Lesser Celandine	*Ranunculus ficaria*
Mugwort	*Artemisia vulgaris*
Nettles	*Urtica dioica*
Red Dead-nettle	*Lamium purpureum*
Ribwort Plantain	*Plantago lanceolata*
Sweet Vernal-grass	*Anthoxanthum odoratum*

Common Name	Latin name
Spear Thistles	*Cirsium vulgare*
Toadflax	*Linaria sp.*
Tufted Vetch	*Vicia cracca*
White Clover	*Trifolium repens*
Wild Teasels	*Dipsacus fullonum*
Yarrow	*Achillea millefolium*
Yorkshire-fog	*Holcus lanatus*

Table 3: Flora Typical of Coastal Grassland

Common Name	Latin Name
Curled Dock	*Rumex crispus*
Marram	*Ammophila arenaria*
Red Fescue	*Festuca rubra*
Sea Couch	*Elytrigia atherica*
Wild Carot	*Daucus carota*

Table 4: Flora Typical of Calcareous Habitats

Common Name	Latin Name
Carline Thistle	*Carlina vulgaris*
Common Bird's-foot-trefoil	*Lotus corniculatus*

Table 5: Flora Comprising the Scattered Scrub

Common Name	Latin Name
Hawthorn	*Crataegus monogyna*
Willow	*Salix sp.*
Bramble	*Rubus fruticosus agg.*
Rose	*Rosa sp.*

Table 6: Swamp Flora

Common Name	Latin Name
Sea Cub-rush	*Scirpus maritimus*

Table 7: Littoral Flora

Common Name	Latin Name
Lichen	*Xanthoria parietina*
Bladder Wrack	*Fucus vesiculosis*
Green Alga	*Enteromorpha sp.*
Green Alga	*Cladophora sp.*

Appendix 16.1

Technical Report 2004 - 1387

Environmental Assessment of Dredging Operations, Changes in Hydrodynamics and Sediment Transport; TERRC Facility

DNV (2004)

TECHNICAL REPORT

ABLE UK LTD

ENVIRONMENTAL ASSESSMENT OF DREDGING OPERATIONS, CHANGES IN HYDRODYNAMICS AND SEDIMENT TRANSPORT; TERRC FACILITY

REPORT NO. 2004-1387
REVISION NO. 01

DET NORSKE VERITAS

DET NORSKE VERITAS

TECHNICAL REPORT

Date of first issue:	Project No.:
2004-12-21	62505907
Approved by: Erling Svendby Marked sector leader	Organisational unit: DNV Consulting
Client: Able UK Ltd	Client ref.: Ian Fenny

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Summary:

Det Norske Veritas (DNV) has conducted a numerical modelling study to assess the impact on hydrodynamics and sediment transport due to dredging required in the development of the TERRC facility in the Tees Estuary. Generally the velocities and bottom shear stress are lowered within the bounds of Seaton Channel due to deepening of the proposed dredging areas. Outside the bounds of Seaton Channel changes in velocities and shear stress are low. The greatest changes are related to the deepening of Seaton Channel. For the most extensive dredging scenario the results indicate a decrease in average velocities of about 7 % on Seal Sands and around 18 % in the lower reaches of Seaton Channel, at some selected locations. The modelled results indicate minor changes in sediment transport and sedimentation rates. Some increase in sedimentation may be expected due to lower velocities and bottom shear stress within the bounds of Seaton channel and especially in the lower parts of the channel. Suspended sediment concentrations, sediment dispersion and sedimentation from the suggested dredging operations will be much larger compared to tidal driven transport and sedimentation. The model results indicate that the suspended sediment concentrations can exceed 1000 mg/l for the backhoe dredge, but are less for the hopper dredge. In all cases, the concentrations drop off quickly away from the dredge. Some of the released sediments for both the backhoe and the hopper dredge are transported into the shallow areas south of the Seaton Channel. The greatest impact are related to dredging Seaton Channel with a hopper dredge on spring tide which yields a deposition rate around 100 g/m^2 after only 2 days of dredging. Dredging around the clock for 12 weeks, as planned, can therefore introduce considerably amounts of sediment onto Seal Sands.

Impact on marine life has been evaluated due to changes in hydrodynamics and sedimentation regime as a result of the planned dredging operations at the TERRC facility. The level of contamination in the dredging areas and at Seals Sand has been mapped and compared with international sediment quality standards. Levels have been mapped for several metals (Ar, Cd, Cr, Cu, Hg, Ni, Pb and Zn), PCBs, PAHs and TBT in dredging area 1 to 4. On Seals Sands the levels of metals mentioned above have been mapped. The levels of contamination have been compared with international sediment quality standards.

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1 CONCLUSIVE SUMMARY

Det Norske Veritas (DNV) have conducted a numerical modelling study to assess the impact on hydrodynamics and sediment transport due to dredging required in the development of the TERRC facility in the Tees Estuary.

Generally the velocities and bottom shear stress are lowered within the bounds of Seaton Channel due to deepening of the proposed dredging areas. Outside the bounds of Seaton Channel changes in velocities and shear stress are low. The greatest changes are related to the deepening of Seaton Channel. For the most extensive dredging scenario the results indicate a decrease in average velocities of about 6 % on Seal Sands and around 18 % in the lower reaches of Seaton Channel, at some selected locations.

The modelled results indicate minor changes in sediment transport and sedimentation rates. Some increase in sedimentation may be expected due to lower velocities and bottom shear stress within the bounds of Seaton channel, especially in the lower parts of the channel.

Suspended sediment concentrations, sediment dispersion and sedimentation from the suggested dredging operations will be much larger compared to tidal driven transport and sedimentation. The model results indicate that the suspended sediment concentrations can exceed 1000 mg/l for the backhoe dredge, but are less for the hopper dredge. In all cases, the concentrations drop off quickly away from the dredge. Some of the released sediments for both the backhoe and the hopper dredge are transported into the shallow areas south of the Seaton Channel. The greatest impact are related to dredging Seaton Channel with a hopper dredge on spring tide which yields a deposition rate around 100 g/m^2 after only 2 days of dredging. Dredging around the clock for 12 weeks, as planned, can therefore introduce considerably amounts of sediment onto Seal Sands.

The levels of contamination have been compared with international sediment quality standards. Concentrations of contaminants are generally below recommended risk limits for effects on the ecosystem. The exceptions are for the following PAHs: benzo(a)pyrene, Acenaphthylene, Anthracene and Benzo(a)anthracene. These PAHs are found in concentrations that exceeds the Probable Effect Level (PEL) according to the Canadian Environmental Quality Guidelines.

2 INTRODUCTION

Able Ltd UK has engaged Det Norske Veritas (DNV) to conduct a numerical modelling study to assess the impact on hydrodynamics and sediment transport due to dredging required in the development of the TERRC facility in the Tees Estuary. The modelling effort consists of two components. The first relates to the impact on circulation and sedimentation due to changing the bathymetry of the Seaton Channel and associated dredged areas. The second relates to water column suspended sediment concentrations due to the dredging activity, which is done in co operation with Computational Hydraulics and Transport (CHT) and Applied Science Associates (ASA).

In addition DNV have, based on the modelling results, evaluated potential effects on marine life in the modelling area. DNV's work is a part of a larger Environmental Impact Assessment (EIA) carried out by another party. This report describes the modelling results and the potential impact on marine life in the area.

2.1 Assumptions and limitations

The following section discusses assumptions and limitations imposed upon this study which affect results and interpretations. As the study is based upon external data sources and no measurements or observations have been made on site it is influenced by assumptions and limitations from other studies, some of which may not be clear.

The scope of the study is to investigate the relative impact of the proposed development on hydrodynamic and sediment regimes, and thereby on marine life in the Tees estuary. In order to see the impacts clearly, masking elements like floods, storms, waves, dredging activities and vessel traffic have been omitted. The essential impact of each element of the proposed development is thus clear. However, the absolute values of water velocities, shear stress distribution, sediment concentrations and sediment erosion and deposition rates are not emphasized, as the Tees estuary sediment transportation processes are influenced by events like floods, wave action and propeller currents. Dredging operations are investigated to some degree to find the impact of dredging the TERRC dry dock and Seaton Channel, but the continuous dredging operation along the River Tees and the estuary is not included.

It is therefore important to realise that the relative impacts presented here are of importance, but that siltation rates and subsequent needs for maintenance dredging should not be based upon the modelling results unless specified.

The theoretical basis for the hydrodynamic and sediment transportation models and the cohesive sediments in particular, are known to be simplifications of natural processes. This imposes some limitations on the accuracy and realism of the results obtained. Models for erosion, transportation and deposition of cohesive sediments like clay and silt are unstable, as are the natural processes the models represent. A small change in input parameters or geometry may have severe impacts on the results obtained. Any interpretations made should focus on the relative impact of the proposed developments rather than the absolute values of sediment erosion and accretion.

Further assumptions and limitations are discussed in relevant sections.

3 DREDGING SCENARIOS AND VOLUMES

Based on the bathymetry quantities for different dredging scenarios have been calculated.

3.1 Initial dredging

Figure 3-1 to Figure 3-6 illustrates the definition of each area in question. With regards to quay 10 and 11 there are missing depth data just outside the quays, so in the calculations the assumption that the depth just outside the quays is the same as the first point in the bathy data (transects) has been made.

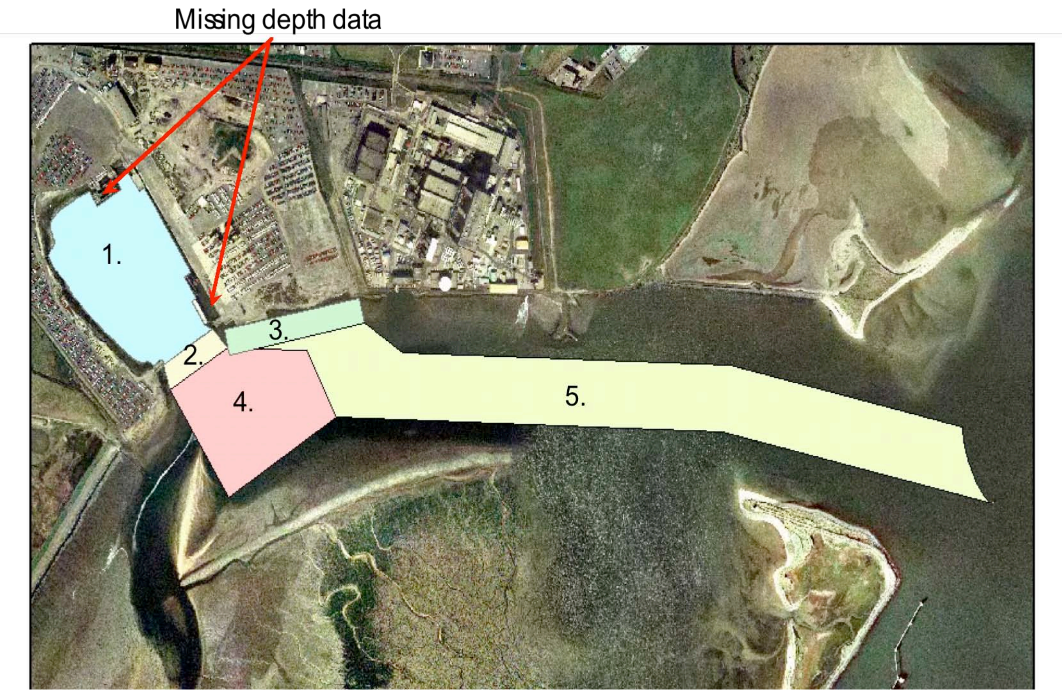


Figure 3-1 Overview of the dredging areas. 1) dry/wet dock, 2) Bund/cofferdam area, 3) Quays 10 and 11, 4) holding basin and 5) Seaton Channel

Detailed figures showing the bathymetry in each dredging area are presented below. The bathymetric charts are drawn up such that the areas which need to be dredged are made as visible as possible.

Figure 3-2 Detailed bathymetry for dredging of Seaton Channel

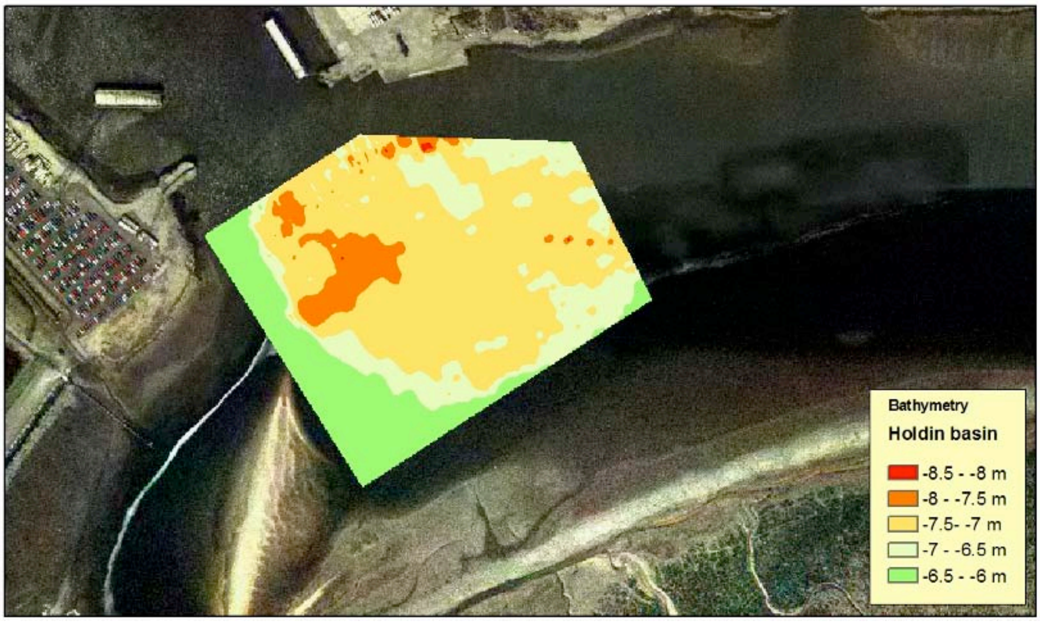


Figure 3-3 Detailed bathymetry for dredging of Holding Basin

Figure 3-4 Detailed bathymetry for dredging of Quay 10 and 11

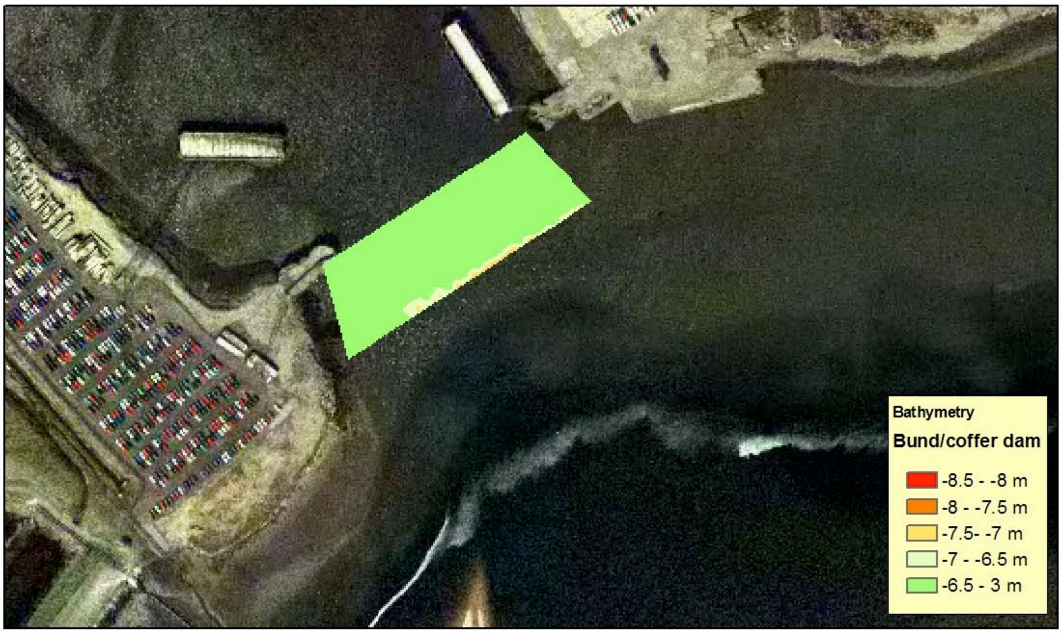


Figure 3-5 Detailed bathymetry for dredging of Bund/cofferdam area

Figure 3-6 Detailed bathymetry for dredging of Dry/wet dock

With regards to the dock itself there are some missing depth data under the ships and the construction in the south eastern and north eastern limit of the dock, which is illustrated in Figure 3-1. Based on the surface area of these two areas an assumption is made on the dredging volumes in these two areas, and these have to be added to the calculated volumes for the dock.

The area in the south eastern corner of the dock is approximately 2500 m^2. The depth in this area is assumed to be 3 m on average and is based on the depths in the bathymetric transect which border on this area.

The area in the north eastern corner of the dock is also approximately 2500 m^2. The depth in this area is assumed to be 4.5 m on average and is based on the depths in the bathymetric transect which border on this area.

The estimated volumes of these two areas have to be added to the volumes for the dry/wet dock.

Calculated dredging volumes for different scenarios are presented in Table 3-1. In addition dredging volumes for a proposed extension of quay 10 & 11 are calculated and presented in the table. The areas of dredging related to the proposed extension are shown in Figure 3-7 below.

Figure 3-7 Areas of dredging for the proposed extension of Quay 10 and 11

Table 3-1 Calculated volumes of dredged sediments.

Scenario	Reference area	2D area m^2	Dredging depth	Volume m^3
Seaton Channel	5	179 555.69	- 6.0 m LAT	276 797
Seaton Channel	5	189 565.76	- 6,5 m LAT	369 496
Seaton Channel	5	194 714.11	- 7.0 m LAT	465 568
Seaton Channel	5	196 570.24	- 7.5 m LAT	563 492
Seaton Channel	5	197 083.74	- 8.0 m LAT	661 934
Seaton Channel	5	197 404.28	- 8.5 m LAT	760 559
Holding basin	4	8 698.49	- 6.0 m LAT	15 157
Holding basin	4	12 655.33	- 6.5 m LAT	20 585
Holding basin	4	25 340.03	- 7.0 m LAT	28 710
Holding basin	4	59 683.65	- 7.5 m LAT	52 332
Holding basin	4	64 426.92	- 8.0 m LAT	83 793
Holding basin	4	64 483.00	- 8.5 m LAT	116 031
Holding basin	4	64483.00	- 9.0 m LAT	148 273
Holding basin	4	64483.00	- 9.5 m LAT	180 515
Quay 10 and 11 – 30 m off	3	8 600.18	- 5.0 m LAT	36 920
Quay 10 and 11 – 30 m off	3	8764.83	- 6.0 m LAT	45 608
Quay 10 and 11 – 40 m off	3	11 719.74	- 7.0 m LAT	68 575
Quay 10 and 11 – 40 m off	3	11 871.00	- 8.0 m LAT	80 415
Quay 10 and 11 – 40 m off	3	11 871.00	- 9.0 m LAT	92 286
Quay 10 and 11 – 40 m off	3	11 871.00	- 10.0 m LAT	104 157
Quay 10 and 11 – 40 m off	3	11 871.00	- 11.0 m LAT	116 028
Quay 10 and 11 – 40 m off	3	11 871.00	- 12.0 m LAT	127 899
Quay 10 and 11 – 40 m off	3	11 871.00	- 12.5 m LAT	133 835
Quay 10 and 11 – area A	3	2 696	- 12.5 m LAT	20 007
Quay 10 and 11 – area B	3	2 529	- 12.5 m LAT	37 286
Quay 10 and 11 – area C	3	5 559	- 12.5 m LAT	63 591
Bund/coffer dam area	2	5 975.13	- 6.0 m LAT	5 357
Bund/coffer dam area	2	6 321.10	- 6.5 m LAT	8 440
Bund/coffer dam area	2	6 584.91	- 7.0 m LAT	11 671
Bund/coffer dam area	2	6 630.00	- 7.5 m LAT	14 983
Bund/coffer dam area	2	6 630.00	- 8.0 m LAT	18 298
Bund/coffer dam area	2	6 630.00	- 8.5 m LAT	21 613
Bund/coffer dam area	2	6 630.00	- 9.0 m LAT	24 928
Bund/coffer dam area	2	6 630.00	- 9.5 m LAT	28 243
Dry/wet dock	1	68 271.40	- 6.0 m LAT	66 709 [1)]
Dry/wet dock	1	76 739.22	- 6.5 m LAT	106 916 [2)]
Dry/wet dock	1	76 922	- 6.65 m LAT [4)]	119 192 [3)]

1) An estimated volume of 12 500 $m^3$is added for the two areas where depth data is missing
2) An estimated volume of 15 000 m^3 is added for the two areas where depth data is missing
3) An estimated volume of 15 750 m^3 is for the two areas where depth data is missing
4) Original dock floor level

3.2 Maintenance dredging

The hydrodynamic and sediment transport model are assumed to be driven by tidal processes. This assumption is valid when comparing the relative impacts from the different scenarios, but when absolute values of sedimentation are considered, other factors like floods, storms and dredging will have a great impact on the sediment transport and distribution. It is unrealistic to take all these factors into account in one model, and indeed they would create an unclear picture, and mask the relative impacts that are important in the EIA.

We have therefore based this estimate of probable dredging quantities during operation on historical dredging quantities, and used the model results to indicate areas of higher and lower sedimentation. This is justified by the hydrodynamic modelling results, which indicate minor changes to the hydrodynamic regime and sediment transport in the area for the different modelled scenarios. However, some more sedimentation might be expected due to lower velocities and shear stresses at the bottom, especially at the lower part of Seaton channel.

Table 3-2 Dimensions of "Chart 9"

Element	Dimensions (m)	Area (m^2)
Turning circle	D = 500 m	196,250
Channel N of turning circle	L x W = 450 x 230 m	103,500
Channel S of turning circle	L x W = 400 x 400 m	160,000
Philips inset dock	L x W = 800 x 270 m	216,000
Seaton Channel	L x W = 1500 x 120 m	180,000
Holding basin	L x W = 250 x 180 m	45,000
SUM		**900,750**

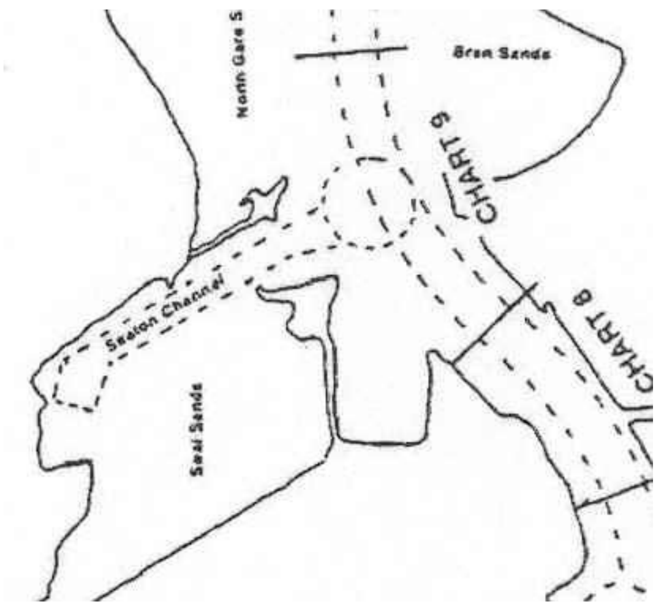


Figure 3-8 "Chart 9" in Tees Estuary dredging plan /2/

The average annual dredging volume for “Chart 9” from 1991 to 2001 is found to be 106,000 m^3 /2/. The estimated average annual deposition rate for Chart 9 can be calculated thus:

$$106{,}000\ m^3/year\ /\ 900{,}750\ m^2 = 0.12\ m/year$$

The average deposition rate for the area of Chart 9 can be expected to be in the region of 120 mm/year.

Higher siltation rates can be expected in areas where water velocities are lower, such as the inner reaches of Seaton Channel, the holding basin, and in the dry dock when this is open. Relative differences of siltation rates are estimated from the sediment transportation model. The following quantities are therefore estimated:

Table 3-3 Estimated annual maintenance dredging quantities from “chart 9” /2/

Element	**Area (m^2)**	**Expected siltation rate (m)**	**Expected siltation vol**
Seaton Channel	180,000	0.10 (80% of average)	18,000 m^3
Holding basin	45,000	0.12	5,400 m^3
Sum ex dry dock			**23,400 m^3**
Dry dock	83,600	0.15 (30% over average)	12,540 m^3
SUM			**35,940 m^3**

Based on chart 9 /2/ and when the dry dock is closed, an annual dredging volume of 23,000 m^3 is estimated for Seaton Channel and the holding basin. When the dry dock is open, this volume is anticipated to rise to an estimated 36,000 m^3.

Estimated volumes for different scenarios are presented in Table 3-4. These numbers are based on calculated dredging areas in this project and will differ somewhat from the numbers in Table 3-3 which are based on the dimensions in chart 9 /2/.

Table 3-4 Estimated annual maintenance dredging for different scenarios, based on calculated areas of the dredging areas in this project

Element	**Area (m^2)**	**Expected siltation rate (m)**	**Expected siltation vol**
Dock & Holding basin	141 580	0.15 Dock and 0.12 Holding basin	19,303 m^3
Dock & Seaton channel	275 440	0.15 Dock and 0.1 S.Channel	31,399 m^3
Dock and Quays 10 and 11 50 m off	92 134	0.15 Dock and 0.12 Quays	13,369 m^3
Dock, S. channel and Quays 10 and 11 50 m off	290 477	0.15 Dock, 0.12 Quays and 0.1 S. Channel	33,203 m^3
S. channel & Quays 10 and 11 50 m off	213 380	0.12 Quays and 0.1 S.Channel	21,638 m^3
Quays 10 and 11 30 m off	8 781	0.12	1,053 m^3
Quays 10 and 11 40 m off	11 871	0.12	1,424 m^3
Quays 10 and 11 50 m off	15 037	0.12	1,804 m^3
Area A	2 826	0.12	339
Area B	2 660	0.12	319
Area C	5 803	0.12	697
Bund/cofferdam area	6 630	0.135	895 m^3

Based on this maintenance dredging of all the areas in Figure 3-1 (Dock, bund/cofferdam, Holding basin, Quays 10 and 11 50 m off and Seaton Channel), an annual dredging volume of 41,836 m^3 is estimated. An additional volume of 1355 m^3/year is estimated for the three areas marked A, B and C in Figure 3-7, and total annual dredging volume then yields 43,191 m^3. When the dry dock is closed, this volume is anticipated to decrease to an estimated 30,271 m^3 or 31,626 when area A, B and C are included.

4 METHODS AND MODELS

The aim of this study is to describe the general impact on the hydrodynamic properties and sediment transportation regime, with subsequent impact on marine life, stemming from the proposed developments at the TERRC site and Seaton Channel.

In order to capture these general impacts, the basic hydrodynamic and sediment processes are modelled. Impacts from unpredictable events like storms, waves and traffic complicate the picture and may “mask” the general impacts from the developments. These events are therefore omitted from the study.

Omitting wave, storm and traffic action will, however, have an impact on absolute figures for hydrodynamic and sediment processes. The sediment transportation in particular is influenced by wave action and storm events. It is found that predicted sediment concentrations and erosion/deposition rates differ from observed values and rates. It is therefore important to realise that the relative differences between the baseline and the various scenarios are of interest, as these best describe the impact of the proposed development.

4.1 Modelling the hydrodynamic regime and sediment transport

4.1.1 Software

River hydrodynamics are modelled with Surface Water modelling System (SMS) from EMS-I (Environmental Modelling Systems, Inc.). More specific the RMA-2 hydrodynamic model and the SED2D model are used in this project. The RMA2 and SED2D model have been developed since 1972-73 and they are well documented models.

4.1.1.1 Hydrodynamic modelling software – RMA2

The RMA2 model was developed by Norton, King and Orlob (1973), of water Resources Engineers. Further developments have been carried at the University of California and by the USA ERDC at the Waterways Experiment Station (WES) Coastal and Hydraulics Laboratory.

The RMA2 is a two-dimensional depth averaged finite element hydrodynamic numerical model /10/. It computes water surface elevations and horizontal velocity components for sub critical, free-surface two-dimensional flow fields.

RMA2 computes a finite element solution of the Reynolds form of the Navier-Stokes equations for turbulent flows. Friction is calculated with the Manning’s or Chezy equation, and eddy viscosity coefficients are used to define turbulence characteristics. Both steady and unsteady (dynamic) problems can be analyzed.

The RMA2 has been applied to calculate water levels and flow distribution around islands, flow at bridges having one or more relief openings, in contracting and expanding reaches, into and out of off-channel hydropower plants, at river junctions, and into and out of pumping plant channels, circulation and transport in water bodies with wetlands, and general water levels and flow patterns in rivers, reservoirs an estuaries.

4.1.1.2 Sediment transport modelling software – SED2D

The SED2D was originally developed by Dr. Ranjan Ariathurai (STUDH model) and rewritten at USACE-WES to become SED2D-WES.

The SED2D is a generalized finite element computer model for vertically averaged sediment transport in open channels flow /11/. It is the sediment transport companion for the RMA2 hydrodynamic model, and is so based on the results from the RMA2. Both clay and sand may be analyzed, but the model considers a single effective grain size during each simulation. Generally the sediment is mobilized when energy forces exceed critical shear stress, and sediment is immobilized when opposite conditions exists.

When modelling erosion and deposition of non-cohesive sediments (sand) the model assumes a bed of finite thickness, a non-erodible surface under bed, one grain size for transport equations, separate grain size for bed roughness calculations (Ackers-White only), and that erosion and deposition occur simultaneously.

For modelling of cohesive sediments (silt, clay), up to ten layers can be defined and clay layers change with time and overburden. Three shear stress (τ) values can be defined which will determine the erosion and deposition pattern.

4.1.1.3 The SSFATE modelling system

SSFATE was developed by Applied Science Associates, Inc located in Narragansett, RI and the US Army Corps of Engineers Research Development Center located in Vicksburg, MS in response to a need for tools to assist dredging project managers confronted by requests for environmental windows. Details about SSFATE can be found in The DOER Technical Notes Collection (ERDC TN-DOER-E10). A summary of the modelling system is given below.

SSFATE is a versatile suspended sediment computer modelling system based on the concept of Lagrangian sediment particles. SSFATE contains many features. For example, ambient currents, which are required for operation of the basic computational model, can either be imported from a numerical hydrodynamic model or drawn graphically using interpolation of limited field data. Model output consists of concentration contours in both horizontal and vertical planes, time-series plots of suspended sediment concentrations, and the spatial distribution of sediment deposited on the sea floor. In addition, particle movement can be animated over Geographic Information System (GIS) layers depicting sensitive environmental areas.

SSFATE employs a shell-based approach consisting of a colour graphics based, menu-driven user interface, GIS, environmental data management tools, gridding software, and interfaces to supply input and display output data from the model. SSFATE runs on a personal computer and makes extensive use of the mouse (point/click) and pull down menus. Data input/output is interactive and mainly graphics based. The system allows a full set of tools to allow the user to import data from standard databases, a wide variety of GIS's, and other specialized plotting/analysis programs. At the heart of the system is a computational model that predicts the transport, dispersion, and settling of suspended dredged material released to the water column as a result of dredging operations. An integral component of the modelling system is the specification of the sediment source strength and vertical distribution.

4.1.2 Hydrodynamic model setup, calibration and verification

The numerical hydrodynamic model of the Tees estuary is based upon measured bathymetry, observed tidal variations and documented river flows.

The upstream boundary of the model was taken as the Tees barrage, where good flow records exist and the tidal influence is negligible. The long distance upstream of the study area ensures that the model is numerically stable in the area if interest, and that the upstream tidal storage is described adequately.

The downstream boundary was chosen to be an arbitrary arc in the ocean approximately 3-5 km from the mouth of the estuary. This ensures that tidal effects are well established in the study area.

Predictions close to the model boundaries must be evaluated carefully, as the boundary conditions will affect results, especially regarding sediment concentration and deposition.

See Figure 4-1 for details of area included in the model.

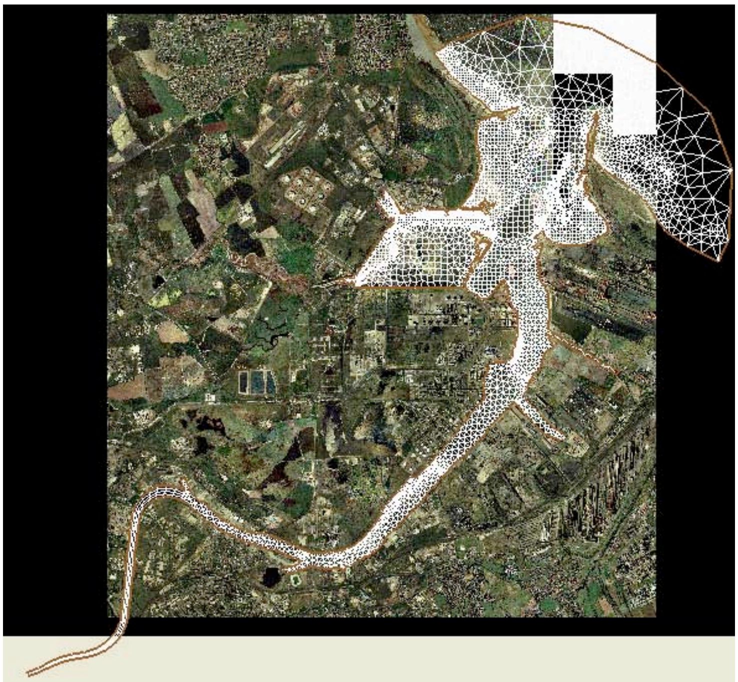


Figure 4-1 Area included in numerical model

4.1.2.1 Base data

Updated bathymetric data showing levels in the dredged parts of the Tees River, the Tees estuary and Seaton Channel were obtained from PD Teesport /6/. These data were sounded throughout summer 2004. In addition, bathymetry of Seal Sands, other sand/mudflats and tidal areas were obtained from the Environment Agency /7/. Further data were sourced from local authorities. Charts were digitized to describe the bathymetry of the area immediately outside the estuary mouth /8/.

River flow data were obtained from Zeneca /3/. This describes the flow at Tees Barrage on 6th and 14th of June 1995, after the commission of the barrage. River flow data for Greatham Creek do not exist according to the EA. The flow in the Tees estuary is, however, found to be heavily influenced by tidal movements, and the river flow has little impact on flow velocities. For instance, the normal flow in the river Tees is in the order of 6 m^3/s. With a relatively high river flow of 25 m^3/s and a spring tidal cycle, the maximum velocities on rising and ebbing tides are very similar, see Figure 4-2 below.

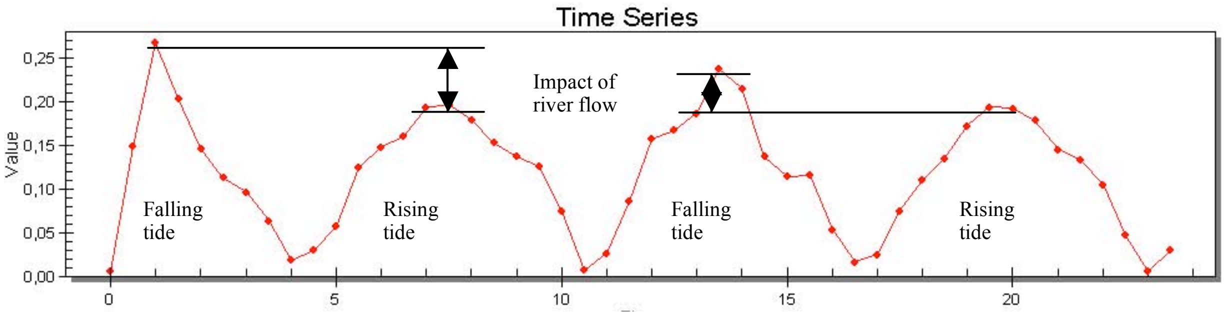


Figure 4-2 Water velocities (m/s) at Teesport with river flow 25 m^3/s, spring cycle

Observed tidal data from Teesport are found in /3/ for the 6th and 14th of June 1995, the same dates that river flow measurements at Tees barrage are found. This is used as downstream boundary conditions.

4.1.2.2 Calibration

The model was run with a spring and a neap cycle, with a constant inflow at the Tees Barrage and with varying bed roughness. Water surface elevations, water depths and velocity magnitude and directions were calculated at 17,000 points in the estuary for each 1/2 –hour time step throughout 24 hours.

The results were compared with observed water elevations and flow characteristics, and a representative global roughness factor was chosen.

River flow and tidal data for 6th and 14th of June 1995 were used for calibration.

Table 4-1 River inflow at the Tees Barrage for calibration period /3/

Date	**Daily mean (m^3/s)**	**3-day mean (m^3/s)**	**Highest (m^3/s)**	**Lowest (m^3/s)**
1995-06-03	5.31	5.80	6.47	4.10
1995-06-04	7.71	6.10	10.00	5.06
1995-06-05	6.75	6.59	7.97	5.58
1995-06-06	5.98	6.81	6.93	5.22
1995-06-07	6.49	6.41	8.99	4.55
1995-06-08	6.80	6.42	7.98	6.12
1995-06-09	5.46	6.25	6.11	4.91
1995-06-10	4.69	5.65	5.35	3.86
1995-06-11	4.29	4.81	4.95	4.85
1995-06-12	4.59	4.52	5.10	4.30
1995-06-13	5.03	4.64	6.00	4.25
1995-06-14	4.60	4.74	5.65	3.95
1995-06-15	4.82	4.82	5.62	3.70
MEAN	**5.58**	**5.66**	**6.70**	**4.65**

A flow of 6.0 m^3/s is adopted as an adequate "normal" flow for the period.

The neap tidal cycle of 6^{th} of June 1995 and the spring tidal cycle of 14^{th} June 1995 are shown in Figure 4-2 above.

In Table 4-2 and Table 4-3 below, the average difference between predicted and observed water surface elevations at Teesport are listed, together with maximum differences, minimum differences (largest negative difference) and the standard deviation of the differences. The roughness factor as Manning's n is varied from 0.025 (smooth, mud) to 0.085 (coarse pebbles, rocks). Neap and spring cycles are investigated.

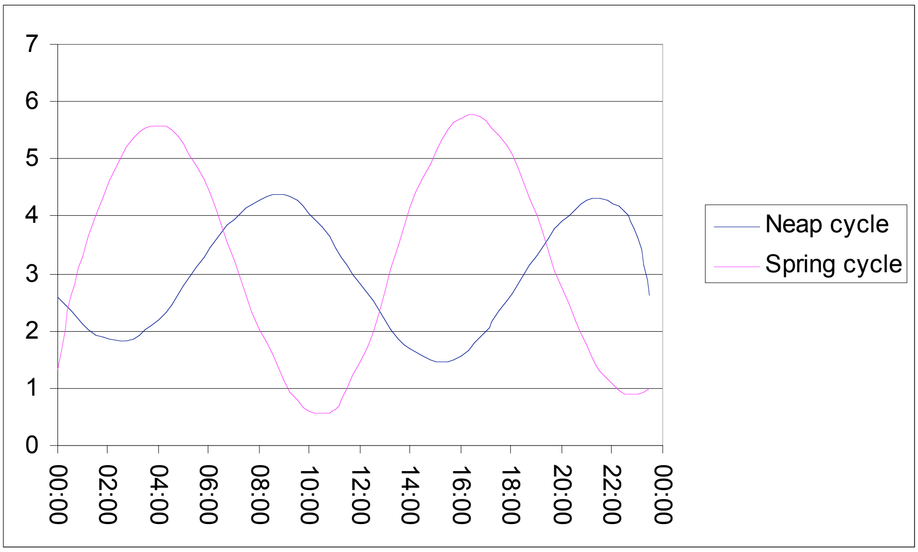


Figure 4-3 Spring and neap cycles for calibration /3/

Table 4-2 Comparison calculated and observed WSE to LAT, neap cycle

Manning's n	**0.025**	**0.045**	**0.065**	**0.085**
Average difference	0.002	0.002	0.003	0.003
Maximum positive difference	0.133	0.128	0.122	0.113
Maximum negative difference	-0.071	-0.080	-0.091	-0.104
Standard deviation	0.028	0.028	0.030	0.033

Table 4-3 Comparison calculated and observed WSE to LAT, spring cycle

Manning's n	**0.025**	**0.045**	**0.065**	**0.085**
Average difference	Not available	-0.004	-0.005	-0.008
Maximum positive difference	Not available	0.066	0.098	0.147
Maximum negative difference	Not available	-0.044	-0.062	-0.092
Standard deviation of differences	Not available	0.028	0.041	0.060

In general, the model predicts water surface elevations within 2-8 mm of observed values, with a spread of 3-6 cm, and maximum differences in the region of 15 cm. This is within acceptable limits when taking into account the complexity of the estuary and the possible errors in measurements. It is seen from the calibration exercise that a global roughness value of 0.03 produces predicted water levels close to observed levels, with a spread of about 3 cm.

Local roughness values are assigned based on references /4/ and /5/ for materials in specific areas. This will ensure local conditions are modelled more accurately. See Section 4.1.2.4 Model below for details.

4.1.2.3 Verification

The model has been reviewed by external numerical modelling personnel. The Environment Agency has been invited to comment on the model. The model and subsequent results have been verified internally in DNV following standard project verification procedures.

4.1.2.4 Model

The model has been adjusted in line with the results from the calibration exercise, by specifying unique material roughness factors for each material in the model. Material zones are displayed in Figure 4-4 below.

Figure 4-4. Material zones defined in the Tees estuary numerical model

The apparent roughness coefficient is estimated taking into account the material roughness, degree of bed irregularities, variations in channel cross section, effect of obstructions and vegetation, and channel meandering factor /9/, as described by the equation below:

$$n = (n_{mat} + n_{bed} + n_{x\sec} + n_{obs} + n_{veg}) * m_{mnd}$$ **(Equation 1)**

Where:

			low	high
n_{mat}	=	material roughness factor	0.010	0.070
n_{bed}	=	relative effect of bed irregularity	0.000	0.020
n_{xsec}	=	relative effect of variations of channel x-section	0.000	0.015
n_{obs}	=	relative effect of obstructions	0.000	0.060
n_{veg}	=	relative effect of vegetation	0.000	0.050
m_{mnd}	=	meandering degree factor	1.000	1.300

Factors are found in /4/, /5/ and /9/. Material descriptions are found in /1/, /2/, /3/, /7/ and /8/.

Table 4-4. Calculation of theoretical roughness factors for materials

Material	Material	n_{mat}	n_{bed}	n_{xsec}	n_{obs}	n_{veg}	m_{mnd}	n
Main channel and Sea	Sand/var.	0.020	0.000	0.005	0.010	0.000	1.050	0.035
Seaton Sands	Sand	0.020	0.000	0.000	0.005	0.000	1.000	0.025
Seal Sands	Sand/mud	0.020	0.005	0.000	0.005	0.005	1.000	0.035
Tees intertid. mudflats	Sand/mud	0.020	0.005	0.000	0.005	0.000	1.100	0.035
Bran Sands	Sand	0.023	0.010	0.010	0.010	0.000	1.100	0.060
Bran Sands Skerries	Rocks	0.050	0.020	0.000	0.050	0.010	1.200	0.155
Coatham Sands	Sand	0.020	0.000	0.000	0.005	0.000	1.000	0.025
Bran Sands Islands	Rocks	0.050	0.020	0.000	0.050	0.020	1.200	0.205
North Gare Sands	Sand	0.023	0.010	0.010	0.010	0.000	1.100	0.060
Seaton Channel	Sand/mud	0.023	0.000	0.005	0.010	0.000	1.000	0.035

The model geometry has not been adjusted for inclusion of jetties, pillars and local features, as this would have decreased model stability and predictability. Instead, anticipated flow resistance has been accounted for by calculating the apparent roughness coefficient as found in the table above. The model calibration exercise validated this approach.

In addition, the underlying bathymetry data is of such a quality that many local features, breakwaters, erosion barriers, skerries and such within the model are accurately described. Features such as the training wall between Seal Sands and Seaton Channel are thus included.

The RMA2 hydrodynamic modelling software includes the option of modelling wetting and drying of tidal areas using the concept of marsh porosity /10/. This involves assigning a fraction volume to elements depending on the degree of wetting. Semi-dry elements are allowed to convey a volume between zero and full dependent on the level of the water surface between the highest (dry) and the lowest (wet) node.

This concept ensures a numerically stable model. The alternative of turning elements completely off and on from iteration to iteration does not reflect reality, and produces an unstable model where flow boundaries and conveyance changes drastically throughout calculation iterations. The result is a divergent model.

The tidal boundary at the seaward end was chosen to be a synthetic 14 day tidal cycle, generated using Simple Harmonic Analysis using constituents for Teesport. The upstream boundary inflow at Tees Barrage was taken as 6 m^3/s, which is a representative normal flow as described in Section 4.1.2.2 above. The Tees estuary is found to be highly influenced by tidal activities as discussed previously, and the magnitude of inflow from the river Tees and Greatham Creek is found to be of little importance. For ease of modelling the inflow from Greatham Creek is therefore omitted.

The hydrodynamic model was run with ½-hour time steps. The tidal cycle goes from neap to spring tides as can be seen in Figure 4-5, and is representative for the full normal tidal activity in the estuary. The subsequent sedimentation rates from this representative 14-day period can be extrapolated to calculate annual sedimentation rates.

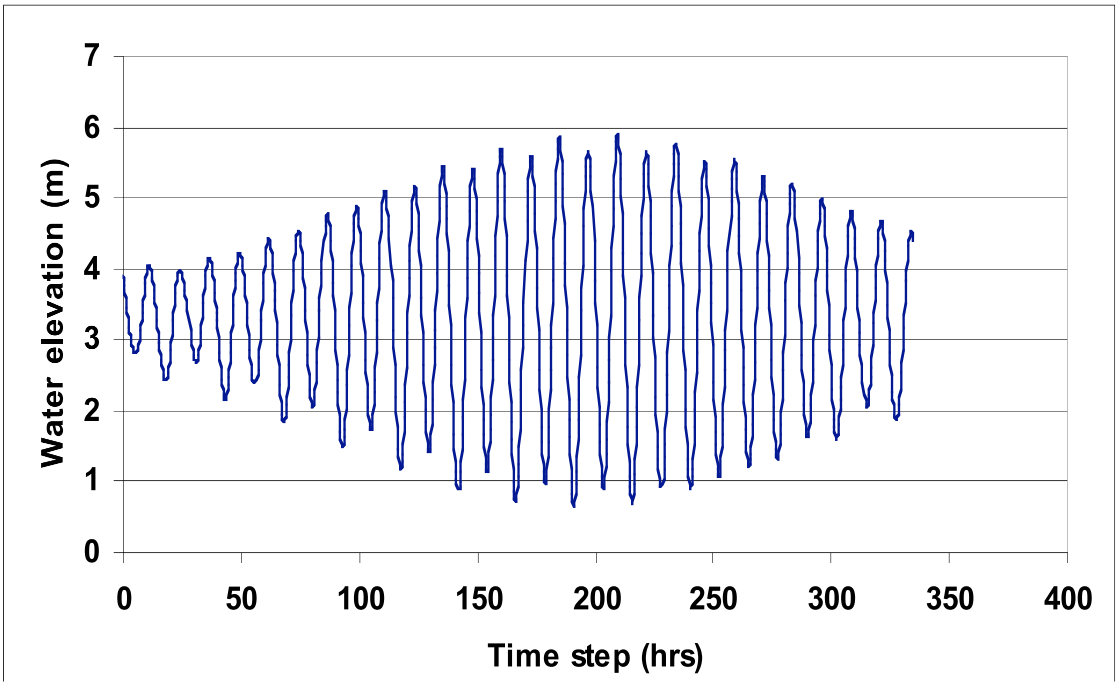


Figure 4-5 Spring and neap cycles for a period of 14 days used in the model runs.

4.1.3 Sediment transport, model setup, calibration and verification

The SED2D sediment transport model is based on the hydrodynamic input computed by RMA2.

The model was run with one representative non-cohesive (fine sand) fraction and one cohesive (silt/clay) setup. In both cases (sand and clay/silt) calculated values of sediment concentration and areas of deposition and erosion where compared to measured data (suspended material) from the area, and data and description on the grain size distribution of the sediment. A number of model runs were performed with varying input parameters in order to get the results fit, as good as possible, the measured field data and to measure the response of the model.

Transportation of sand, being a non-cohesive material, is modelled using simple principles of erosion, deposition and mass balance. The theoretical models are well documented and are known to perform satisfactorily /4/, /5/, /9/, /11/.

Modelling of transportation of cohesive materials like silt and clay is more complex than modelling non-cohesive sediments. A number of models based upon various theoretical approaches exist, but the inherent simplifications of the complex dynamic processes involved mean that they do not always represent reality adequately /4/, /5/, /9/, /11/. A small change in input parameters or geometry can result in overstepping of a threshold, resulting in great changes in results.

4.1.3.1 Non-cohesive sediments (sand)

The important parameters for the sand model are grain size, shape factor, apparent roughness, density and settling velocity. A grain size of 0.2 mm was used for the non-cohesive sediment fractions present in most of the Tees Estuary, coarser sediments are probably not widely present.

The fact that the model is run with only one effective grain size for non-cohesive sediments is justified when test runs have indicated that the velocities are too low to erode sand and that transportation of such sediments is limited, when excluding waves, storms and vessel traffic. Sand will tend to stay where it falls out of suspension. This is also the view expressed in /2/, where it is found that re-suspension of sediments "does not take place in the Tees to any great extent".

Based on grain size distribution data provided by EA and a previous study /2/ a conclusion was made that the uppermost 0-50 mm of the sediment in Seaton Channel consists of 92 % silt/clay and 8 % fine sand /2/ and /12/. The modelled results indicate a sand concentration of around 0.3-0.5 mg/l (average) in Seaton Channel. If one assumes that the suspended sediment grain size distribution "mirrors" the sediment distribution, and based on a median suspended sediment concentration of 10 mg/l /7/ a fine sand concentration of 0.3 mg/l represents 3-5 % of the distribution in the sediment which is quite close to the fraction in the sediment.

The theoretical settling velocity is calculated using Stoke's law and Heywood tables where appropriate /4/, /5/. Dependent on the viscosity of the water, the theoretical settling velocity in still water for the chosen sand grain size was found to be 0.01-0.02 m/s. These values, however, yields zero concentration throughout the model after some time, indicating that the sand falls relatively fast out of suspension. This is known not to reflect the true processes in the Tees estuary, as the true settling velocity will be dependent on the degree of turbulent mixing in the water column. By reducing the settling velocity to 0.0003 m/s a stable model with plausible sediment concentrations and transportation as seen in /2/ and /3/ was reached.

The diffusion coefficient is a somewhat artificially introduced factor needed to avoid unnaturally steep gradients in sediment concentrations in the numerical model. The value chosen for the sand model (90 m^2/s) is well within the recommended value for modelling tidal estuaries /4/, /5/, /9/, /11/.

Boundary conditions at the seaward end were chosen as 15 mg/l. The boundary condition at the upstream end was also set at this value. Values from both /2/ and /3/ were used as basis. Concentrations at the seawards boundary are artificially high to make sure enough sediment reaches the study area. The conditions outside the mouth of the estuary may therefore be unreliable, but the relative changes due to the proposed developments at the TERRC site may still be estimated.

Table 4-5 SED2D Input parameters for non-cohesive sediments (sand)

Input parameters	Unit	Sand
Specific gravity	t/m^3	2.65
Sand grain size	mm	0.2
Grain shape factor	dimensionless	0.67
Thickness of sand layer	m	1
Sand grain roughness	dimensionless	0.5
Diffusion coefficients	m^2/s	90
Settling velocity	m/s	0.0003
Gravitational constant	m/s^2	9.806650
Boundary concentration, sea	mg/l	15
Boundary concentration, Tees	mg/l	15

4.1.3.2 Cohesive sediments (silt/clay)

Dependent on the shear stress exercised by currents on the sea bed, sediments deposit, erode or even peel off in layers. The shear stress at the bed is calculated by using the depth averaged water velocity from RMA2, calculating the theoretical velocity at the bed, and applying the sediment roughness defined as Manning's n.

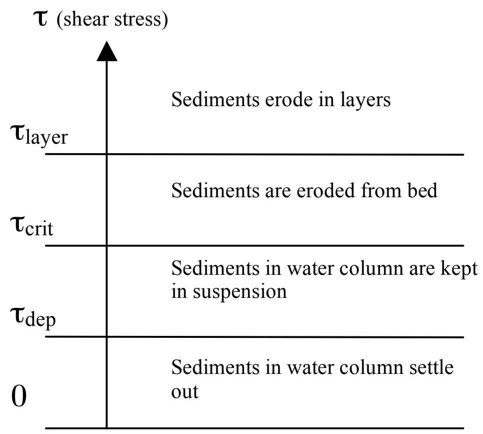


Figure 4-6 Cohesive sediment erosion/deposition dependent on shear stress

The boundary concentrations can be artificially high in order to re-create the processes within the Tees Estuary, but the relative impact from the proposed development at the TERRC site on the areas outside the estuary mouth may still be estimated. Results obtained for areas out with the Tees estuary mouth have to be used with care.

Table 4-6 SED2D Input parameters for silt/clay scenarios

Input parameters	Units	Layer 1	Layer 2	Layer 3	Layer 4
Layer thickness	mm	13	25	30	500
Critical shear stress, erosion τ_{crit}	N/m^2	0.25	0.38	0.65	0.85
Age	years	1	3	5	10
Critical shear stress, deposition τ_{dep}	N/m^2	0.045			
Erosion rate	$g/m^2/s$	0.1			
Settling velocity	m/s	0.000061			
Initial concentration	mg/l	22			
Boundary concentration, seawards	mg/l	30			
Boundary concentration, river	mg/l	35			

4.1.4 Sediment transport due to dredging

To determine suspended sediment plumes resulting from the dredging activities, a numerical model called SSFATE has been applied. Model runs have been made for both the backhoe dredge and the hopper dredge. Results are generated with each working alone, with the results then combined to show the impact of the two dredges working simultaneously. Plans call for the backhoe dredge to work for eight weeks around the clock, with the hopper dredge working for twelve weeks around the clock. However, each SSFATE simulation is for only two days since an equilibrium suspended plume is established by the end of two days of dredging. Simulations have been made for dredging during both neap and spring tides.

The first step in the application of SSFATE was to import an Arc View shape file showing the geographical boundaries of the study area.

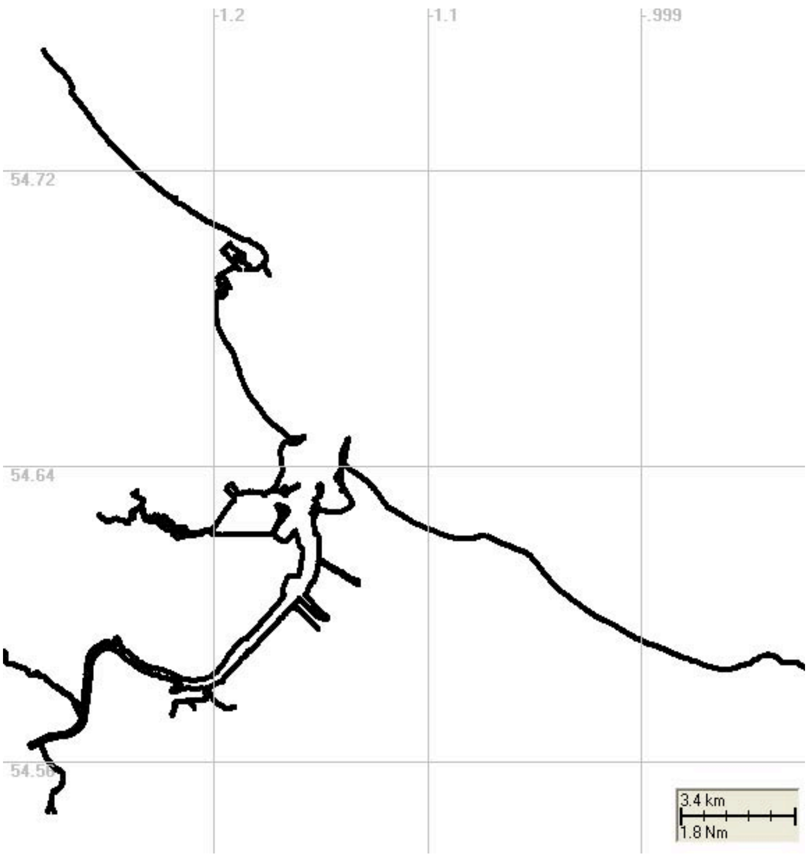


Figure 4-7 Geographical boundary of dredging model

This shape file was provided by DNV. Gridding tools in SSFATE were then employed to create a computational land/water grid. The next step was to modify SSFATE to accept a velocity file (provided by DNV) generated by the RMA2 numerical hydrodynamic model. The RMA2 finite element grid as shown in Figure 4-8 then became the currents grid employed by SSFATE. The sediment released by the dredging activity is simulated using particles, which are transported on the land/water grid through interpolation of the RMA2 velocities computed at the nodes of the RMA2 finite element grid.

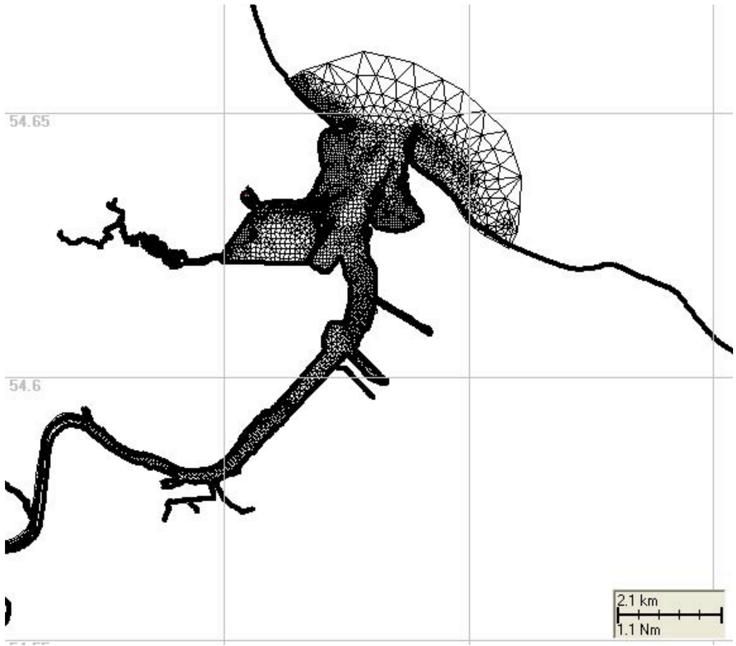


Figure 4-8 Modelling grid

The next step in the application of SSFATE was the representation of the sediment sources generated by the operation of the dredges. A backhoe dredge will be used in the areas labeled 1, 2, and 3 in Figure 3-1, whereas, a hopper dredge will be used in the Seaton Channel labelled 5 and the holding basin labelled 4. The dredging operation for the backhoe will continue around the clock for eight weeks. Dredging at a rate of 90 m^3 /hour will continue for 10 hours. A barge will then carry the dredged material to an open water disposal site. The round trip will take 2 hours. Dredging for another 10 hours will then begin. The hopper dredge will operate for 12 hours at a rate of 300 m^3 /hour around the clock. At the end of 12 hours of dredging, the dredge will transport the dredged material to the disposal site. This activity will take 1.5 hours. Dredging will then begin for another 12 hours. Both of these dredging activities are represented in SSFATE as line sources. The line sources for the backhoe are very short since the movement of the backhoe is expected to be small over a 10 hour dredging period. However, the line source for the hopper dredge runs from the entrance of the Seaton Channel into the turning basin. This line source is shown in Figure 4-9. Assuming that the hopper speed during dredging is 2 kts, it only takes about 30 minutes for the hopper to traverse the line source. Thus, the line source is traversed 24 times (representing 12 hours of dredging) during each dredging cycle.

Specification of the sediment source strength is an important part in the application of SSFATE. Based on sediment samples provided by DNV, it was assumed that 92% of the dredged material is clay and silt, with the remainder being sand. DNV also provided information that stated that about 20% of the sediments in the Tees Estuary is clay, Therefore, the final grain size distribution employed was 20% clay, 50% fine silt, 22% coarse silt, 5% fine sand, and 3% medium sand. Based on information obtained from McLellan, et al (1989), it was assumed that 3% of the sediment dredged by the hopper dredge would be released into the water column over the lower 1.5 m of the water column. For the backhoe, it was assumed that 8% of the dredged volume would be released uniformly over the entire water column. Data collected in Alaska showed that 10% was released during dredging with a backhoe in 15-20 ft of water (U.S. Army

Corps of Engineers 2000). John Land (personal communication) of Dredging Research Limited stated that his best estimate would be 6-8% of the dredged volume. Therefore, it was decided to use a release rate of 8% for the backhoe SSFATE simulations. Personal communication with Dr. Allen Teeter of CHT led to assuming that the bulk density of the sediments being dredged with a backhoe was likely to be about 1.6 g/cc, whereas the bulk density of material to be dredged in the Seaton Channel were more likely to be lower, e.g., 1.4 g/cc.

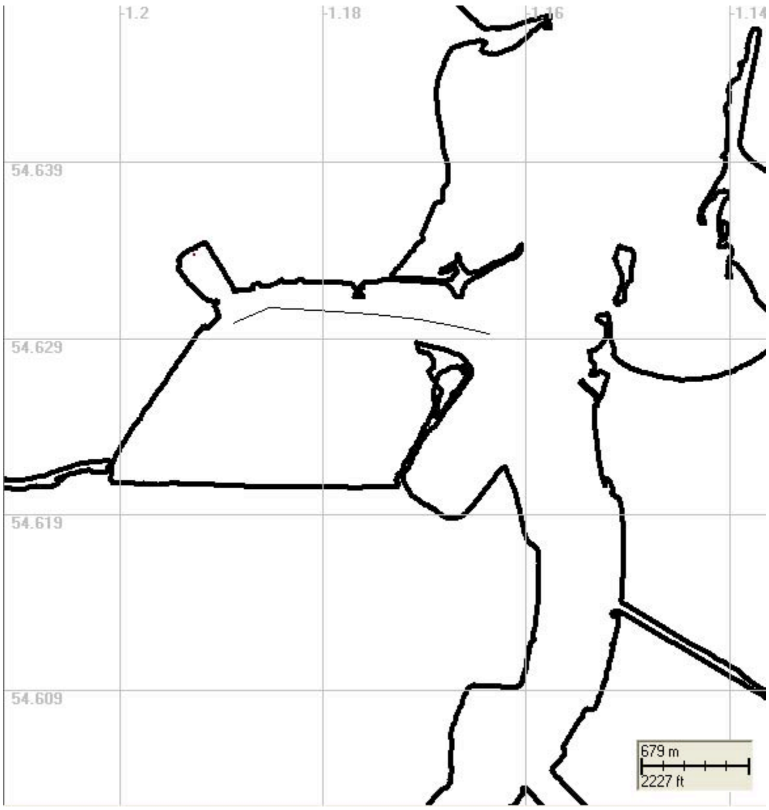


Figure 4-9 Line source for hopper dredge

The final input data required in the application of SSFATE were the velocities generated by the RMA2 model. DNV provided a 14-day record that began with a neap tide and then moved through a spring tidal cycle. Each simulation scenario lasted for 48 hours and was run using neap tide currents first and then spring tide currents.

4.1.5 Scenarios

Based upon the proposed developments at the TERRC site, the scenarios described below have been modelled. For scenarios which involves dredging the model grid has been manipulated to represent the new bathymetry (depth change) and the hydrodynamics and sediment transport have been calculated based on the new bathymetry.

1. Dredging of dock to -6.65 m LAT and holding basin to – 9.5 m LAT
2. Dredging of the dock to -6.65 m LAT and Seaton Channel to – 8.5 m LAT

3. Dredging of the dock to – 6.65 m LAT and quays 10 and 11 to – 12 m LAT (50 m off and along the length of the quays.
4. Dredging of the dock to -6.65 m LAT, Seaton Channel to -8.5 m LAT and quays 10 and 11 to -12 m LAT
5. Dock closed and holding basin dredged to -9.5 m LAT
6. Dock closed and Seaton Channel dredged to – 8.5 m LAT
7. Dock closed and quays 10 and 11 dredged to – 12 m LAT
8. Dock closed, Seaton Channel dredged to -8.5 m LAT and quays 10 and 11 dredged to -12 m LAT
9. Dock closed, Seaton Channel dredged to -8.5 m LAT and quays 10 and 11 extended and dredged to -12.5 m LAT

Emptying the dock for water is planned to be done by pumping water out of the dock at a rate of 1000 m^3/h (280 l/s). This scenario has not been considered because such small volumes will not have any impact on the velocities or flow pattern in the estuary.

In each of the scenarios listed above, the following items are considered and discussed:

- Modelling of the tidal flow and hydrodynamic regime;
- Modelling erosion (resuspension), particle transport and sedimentation;
- A qualitative description on possible impact on ecological habitats due to sediment erosion, sediment transport and sedimentation. This part will focus on the most relevant taxonomic groups in the estuary (for example breeding and feeding grounds for birds, seals and fish and possible impact on soft bottom fauna);
- Based on existing data regarding the distribution and contamination level of environmental toxins (metals- and organic toxins) combined with the modelling results (erosion, particle transport and sedimentation) will give a picture of the dispersion and sedimentation of contaminants in the estuary and channels. We have not included in this any modelling or quantification of contaminants release from the particles (particle state) to the water column (dissolved state) due to resuspension into to water column. Generally the major fraction of the contaminants will be particle bounded;
- The current sedimentation regime may affect the vessel movements in the estuary with time. This will be discussed and compared with possible impacts regarding vessel movements. This item will also cover possible need for maintenance dredging; and
- The modelling shall also consider the suspended sediment concentrations in light of the intake from the nuclear power station.

4.2 Impact on marine life

Impact on marine life has been evaluated due to changes in hydrodynamics and sedimentation regime as a result of the planned dredging operations at the TERRC facility. The level of contamination in the dredging areas and at Seals Sand has been mapped and compared with international sediment quality standards. Levels have been mapped for several metals (Ar, Cd, Cr, Cu, Hg, Ni, Pb and Zn), PCBs, PAHs and TBT in dredging area 1 to 4. On Seals Sands the level of metals mentioned above have been mapped. The levels of contamination have been compared with international sediment quality standards.

5 HYDRODYNAMIC AND SEDIMENT TRANSPORT MODELLING

5.1 Hydrodynamics and sediment regime in the Tees Estuary

5.1.1 Prevailing hydrodynamic regime

As discussed in Section 4.1.2.2 above and supported by /2/ the Tees Estuary below the Tees Barrage is highly influenced by tidal activity. Studying the water velocities at Teesport, for outflows at falling tides the velocities are only in the order of 20% higher than for inflows at rising tides, when using relatively high river inflows of 25 m^3/s. With the normal river flow of 6 m^3/s this difference is reduced. It is anticipated that high flow events change this picture for periods /2/. At Seaton Channel and Seal Sands, where the only freshwater inflow comes from Greatham Creek, the tidal flows are even more dominating.

The Tees Estuary is known to be stratified, especially at the upstream end near Tees Barrage. Further down towards Teesport and the estuary mouth the stratification is less marked /2/ and the freshwater layer on top is thin compared to the water depth. More chaotic mixing is evident here /3/. The “bottom” layer, representing 90 % of the water flow, is found to be dominant when it comes to sediment transportation, especially as the bulk of the sediments are found to originate from the seaward boundary /1/, /2/, /3/. For this study it is therefore believed that the accurate modelling of this “bottom” or main layer is most important.

For Seaton Channel and Seal Sands, the freshwater inflow from Greatham Creek is small, and this part of the estuary is not believed to be stratified to a great degree. The recent increase of algal mat growth in Seal Sands has been predicted to reduce the local flows with up to 20 % /2/.

In general, alluvial estuaries which are “in regime” i.e. the sediment budget is balanced and they have no net annual deposition, experience average velocities around 1 m/s. Velocities in the Tees estuary are in general well below this figure, creating deposition of sediments. These low velocities stem from the unnaturally large cross sectional area of the channel due to dredging. Sediments will deposit in the channels until the velocities increase enough to achieve a balanced sediment budget. As the velocities are low, sediments are less likely to be carried upstream to the upper reaches of the estuary, and larger fractions with higher settling velocities will tend to settle out at the downstream end. The effect on clay is somewhat alleviated by the tidal undercurrent ensuring that fractions with low settling velocities are carried further upstream.

5.1.2 Prevailing sediment regime

The main bulk of sediments originate from the seaward boundary /2/. Maintenance dredging of the Tees Estuary currently yields some 700,000 tonnes per year. The sediments are found to be both sand and silt/clay fractions. Both deep channels and mudflats are found to have sand and silt/clay, but are in general sandy rather than muddy. The sediments at the seawards end of Teesmouth consist mainly of sand /1/, /2/, /7/. Finer fractions stay in suspension longer and are transported further into the estuary. Most of the sediment is transported by rising tides at times of high wave action, such as storm events. In fact 90 % of siltation comes from the sea of which 45

% is sand. The study also showed strong stratification ensuring the upstream migration of finer particles “after disturbance by storms, shipping and dredging” /2/.

Previous studies /2/ shows that most sediment are carried into the estuary from the Tees bay from North Gare Sands on rising tides during storm events. 80 % of the sediment moves into the estuary during 7 months from October to April, with 60 % of transport occurring during 30 days of storm activity.

Within the last 10 years a decrease in the rate of sediment deposition has been noticed for the whole estuary, with a shift towards less dense material especially towards the seawards end of the estuary. This may stem from the construction of the Tees Barrage, from changes in weather patterns influencing the suspension of sediments in the Tees bay, from decreased maintenance dredging resulting in less suspended sediment, or from a combination of these possibilities. However, at the confluence of Seaton Channel and the Tees Channel, more material is settling out. It is thought that the supply of sand around the tip of the North Gare breakwater may have increased, spilling on to North Gare Sands and past the training wall towards Tees and Seaton Channels.

5.1.2.1 Suspended sediment

Suspended sediment is of high importance in the Tees estuary as little re-suspension of settled sediments occurs /2/. Carriage in suspension is thus the main pathway where sediments may spread to new locations, controlling erosion and sedimentation zones in the area and transport adsorbed/entrained pollutants. Data on suspended sediment cover 26 sampling points as shown in Figure 5-1. Median suspended sediment concentrations in the period 2003-2004 are shown in Figure 5-2 and Figure 5-3. The data show rather large variations in the suspended sediment concentration over one year, and will be influenced by several factors as waves, storms and ship movements. It is very probable that a highly industrialized estuary such as the Tees, the ship traffic will have a great influence on the suspended sediment concentration due to erosion by propeller currents. In addition, “extreme” events such as periods of storms and massive rainfall creates periods of high river flow, and wave erosion especially during winter storms have a high impact. Such events may be the most controlling factors regarding the sediment regime (erosion, entrainment and redistribution) in the area /1/, /2/, /13/.

Another important source of sediment re-distribution is the continuous dredging operations which have increased the concentrations of suspended sediments, affecting the sediment distribution in the estuary /2/. Both development and maintenance dredging create sediment plumes which, dependent on the hydrodynamic conditions at the time, may distribute various fractions of sediments up- and downstream at great lengths from the dredging area.

Based on data from throughout 2003 and early 2004 /7/ the median amount of suspended sediment varied from 4.5 mg/l at sampling point 1029 to 57 mg/l at sampling point 1347. There is also a great variation between different sampling dates on the sampling point ranging from < 1 mg/l up to 302 mg/l. The highest values are found on sampling point 1342 to 1348 which are located in and very near the TERRC facility and along the eastern boundary of Seaton Channel near the TERRC facility. The concentration seems to decrease somewhat downstream of the TERRC facility illustrated by sampling point 909 and 888 where the median concentration is 12.8 and 5 mg/l respectively.

Sampling point 1025 just upstream of the TERRC facility has a median concentration of 11 mg/l.

Sampling point 834 in Tees river has a median value of 7.8 mg/l and sampling point 817 out in the Tees bay has a median concentration of 7.3 mg/l.

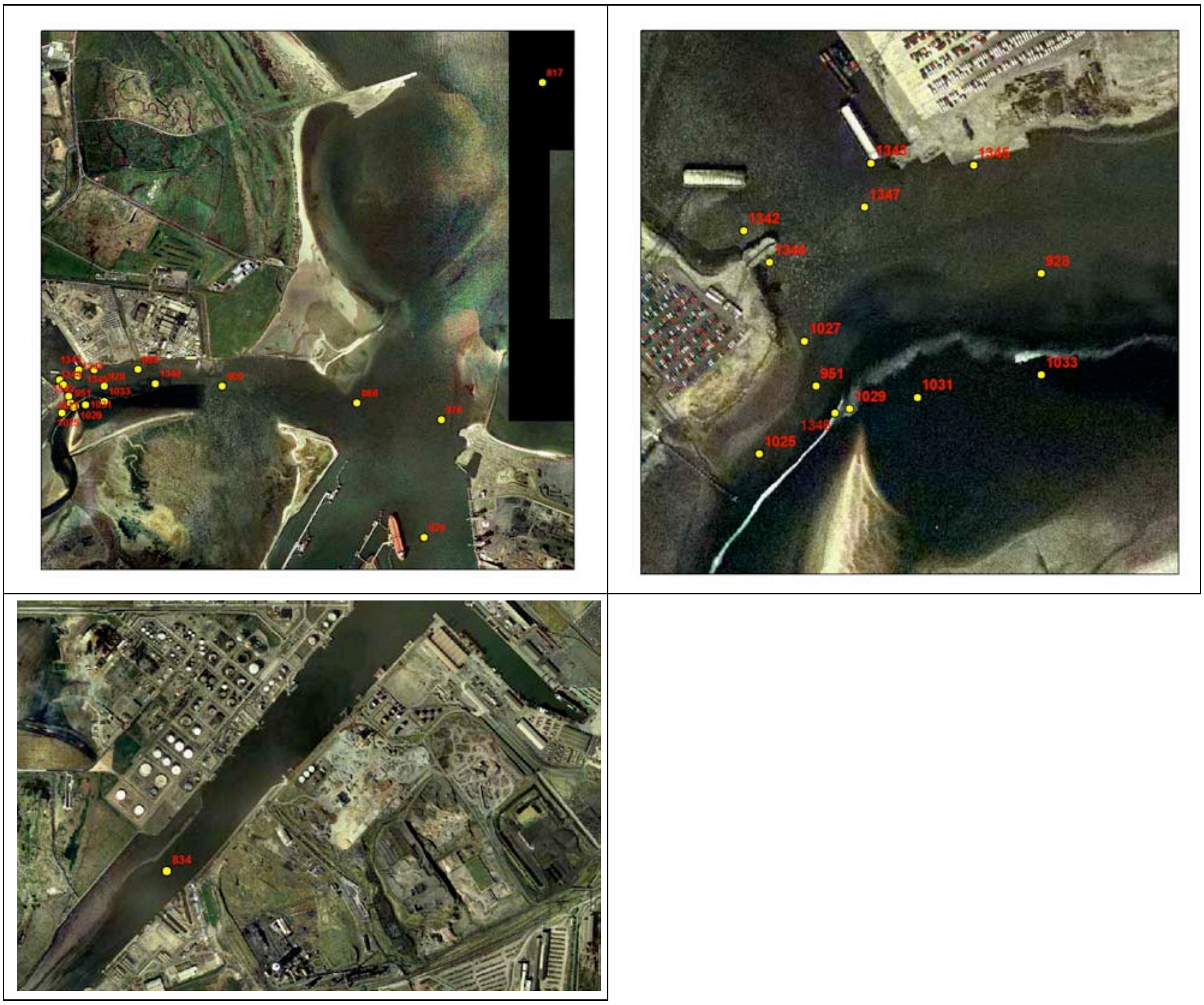


Figure 5-1 Sampling locations for suspended sediment. Data from EA

HR Wallingford /2/ points out that there is some characteristic form of variation with time during the tidal cycle. In the upper reaches (Billingham Reach) there is a tendency for the highest concentrations to occur around low water, indicating mainly river borne material. Further down at Middlesbrough Dock some material seems to arrive during ebb tide but the main source appear to arrive during the flood tide. Further down the estuary (Shell Jetty) the Billingham pattern is reversed indicating a source of material outside the estuary.

HR Wallingford /2/ also points out the relatively high contribution of silt and sand carried in to the estuary (1.5 Mm^3 in situ volume or 700 000 tones dry solids) from Tees bay compared to river borne transport estimated to 40 000 tones/year. The sand settles out in the lower estuary (chart 9 and 10 in /2/). The silt and clay are re-suspended by activities like shipping and dredging, as the near bed velocities are generally too low to erode deposited sediment. This means that deposited sediment will tend to stay where it falls out of suspension unless the sediment is disturbed some other way (dredging, shipping). Suspended sediments concentrations have been found to have declined somewhat since 1995 and are low, in the order of 10-30 mg/l.

University of Durham /1/ is focused on the erosion and sedimentation regime on Seal Sands, and lists some controlling factors regarding suspended sediment and sediment transport. See also Section 6.2 below.

- Since the commissioning of the Tees barrage tidal current velocities have decreased by approximately 10 % due to a decrease in tidal volume of 10 %
- Less fluvial sourced sediment is reaching the intertidal zone because settling behind the Barrage and conversely estuarine and marine sediment is unable to pass upstream of the barrage point.

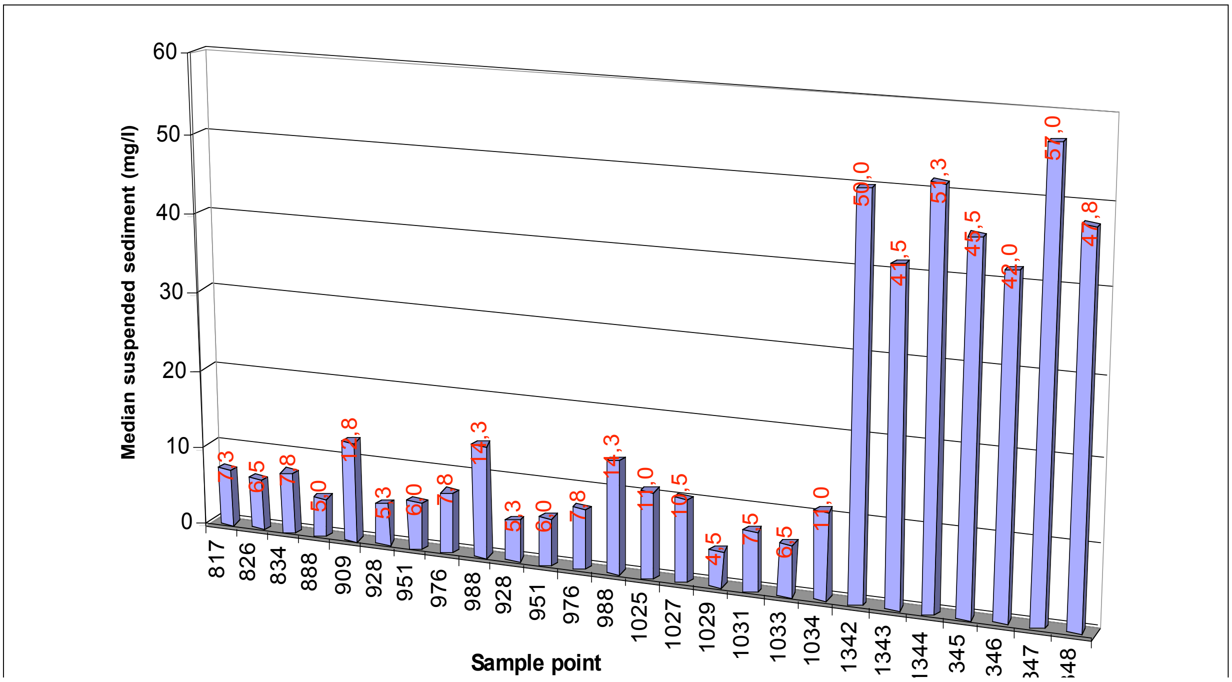


Figure 5-2 Suspended sediment concentrations mg/l (medians)

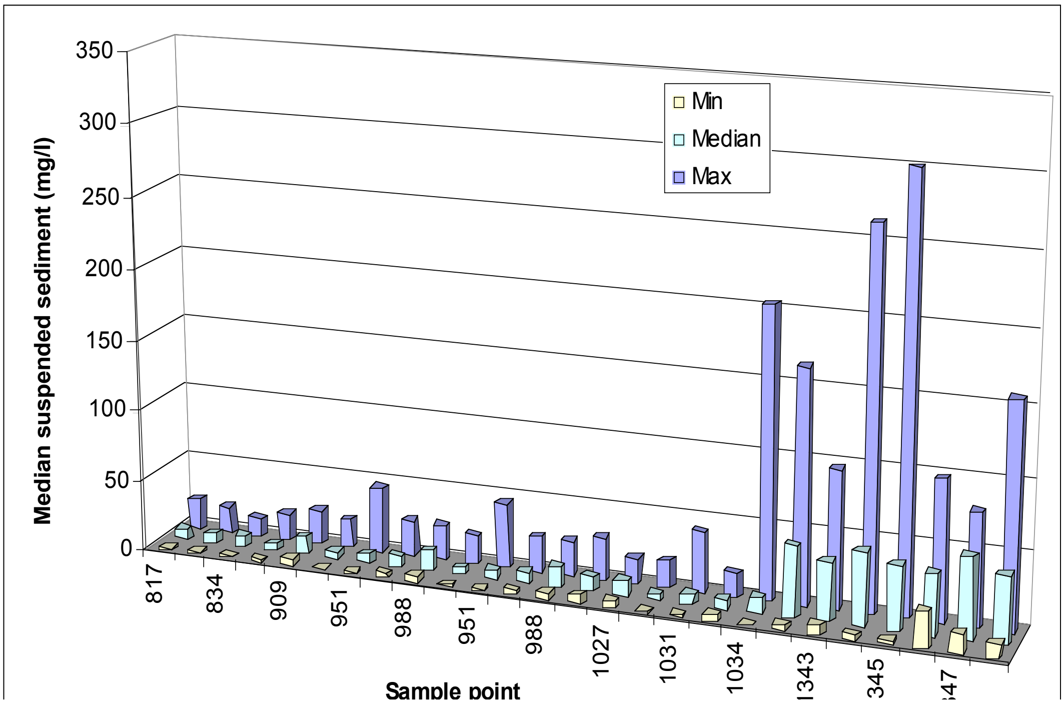


Figure 5-3 Suspended sediment sampling (medians)

5.1.2.2 Bed characteristic

Figure 5-4 shows an isoline plot of percent silt and clay (<63 µm) distribution based on the data from EA. The plot shows that the areas to be dredged, excluding the Dry/Wet dock, namely Seaton Channel, Holding basin and quays 10 and 11 contain a high proportion of silt and clay. Generally the percent of silt and clay varies from 50 % to over 90 % of the total grain sizes, when considering the dredging areas. The grain size data which this is based on gives no information of the amount of silt or clay in this fraction. HR Wallingford /2/ states that the percentage of clay throughout the estuary is fairly low at typically between 15-20 %, meaning that much of the fraction <63 µm can be defined as silt. It also means that a significant proportion contains a larger grain size. Based on this it is reasonable to assume that this is mainly fine sand.

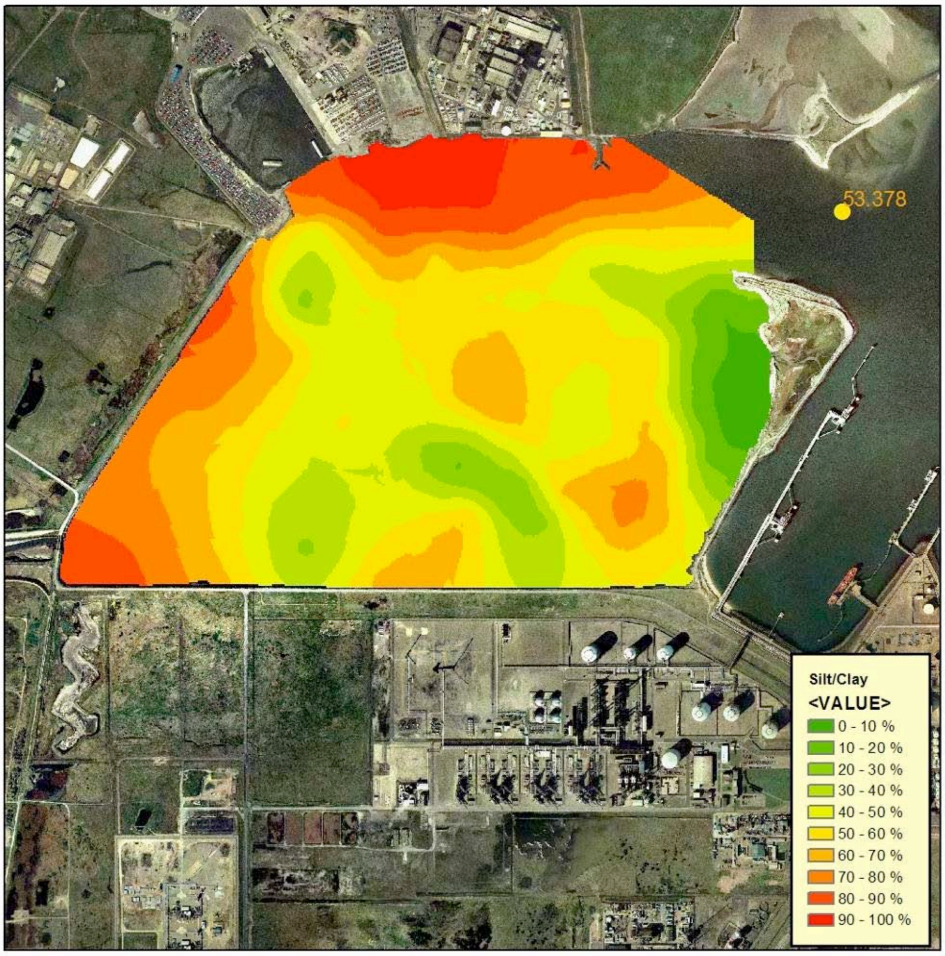


Figure 5-4 Percent silt/clay in the dredging areas and Seal Sands

A general description of the particle size distribution throughout the estuary is described by HR Wallingford /2/. At the furthest point upriver the sediment is mainly sand. In midst estuary it is a high proportion of silt, whilst in the entrance channel the sediment is again mainly sand. The sand is defined as fine sand with a grain size mainly in the range of 0.1 – 0.2 mm. It is worth noting however that the description is based on data from 1991.

University of Durham /1/ concludes that there is net accretion on Seal Sands of 0.0035 m^3/year/m^2 or 3.5 mm/year, net erosion on Bran Sands from 0.0 to 0.02 m3/year/m^2 or 20 mm/year, and net erosion on North Tees Mudflats of 0.02 m^3/year/m^2 or 20 mm/year. With regards to Seals Sands there is a uniform increase of the silt and clay fraction over the last 11 years (1992-2003).

5.2 Modelling results

Based on the proposed developments at the TERRC site and in Seaton Channel as described in Section 4.1.5 above, the following scenarios have been modelled:

Table 5-1 Definition of modelling scenarios

Case no	Description	Dock dredg/closed	Seaton Ch. dredged	Q10 & Q11 dredged	Tidal Cycle
0	Today – baseline	No	No	No	14 days
1	Dredg of dock (incl bund & HB)	Dredged	No	No	14 days
2	Dredg of dock and Seaton Channel	Dredged	Yes	No	14 days
3	Dredg of dock and Q10 and Q11	Dredged	No	Yes	14 days
4	Dredg dock, SC and Q10 & 11	Dredged	Yes	Yes	14 days
5	Dock closed (bund + HB dredg)	Closed	No	No	14 days
6	Dock closed dredg Seaton Channel	Closed	Yes	No	14 days
7	Dock closed dredg Q10 & Q11	Closed	No	Yes	14 days
8	D.Close, dredg SC, Q10 & Q11 (-12 m)	Closed	Yes	Yes	14 days
9	D.Close, dredg SC, Q10 & Q11 (-12.5 m)	Closed	Yes	Yes	14 days

Boundaries of dry dock, holding basin, Seaton Channel and quay 10 and 11 are defined in Figure 3-1 above. A series of reporting points are set up to quantify the changes in hydrodynamics and sediment regime as follows:

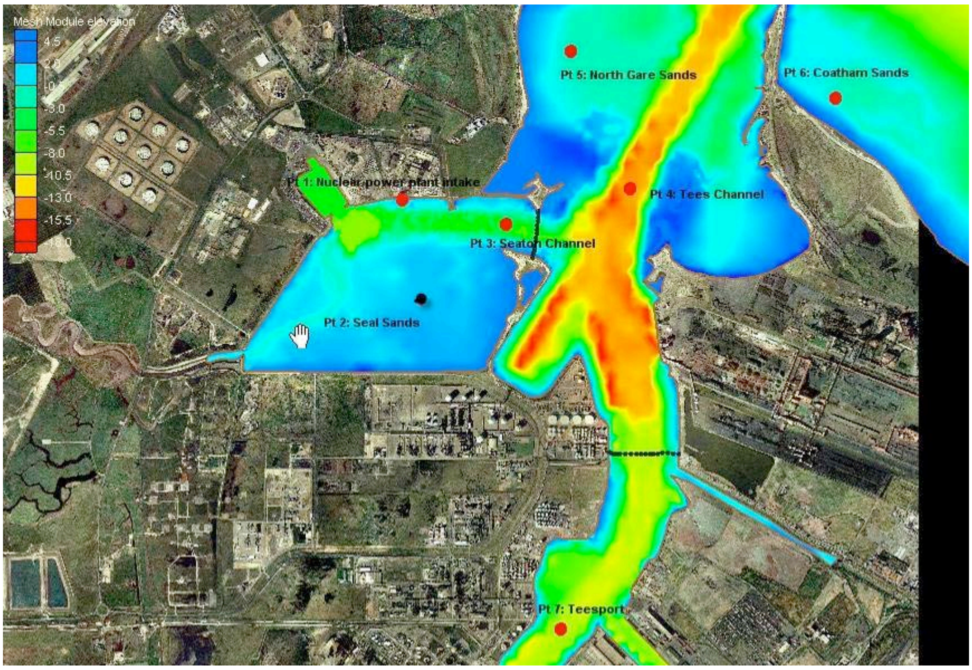


Figure 5-5 Locations of reporting points

Table 5-2 Definition of reporting points

Point No	Description	X-coordinate	Y-coordinate
1	Cooling water intake, nuclear power plant	452888	526745
2	Seal Sands	453020	526004
3	Seaton Channel	453653	526558
4	Tees Channel	454577	526823
5	North Gare Sands	454136	527849
6	Coatham Sands	456101	527500
7	Teesport	454062	523544

5.2.1 General impacts on Hydrodynamics

The general impact of the proposed developments of the TERRC site and Seaton Channel on hydrodynamics is described below.

5.2.1.1 Velocities

Figure 5-6, Figure 5-7 and Figure 5-8 describe the flow velocities in the estuary for Scenario 8 where the greatest changes in channel geometry are proposed. At time step 207.5 on a rising tide, a period of high velocities in the estuary, the highest velocities of 0.4 to 0.6 m/s are found in the entrance channel leading into Seaton Channel and river Tees. The velocities in Seaton Channel vary between 0.045 m/s in the upper reaches and up to 0.4 m/s in the centre of the channel at the most constricted parts. The velocities in the main river Tees are generally between 0.1 and 0.2 m/s. Some shallower parts in the main river reach velocities up to 0.3 m/s.

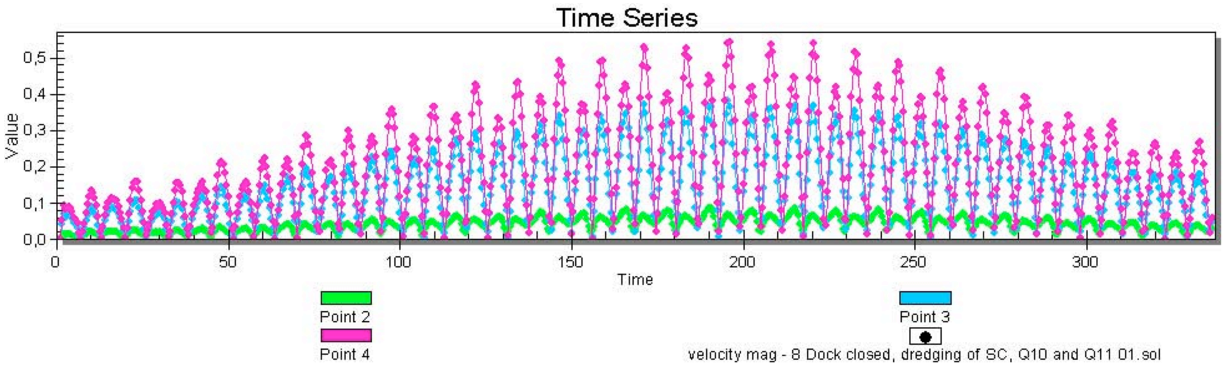


Figure 5-6 Velocity magnitude (m/s) for Pt 2 Seal Sands, Pt 3 Seaton Channel and Pt 4 Tees Channel for Scenario 8, see Figure 5-5

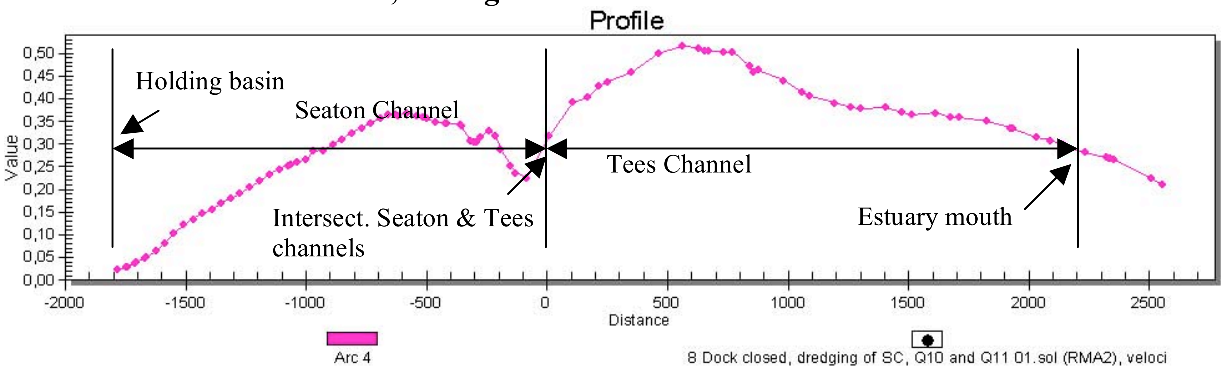


Figure 5-7 Velocity (m/s) transect from innermost reaches of Seaton Channel to the mouth of the estuary. Scenario 8 at T = 207.5 (hrs)

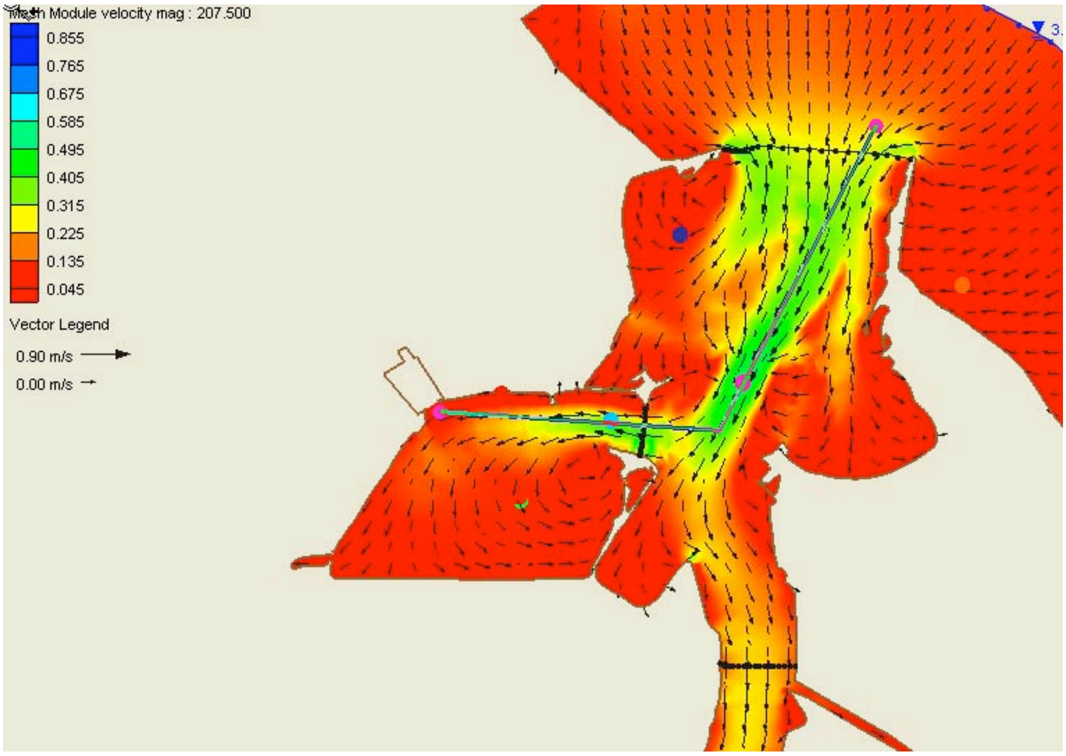


Figure 5-8 Scenario 8 Maximum tidal velocities (depth averaged), T = 207.5 (hrs), transect in Figure 5-7 shown.

Figure 5-9 shows the maximum changes in velocities in Seaton Channel, Seal Sands and Tees Channel from the baseline scenario (0) to the largest changes in geometry (8). At the downstream end of Seaton Channel, velocities are reduced in the order of 0.05-0.10 m/s due to the increased water depth. Baseline velocities in this area are in the order of 0.4-0.6 m/s, and the reduction is therefore about 12 %.

Immediately outside Seaton Channel velocities increase localized in the order 0.04-0.08 m/s due to the higher water volumes that are being moved.

The results indicate a decrease in the flow velocities due to the new bathymetry. This is natural because after dredging the tidal volume can pass trough a greater river cross section. Adjustments may be considered especially with regards to roughness of the sediment type which will be exposed after the dredging and which may alter the flow. There were no data available for the sediment type at the planned dredging depth so the calculations have been based on data covering 0-5 cm of the sediment.

All velocities presented are depth averaged.

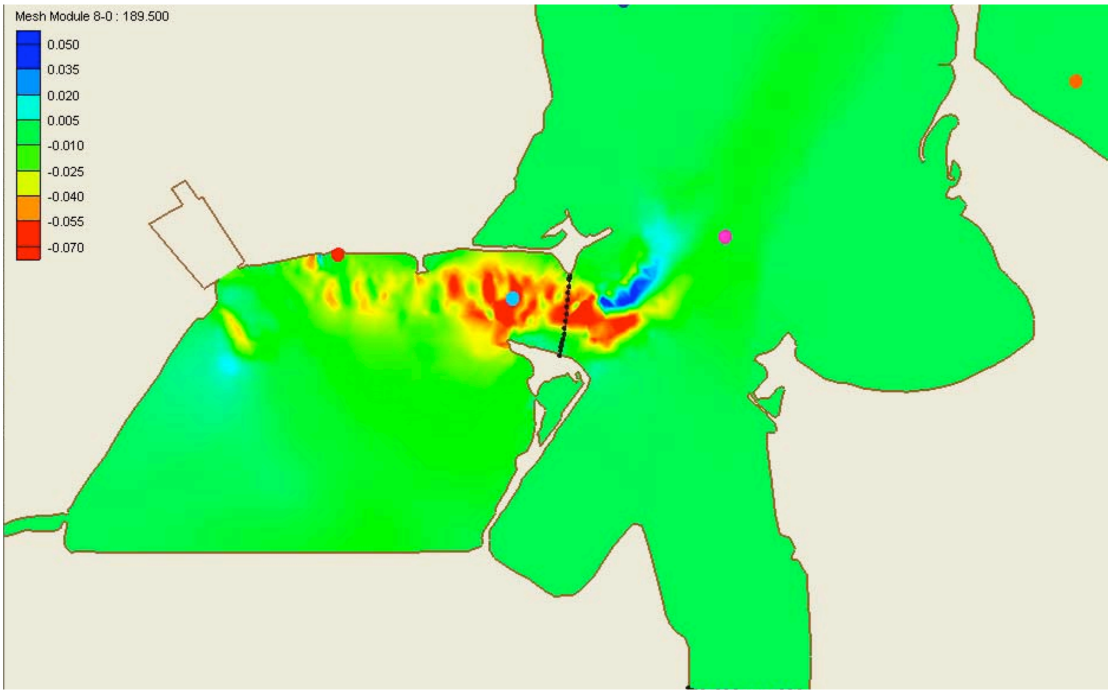


Figure 5-9 Max changes in velocities (depth averaged) at T = 189.5 (hrs) between scenario 0 and 8

Local maxima and minima as predicted by the model are due to bed undulations present in the Baseline scenario and may not reflect reality. Local extreme maxima and minima are therefore not taken into account, and only general changes are considered.

Table 5-3 Velocity difference maxima in % (depth averaged) between baseline (0) and scenarios 1 to 9.

Scenario	m/s	Pt 1 Nuclear PP intake	Pt 2 Seal Sands	Pt 3 Seaton Channel	Pt 4 Tees Channel	Pt 5 North Gare Sds	Pt 6 Coatham Sands	Pt 7 Teesport
0 abs. value	Max	0.047	0.096	0.469	0.552	0.074	0.028	0.206
	Min	0.000	0.002	0.002	0.002	0.003	0.000	0.001
	Average	*0.018*	*0.045*	0.189	0.216	0.039	0.012	*0.090*
1	Average	1.55E-05	-6.25E-05	3.64E-04	1.12E-04	9.81E-06	4.53E-06	-7.98E-07
	Avg. diff %	**0.09**	**-0.14**	**0.19**	**0.05**	**0.03**	**0.04**	**-0.00**
2	Average	-1.08E-03	-1.58E-03	-2.66E-02	-1.25E-04	4.16E-06	4.19E-06	9.36E-07
	Avg. diff %	**-6.00**	**-3.51**	**-14.07**	**-0.06**	**0.01**	**0.03**	**0.00**
3	Average	2.17E-04	-4.24E-04	3.26E-04	1.17E-04	1.20E-05	6.55E-06	3.58E-06
	Avg. diff %	**1.21**	**-0.94**	**0.17**	**0.05**	**0.03**	**0.06**	**0.00**
4	Average	-8.98E-04	-1.83E-03	-2.66E-02	-1.23E-04	2.52E-06	6.51E-06	-1.92E-06
	Avg. diff %	**-5.00**	**-4.07**	**-14.07**	**-0.06**	**0.01**	**0.05**	**-0.00**
5	Average	-1.07E-03	-1.35E-03	-7.99E-03	-2.77E-03	-1.59E-04	-6.25E-05	-4.93E-06
	Avg. diff %	**-5.94**	**-3.00**	**-4.23**	**-1.28**	**-0.41**	**-0.52**	**-0.01**
6	Average	-4.44E-03	-4.86E-03	-6.05E-02	-3.35E-03	-1.78E-04	-7.17E-05	-5.99E-06
	Avg. diff %	**-24.67**	**-10.80**	**-32.01**	**-1.55**	**-0,46**	**-0.60**	**-0.01**
7	Average	-9.36E-04	-1.63E-03	-8.01E-03	-2.76E-03	-1.60E-04	-6.39E-05	-7.69E-06
	Avg. diff %	**-5.20**	**-3.62**	**-4.24**	**-1.28**	**-0.41**	**-0.53**	**-0.01**
8	Average	*-2.01E-03*	*-2.97E-03*	-3.38E-02	-2.98E-03	-1.63E-04	-6.38E-05	*-2.94E-06*
	Avg. diff %	**-11.16**	**-6.60**	**-17.88**	**-1.38**	**-0.42**	**-0.53**	**-0.01**
9	Average	4.09E-03	-3.28E-03	-3.38E-02	-2.96E-03	-1.65E-04	-6.38E-05	-5.93E-06
	Avg. diff %	**22.72**	**-7.28**	**-17.88**	**-1.37**	**-0.42**	**-0.53**	**-0.01**

The differences for the various scenarios in relation to the absolute values for Scenario 0 (top row) show in general small changes in velocities. For instance, the average velocity between baseline and scenario 8 at Pt 1 Nuclear power plant intake decreases by 0.002 m/s from 0.018, an 11 % decrease, at Pt 2 Seal Sands the corresponding figure is 7 %. These points are in an area close to the proposed developments. At Pt 7 Teesport a decrease by 0.000003 m/s from 0.09 m/s is seen, a decrease of 0.003 %, which is negligible. The impacts on the hydrodynamic regime within the mouth of Seaton Channel are within 10 to 11 % in general, although some local areas may experience higher changes. Outside the mouth of Seaton Channel the changes in the hydrodynamic regime are negligible.

In Figure 5-10 the average changes between baseline (scenario 0) and the different scenarios are plotted for each location. As stated above Figure 5-8 shows that the greatest impact will be within the bounds of Seaton Channel (location 1, 2 and 3). It also shows that the greatest changes are related to scenario 6 (when the dock is closed and Seaton Channel is dredged) and 8 (Dock closed, Seaton channel and quays 10 and 11 dredged). The least changes in velocities can be seen for scenario 1 (Dock and Holding basin dredged) and 3(Dock and Quays 10 & 11 dredged).

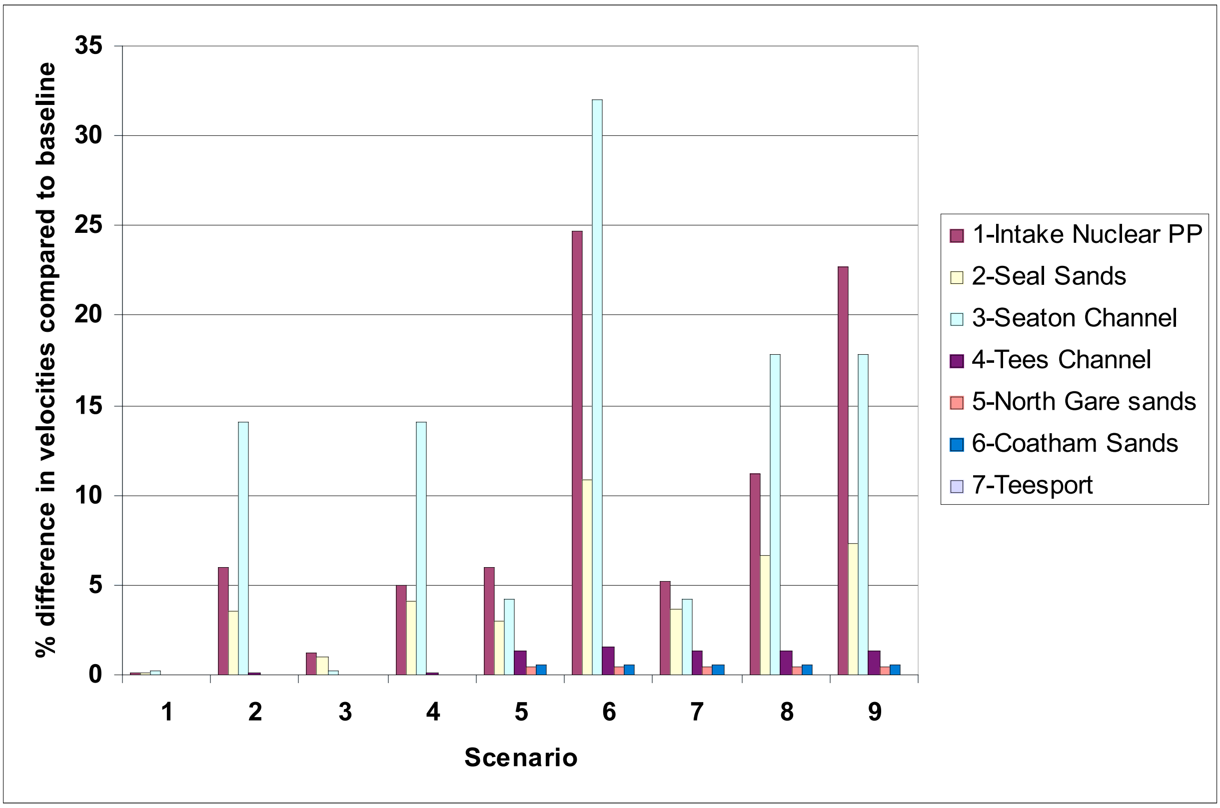


Figure 5-10 Average changes (%) in velocities between baseline and the different scenarios at each location

5.2.1.2 Bed shear stress

As explained in Section 4.1.3.2 above, sediments will erode from or deposit to the bed dependent on the shear stress acted upon it by the moving water. The shear stresses predicted for Pt 2 Seal Sands and Pt 3 Seaton Channel for Scenario 8 throughout the study period are presented in Figure 5-11 below.

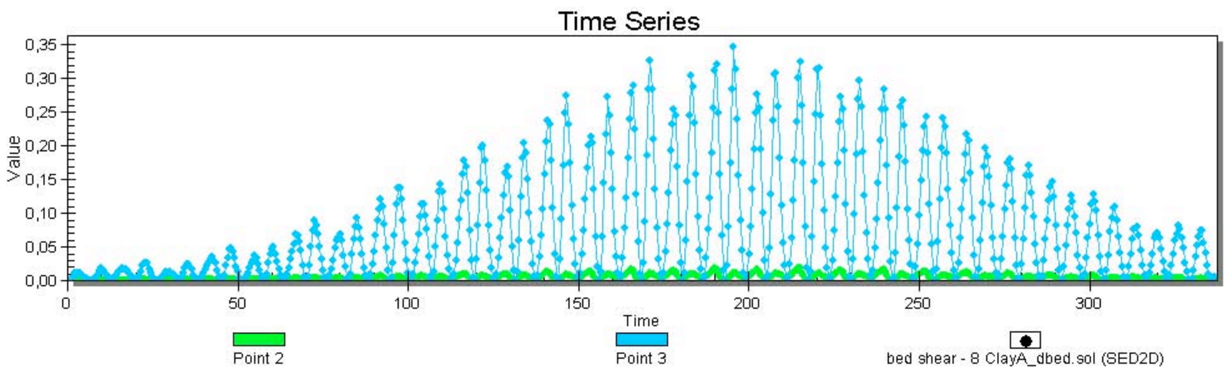


Figure 5-11 Shear stress (N/m^2) for Pt 2 Seal Sands and Pt 3 Seaton Channel for Scenario 8

The maximum shear stress magnitudes and distributions experienced in Scenario 8 are plotted in Figure 5-12 below.

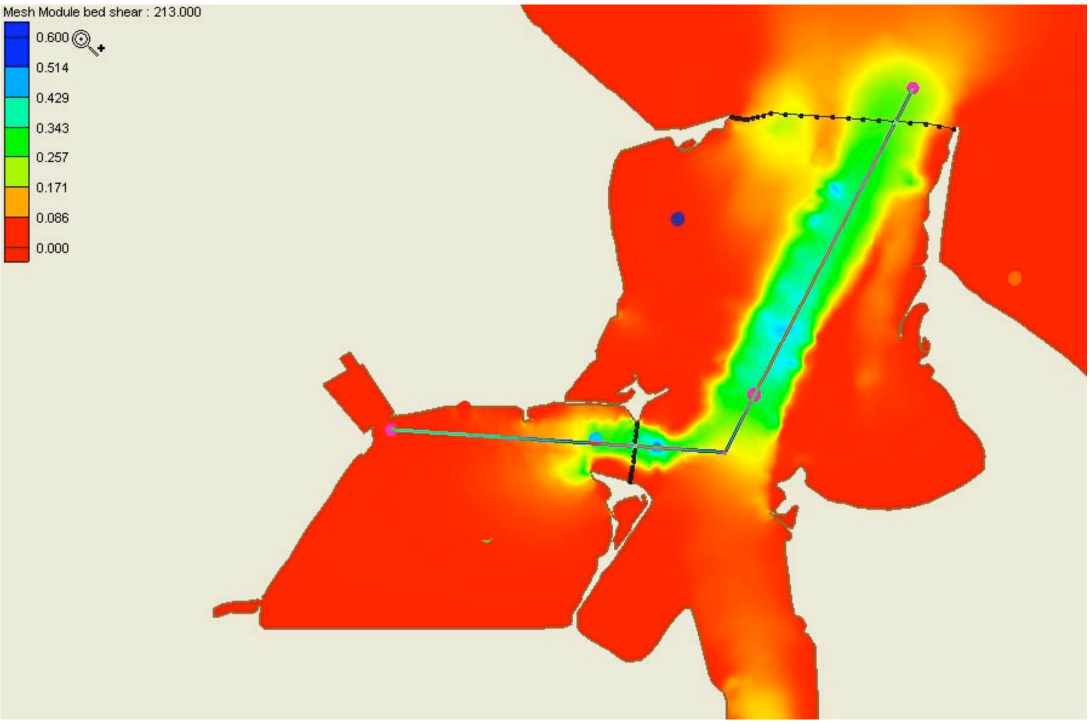


Figure 5-12 Maximum shear stress (N/m²) acted upon bed for Scenario 8, at T = 213 (hrs). Transect indicated is plotted in Figure 5-13 below.

The maximum shear stress (at T = 213 hrs) along Seaton Channel, through Tees Channel and out towards the estuary mouth is plotted in Figure 5-13 below. A local maximum is seen in the most constricted part of the mouth of Seaton Channel. Constricted areas of Tees channel also experience high shear stress.

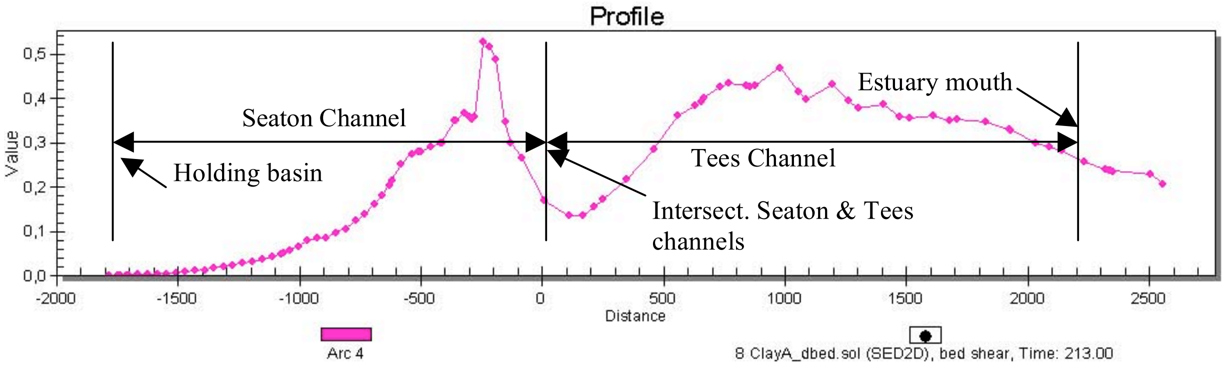


Figure 5-13 Maximum shear stress (N/m²) for Scenario 8, at T = 213, from Seaton Channel to sea. Transect defined in Figure 5-12 above.

It can be seen from Figure 5-11, Figure 5-12 and Figure 5-13 that the maximum shear stress is below 0.1 N/m^2 on Seal Sands, in the inner reaches of Seaton Channel, and on most mudflats. The shear stress rises to around 0.5 N/m^2 and above for the outer parts of Seaton Channel and the constricted areas of Tees channel. Erosion of fine sediments may be the case here.

It is clear that the shear stress magnitude on Seal Sands is below the values required to initiate erosion, and also low enough for both sand and clay to deposit. In Seaton Channel the shear stress is high at high water velocities, and there is less likely that silt/clay will deposit in this area.

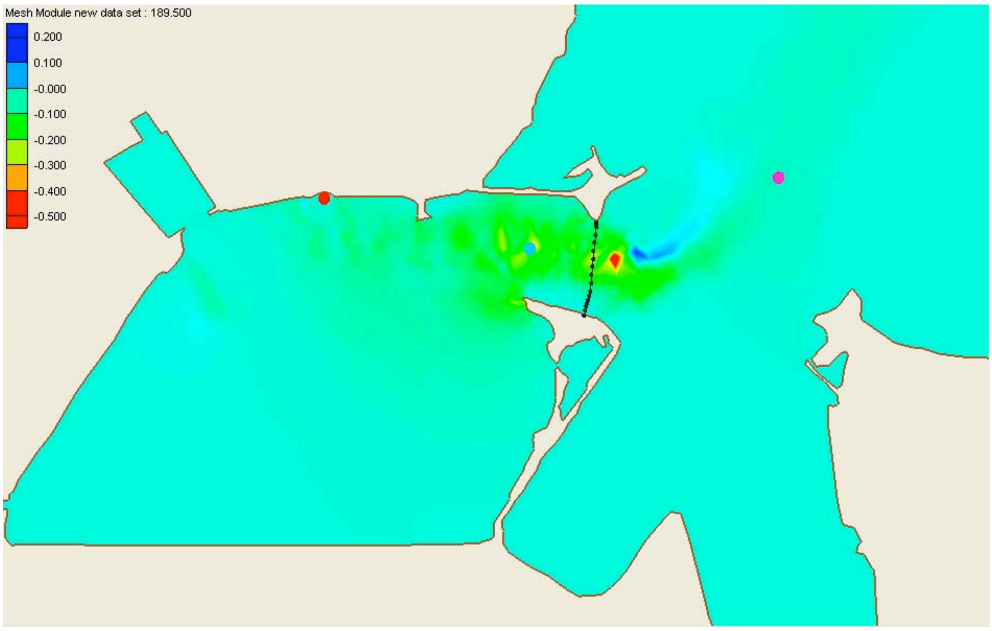


Figure 5-14 Maximum changes in bed shear stress (N/m^2) at T = 189.5 (hrs) from scenario 0 and 8.

The changes in shear stress from Scenario 0 to Scenario 8 are presented in Figure 5-14. Local maxima and minima as predicted by the model are due to bed undulations present in the Baseline scenario and may not reflect reality. Local extreme maxima and minima are therefore not taken into account, and only general changes are considered.

Predictions for each point and each scenario are presented in Table 5-4. Changes in bed shear are small, indicating no great change in sediment regime. However, some local changes occur. The average shear stress at Pt 1 Nuclear power plant intake changes by 0.0003 N/m^2 from 0.001, a decrease of 31%, which is appreciable. Corresponding figures for Pt 3 Seaton Channel are 39 %, which is natural as the velocities decrease due to increased depth. At Pt 2 Seal Sands the change is a decrease of 13 %. At Pt 7 Teesport the figure is 0.01 % which is negligible. Again, appreciable impacts are seen within the mouth of Seaton Channel, but changes outside are negligible.

Table 5-4 Bed shear stress difference maxima (%) between baseline and scenarios between baseline (0) and scenarios 1 to 9.

Scenario	N/m^2	Pt 1 Nuclear PP intake	Pt 2 Seal Sands	Pt 3 Seaton Channel	Pt 4 Tees Channel	Pt 5 North Gare Sds	Pt 6 Coatham Sands	Pt 7 Teesport
0 abs. value	Max	0.007	0.045	0.684	0.729	0.017	0.003	0.111
	Min	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	Average	*0.001*	*0.010*	*0.154*	0.157	0.006	0.001	*0.029*
1	Average	1.61E-06	-8.49E-05	6.33E-04	1.69E-04	2.62E-06	6.89E-07	-6.90E-07
	Avg. diff %	**0.2**	**-09**	**0.4**	**0.1**	**0**	**0**	**0**
2	Average	-1.34E-04	-7.47E-04	-5.14E-02	-1.57E-04	1.12E-06	3.57E-07	1.24E-06
	Avg. diff %	**-13**	**-7**	**-33**	**-0.1**	**0**	**0**	**0**
3	Average	-1.83E-07	-2.37E-04	5.84E-04	1.72E-04	3.17E-06	7.76E-07	2.14E-06
	Avg. diff %	**0**	**-2.4**	**0.4**	**0.1**	**0.1**	**0**	**0**
4	Average	-1.42E-04	-8.52E-04	-5.14E-02	-1.53E-04	5.97E-07	6.21E-07	-2.88E-08
	Avg. diff %	**-14**	**-8**	**-33**	**-0.1**	**0**	**0**	**0**
5	Average	-1.65E-04	-6.37E-04	-1.27E-02	-4.00E-03	-4.89E-05	-6.55E-06	-2.82E-06
	Avg. diff %	**-17**	**-6**	**-8**	**-2.6**	**-0.8**	**-0.7**	**0**
6	Average	4.24E-04	2.05E-03	8.83E-02	4.94E-03	5.65E-05	1.11E-05	2.21E-06
	Avg. diff %	**42**	**21**	**57**	**3.2**	**0.9**	**1**	**0**
7	Average	-1.77E-04	-7.44E-04	-1.27E-02	-3.99E-03	-4.89E-05	-6.79E-06	-4.00E-06
	Avg. diff %	***-18***	**-7**	**-8**	**-2.5**	**-0.8**	**-0.7**	**0**
8	Average	*-3.05E-04*	*-1.31E-03*	*-6.03E-02*	-4.28E-03	-4.98E-05	-6.65E-06	*-1.77E-06*
	Avg. diff %	**-31**	**-13**	**-39**	**-2.7**	**-0.8**	**-0.6**	**0**
9	Average	3.27E-04	-1.53E-03	-7.50E-02	-3.33E-03	-4.41E-05	-6.63E-06	-3.53E-06
	Avg. diff %	**33**	**-15**	**-49**	**-2.1**	**-0.8**	**-0.6**	**0**

In Figure 5-15 the average changes in bead shear between baseline (scenario 0) and the different scenarios are plotted for each location. Figure 5-15 shows that the greatest impact will be within the bounds of Seaton Channel (location 1, 2 and 3). This is in the dredging areas and is also the area with the largest changes in velocities. It also shows that the greatest changes are related to scenario 6 (when the dock is closed and Seaton Channel is dredged) and 8 (Dock closed, Seaton channel and quays 10 and 11 dredged). The least changes in velocities can be seen for scenario 1 (Dock and Holding basin dredged) and 3(Dock and Quays 10 & 11 dredged). It is important to underline that estimated shear stress after dredging is somewhat artificial, because the bed is assumed to be completely flat reflecting the proposed dredging depth.

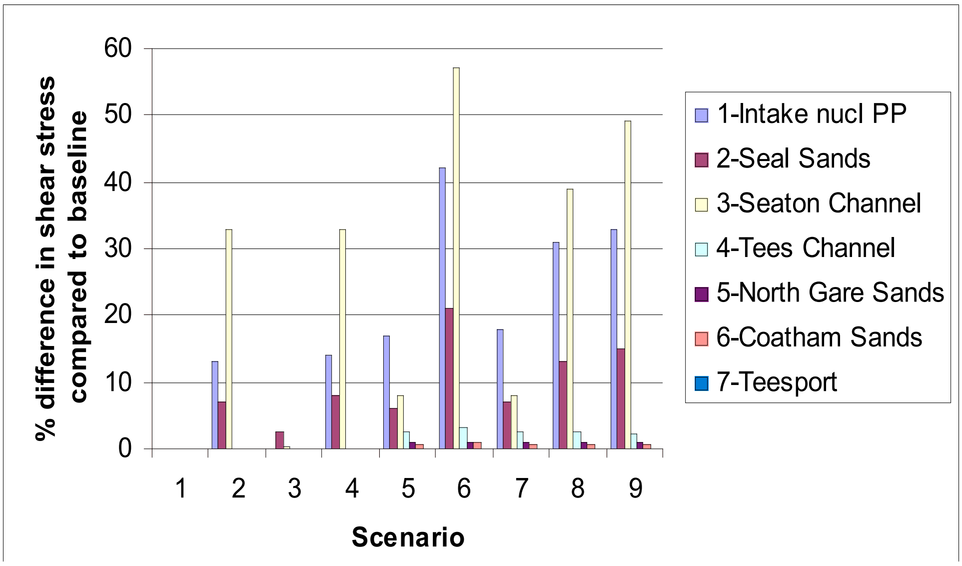


Figure 5-15 Average changes (%) in shear stress between baseline and the different scenarios at each location

5.2.2 General impacts on sediment concentrations

The general impact of the proposed developments of the TERRC site on sediment concentrations is described below.

The main sediment source is the sea, both for cohesive sediments and for non-cohesive sediments, as can be seen in Figure 5-16, Figure 5-17, Figure 5-20 and Figure 5-21. A generally higher concentration together with a domination of tidal processes over river inflow ensures that the influx from the sea is dominant. This is supported by /2/.

5.2.2.1 Selected sediment concentrations, sand

The suspended sediment concentration of sand (at T=210) along Seaton Channel, through Tees Channel and out towards the estuary mouth is plotted in Figure 5-16 and Figure 5-17. There is a gradually decrease from the estuary towards Seaton Channel and the Dock. This reflects that the main source is the estuary and that sand gradually falls out of suspension.

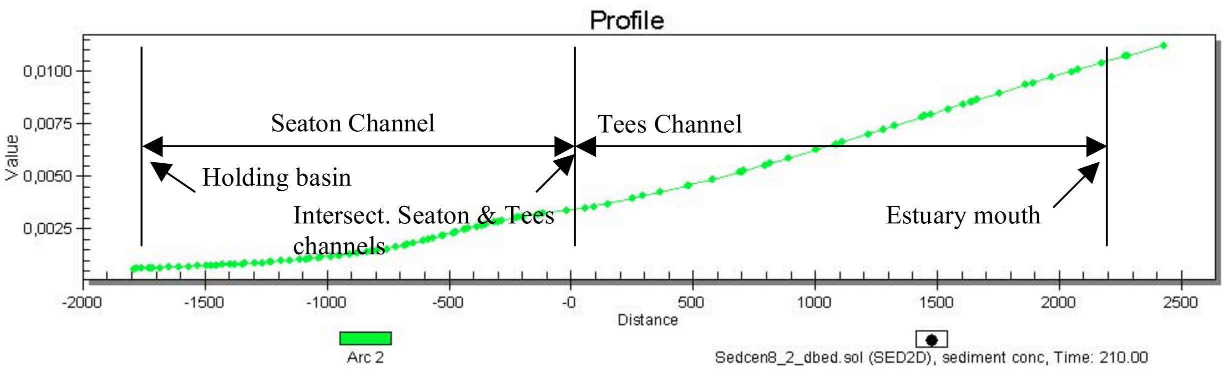


Figure 5-16 Sediment concentration (mg/l) profile, sand, from upstream Seaton Channel to estuary mouth. Sand, scenario 8, T = 210 (hrs)

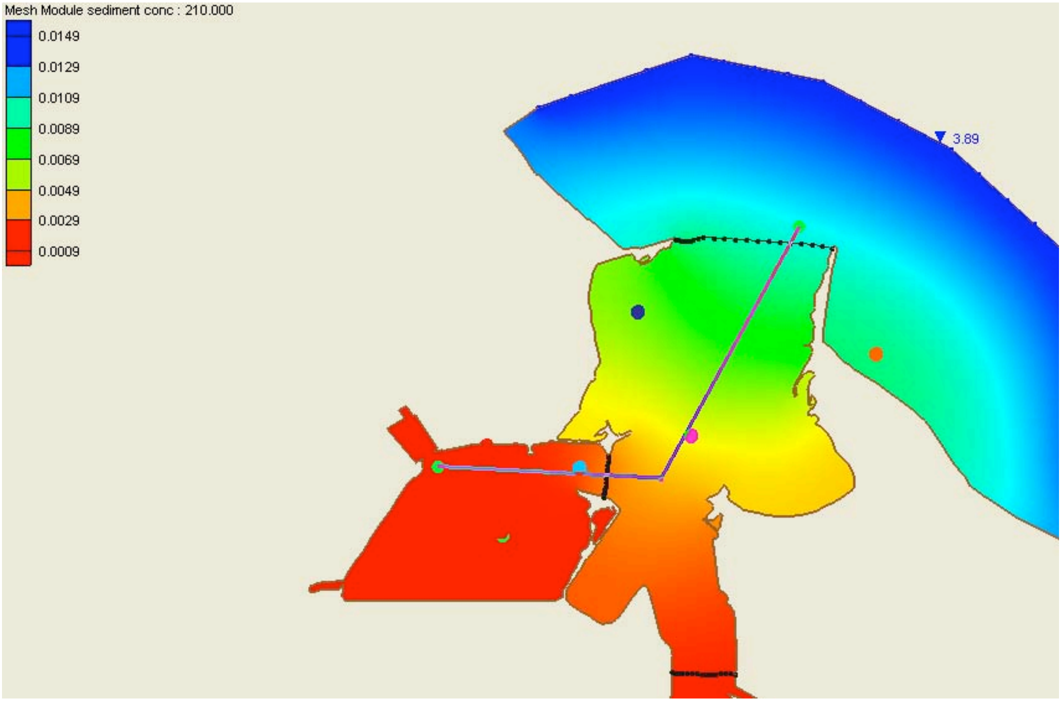


Figure 5-17 Corresponding plot of sediment concentrations (mg/l) for sand, scenario 8, T = 210 (hrs). Transect plotted in Figure 5-16 above indicated

Sand concentrations at Pt 1 nuclear power plant intake and Pt 2 Seal Sands are shown in the Figure below for Scenario 8. It is seen that the concentration of suspended sand varies greatly within the tidal cycles, but that maximum concentrations (as tabulated above) are low, less than 1 mg/l.

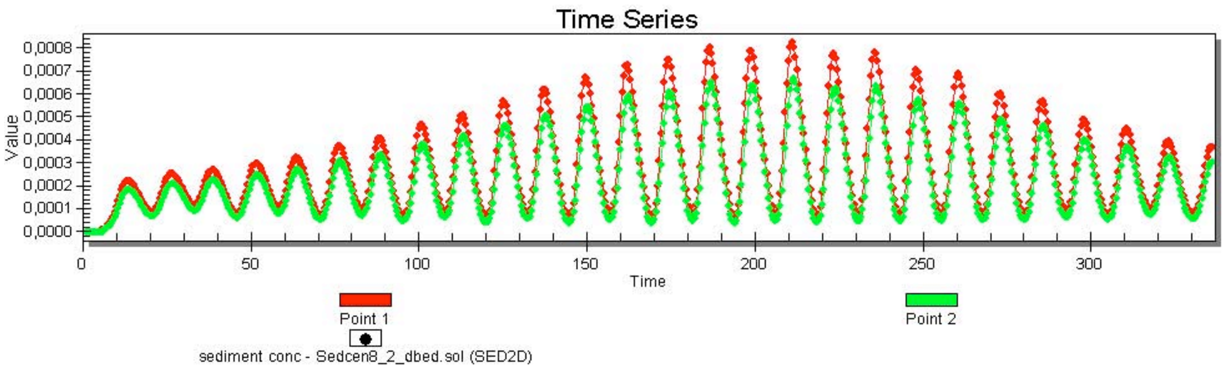


Figure 5-18 Sand concentrations (mg/l) at Pt 1 (nuclear power plant intake) and Pt 2 (Seal Sands) for Scenario 8

Maximum concentrations differences for sand between scenario 0 and 8 is plotted in Figure 5-19. In general the differences are very small and the differences are only a few percent. The differences are most prominent in the lower reaches of Seaton Channel.

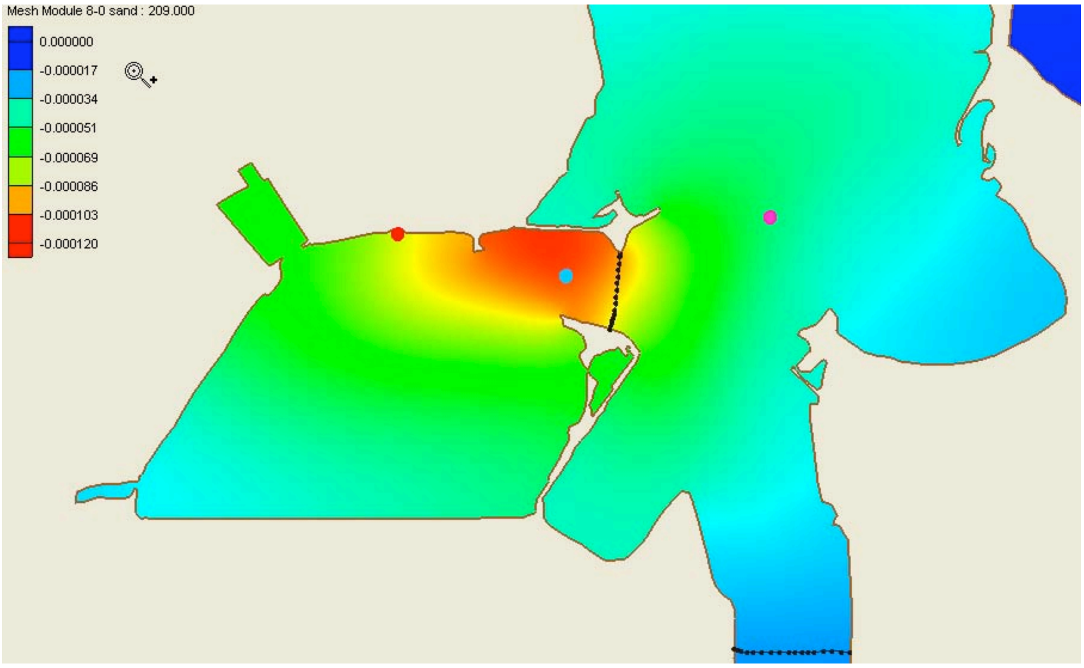


Figure 5-19 Maximum concentration differences, sand, at T = 209 (hrs), scenario 0 and 8

5.2.2.2 Selected sediment concentrations, silt/clay

The suspended sediment concentration of silt/clay (at T=210 hrs) along Seaton Channel, through Tees Channel and out towards the estuary mouth is plotted in Figure 5-20 and Figure 5-21. There is a gradually decrease from the estuary towards Seaton Channel and the Dock.

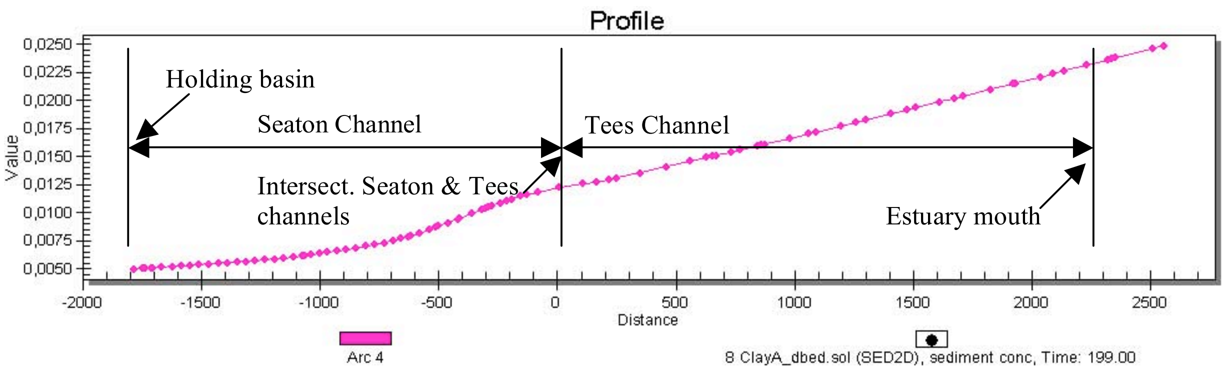


Figure 5-20 Sediment concentration (mg/l) profile, clay, from upstream Seaton Channel to estuary mouth. Scenario 8, T = 199 (hrs)

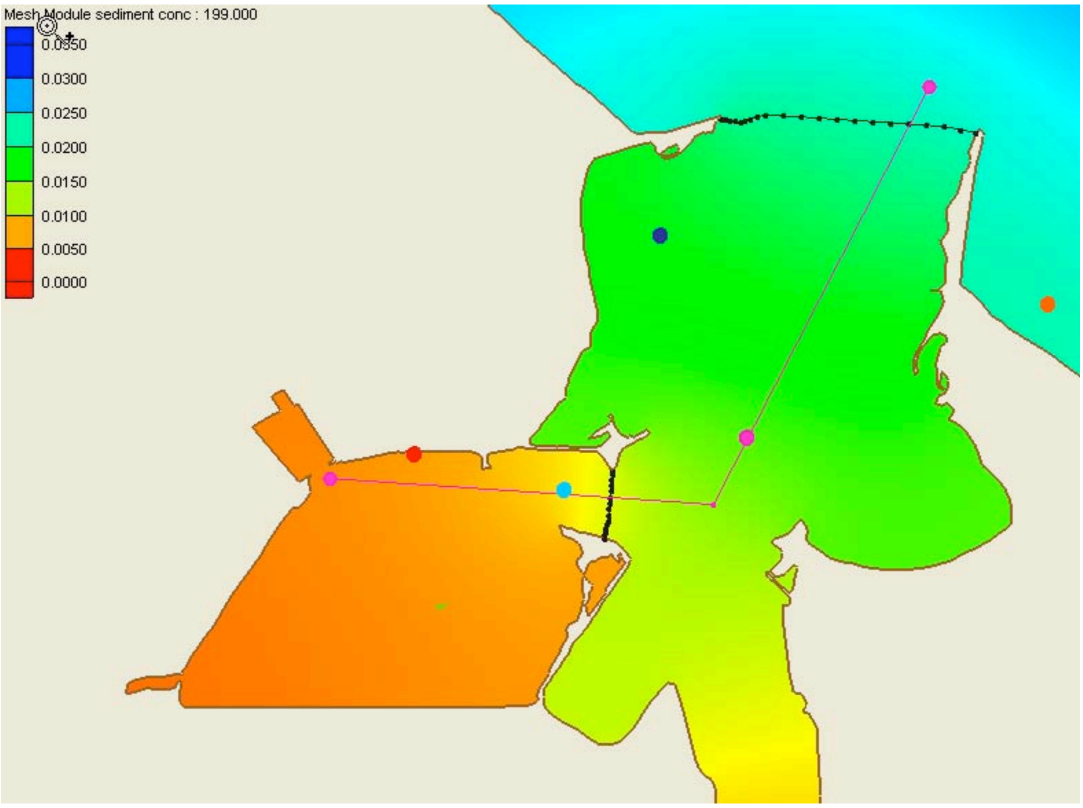


Figure 5-21 Corresponding plot of sediment concentrations for clay, scenario 8, T = 199 (hrs). Transect plotted in Figure 5-20 above indicated.

Silt/clay concentrations at Pt 1 nuclear power plant intake and Pt 2 Seal Sands are shown in the Figure below for Scenario 8. It is seen that the concentration of suspended sand varies greatly within the tidal cycles. Maximum concentrations at Pt 1 Nuclear power plant intake and Pt 2 Seal Sands are in the region of 5-6 mg/l, depending on the stage of the tidal cycle and under the modelled conditions.

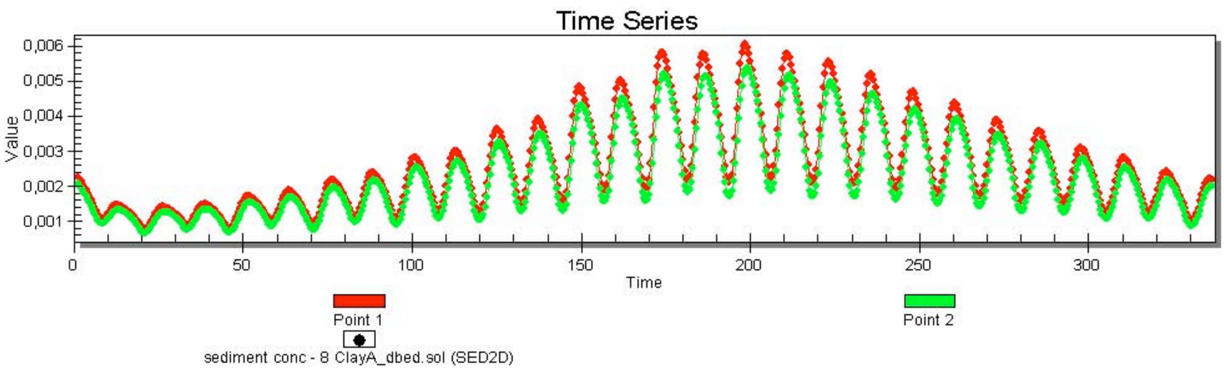


Figure 5-22 Clay concentrations (mg/l) at Pt 1 Nuclear power plant intake and Pt 2 Seal Sands, for Scenario 8

Maximum concentrations differences for silt/clay scenario 0 to 8, is plotted in Figure 5-23. As for sand the differences are most prominent in the lower reaches of Seaton Channel, but the affected area is much smaller. The area of greatest change is where the bead shear stress is relatively high and where the model indicates erosion of the silt/clay bed defined in the model runs.

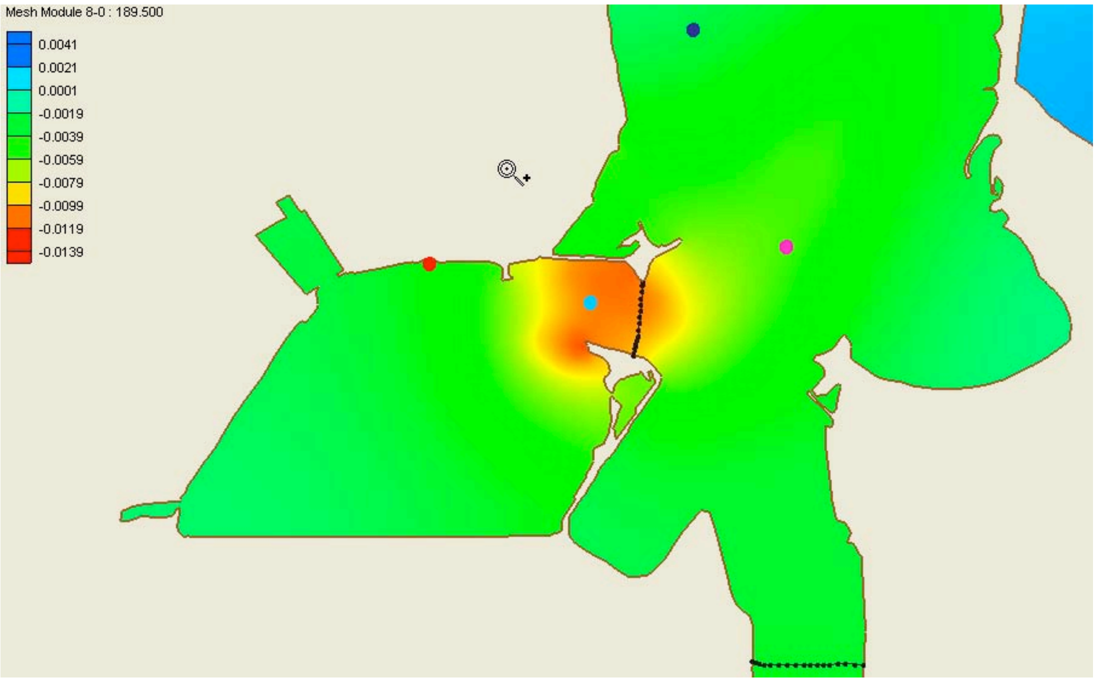


Figure 5-23 Maximum changes in concentrations for clay, T = 189.5 scenario 0 and 8

Detailed impacts on hydrodynamics, sediment concentrations, and deposition rates / erosion potential are presented in Appendix E.

5.3 Conclusions – hydrodynamics and sediment transport modelling

The dynamic response of the model to the changes in geometry with the modelled processes is described in Figure 5-24.

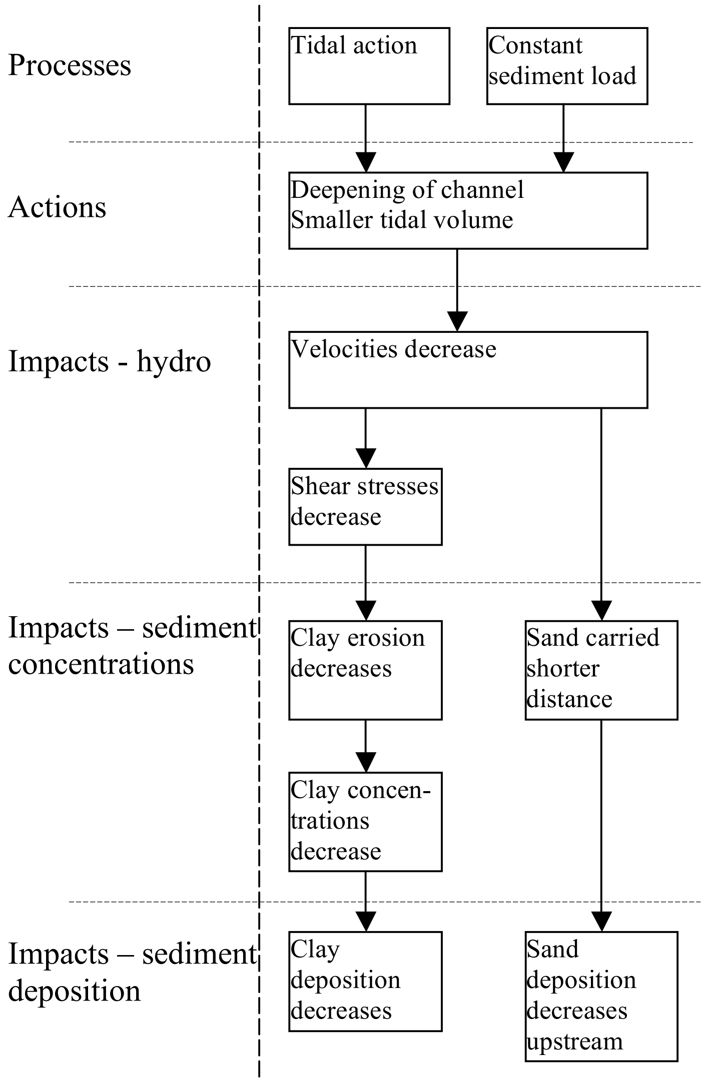


Figure 5-24 Dynamics of hydrodynamic and sediment transportation model

The model is set up to investigate the relative impact of changes in channel geometry as a result of the proposed developments at the TERRC dry dock and in the nearby estuary.

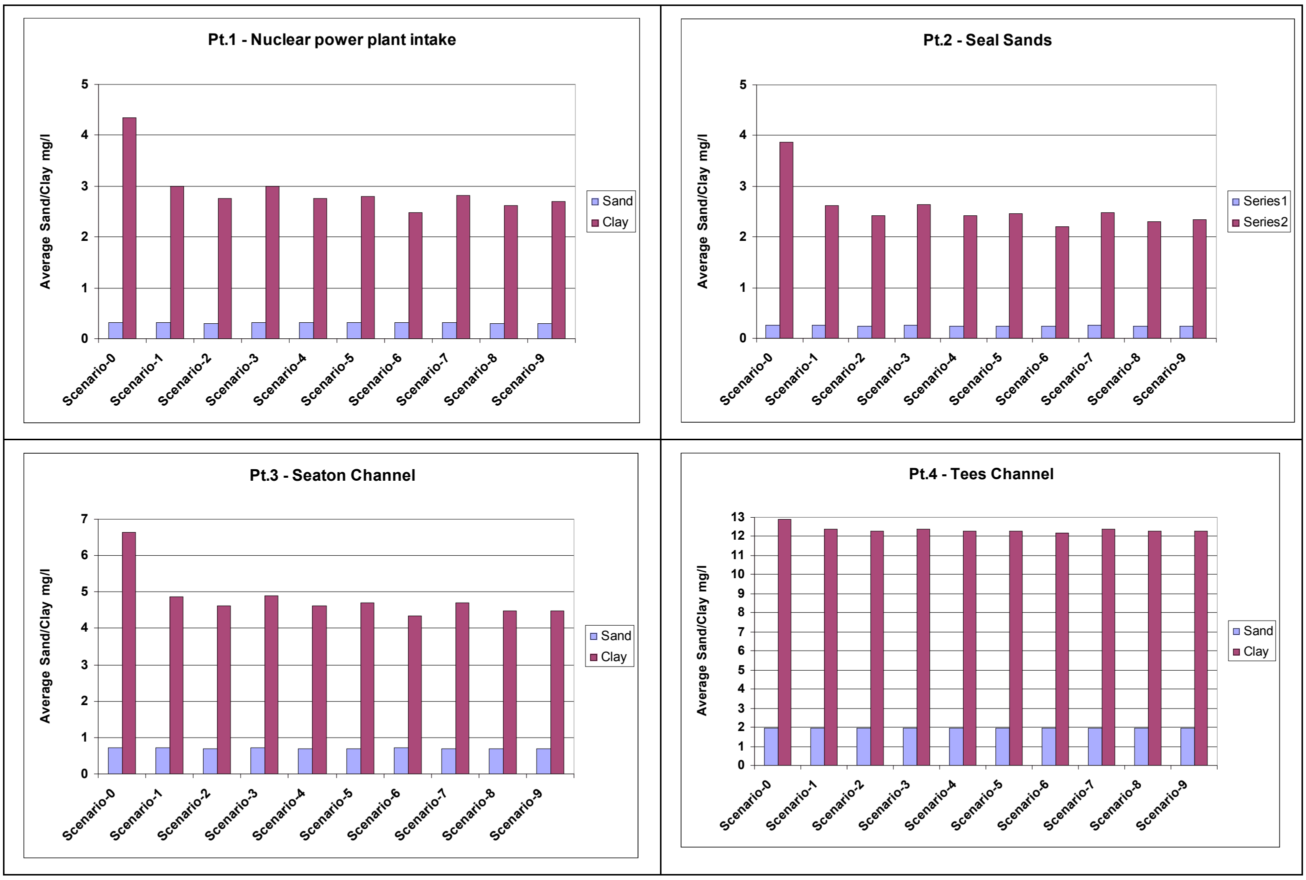
As the relative impacts are of interest, the only process modelled is the action of tidal forces and constant river flow, applying a constant sediment concentration. Other processes contributing to water flow and sediment suspension such as storms, waves, traffic and dredging will produce a much more complex model and results, masking the important relative difference.

Throughout the various scenarios, changes are made in the geometry to reflect the dredging and closing of the dry dock, dredging of the holding basin, various quays, and Seaton Channel. It is seen that the water velocities in general decrease as the tidal volume is decreased when the dry dock is closed, and when the cross sectional area of the channel is decreased. Corresponding decreases in shear stresses on the bed are detected.

For modelling of sand, the decreased velocities mean that the sand is carried a little shorter upstream, and the deposition rate here decreases. The differences are very small as the baseline carriage of sand upstream is small. This is also reflected in the true sediment found further up Seaton Channel which contains less sand, see Figure 5-4. As seen in Figure 5-25 the differences for sand concentrations between the different scenarios are negligible.

The clay model, however, is effectively lined with a clay bed all over, including areas where the shear stress is too high for clay to be present. A somewhat "false" erosion of clay in these areas suspends sediments that are transported to other areas. Throughout the scenarios the shear stress decreases, also decreasing the concentration of clay sediments in the water column. Less clay is therefore available to deposit elsewhere, and the clay deposition rate decreases in general. This is the reason why the concentration of clay decreases for scenario 1 to 9 compared to the baseline, as seen in Figure 5-25. The differences between scenarios 1 to 9, however, are relatively small. The differences are small outside the bounds of Seaton Channel which reflect the changes in velocities.

The influence of other processes is discussed further in Section 10 below.



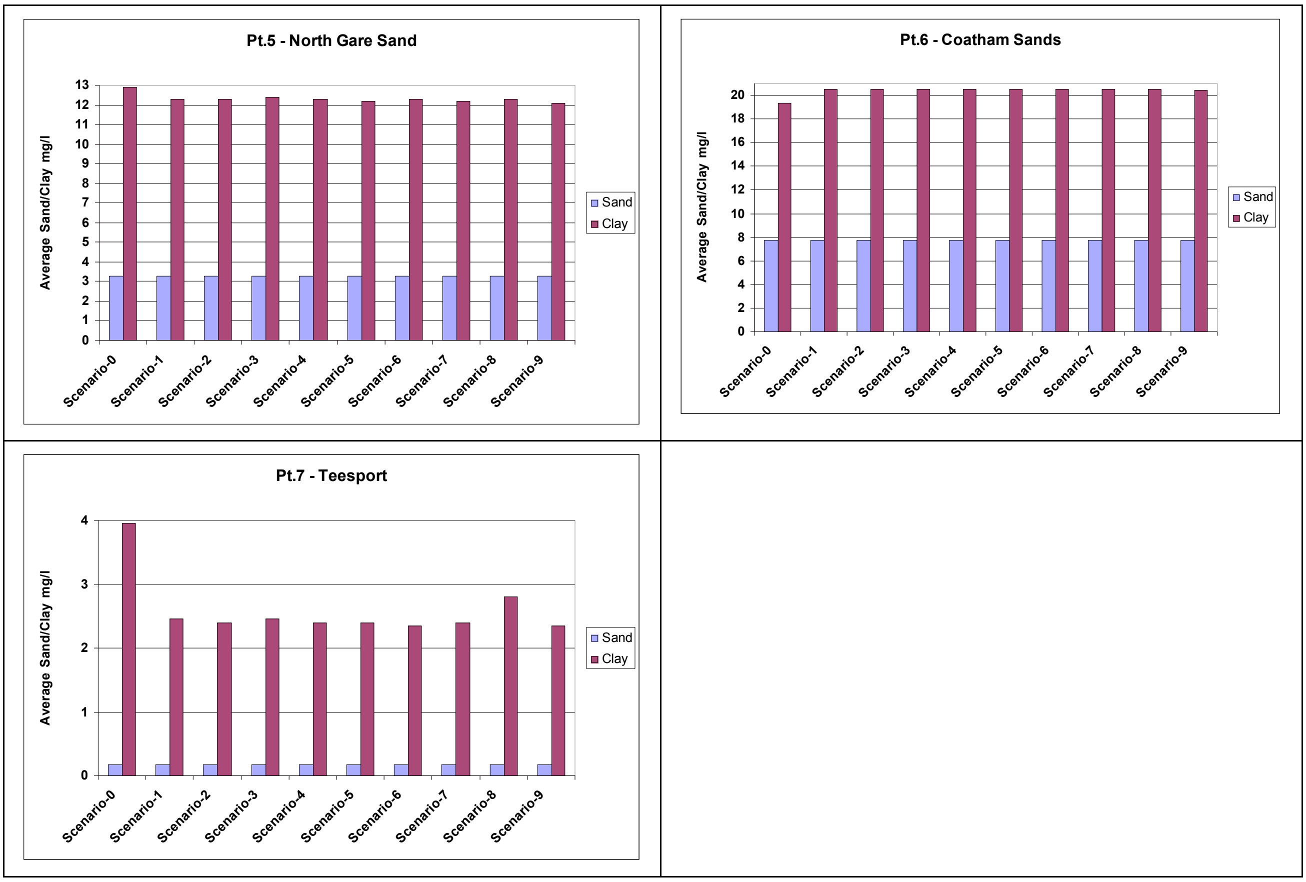


Figure 5-25 Differences in suspended sand and clay concentrations (mg/l) between different scenarios

6 REVIEW OF PREVIOUS STUDIES AND DATA SETS

The dry dock has previously been used for the construction and disassembly of ships and offshore structures. Until 1963 the site was used for shipbuilding, later for construction of offshore structures. Throughout the late 1960’s and 70’s Seaton Channel was dredged several times in order to float out offshore structures, and maintenance dredging has been carried out intermittently. In 1985 the Albuskjell platform was remediated and recycled at the site, and several other structures have been recycled after this.

6.1 HR Wallingford 2002 /2/

In 2001 HR Wallingford was contracted by the Environment Agency to investigate possible reasons for the decline in numbers of feeding birds at Seal Sands. Changes in sedimentation patterns and the subsequent increases in algal mat densities were believed to have had detrimental effects on feeding capacity, with the numbers of sediment feeders such as Shelduck and Dunlin falling dramatically.

The Tees estuary has been extensively modified over the last two and a half centuries, with straightening and deepening of the main channel, and extensive reclamation of intertidal mudflats. A total of 3100 Ha have been reclaimed, leaving at present 470 Ha of intertidal foreshore.

Seaton Channel has been dredged routinely, with some additional dredging for the float-out of several oil rig modules constructed at the dry dock in the 1970’s and 80’s. Seaton Channel is at present dredged to some degree.

In 1990-91, Halcrow and HR Wallingford undertook a strategic review of dredging and siltation, showing that the estuary was dredged more than necessary for navigation, resulting in the estuary being gradually deepened. A computer model showed that the river contributed little sediment relative to contributions from the Tees bay. Most of the sediments are of marine origin, coming from the sea with incoming tides when already suspended by waves, in fact 90 % of siltation comes from the sea of which 45 % is sand. The study also showed strong stratification ensuring the upstream migration of finer particles “after disturbance by storms, shipping and dredging”.

Most sediment originates from North Gare Sands on rising tides during storm events. 80 % of the sediment moves into the estuary during 7 months from October to April, with 60 % of transport occurring during 30 days of storm activity.

The construction of the Tees Barrage in 1995 has decreased the tidal volume by 10 %, with an expected long term sediment deposition decrease of 10 %. The Barrage was not expected to have any significant effects in Seaton Channel, because the tidal volume and circulation there would not be affected.

Sedimentation rates are reported to have decreased in the last 10 years, with a shift towards less dense materials at the seawards end of the estuary. In addition to the construction of the Tees Barrage, possible reasons may be changes in weather patterns, decreased dredging rates or a combination of reasons. At the confluence of Seaton Channel and the Tees, however, an increased rate of deposition has been noticed, possibly due to changes at the North Gare breakwater. Sediment deposits at the edge of the Seaton turning area are reported to collapse into the dredged area, restricting ship movements.

In fact the dredging quantities reported for “Chart 9” (see Figure 3-8 above) have doubled lately, although the total annual deposition quantities for the whole Tees estuary are calculated to have decreased from 1.5 Mm^3/y in the years around 1986-1991 to 0.95 Mm^3/y for 1995-2001. This calculation is, however, based upon dredged quantities, and may simply be a product of privatisation of the Porch Authority and an efficiency improvement of dredging, so that cost savings on dredging operations have resulted in a reported drop in deposition rates. If indeed dredging has fallen below deposition rates, the bed levels are rising and the Tees estuary is silting up. It is reportedly the view of dredging staff that dredging rates are too low to sustain target depth.

The observed accretion of sand fractions on Seal Sands, which is believed to be the reason for the deterioration of the feeding conditions for seabirds, and thus the decline in bird numbers, may be alleviated by deepening Seaton Channel to create a sediment trap.

The general findings regarding Seal Sands conclude that the reclamation of Seal Sands in the mid 1970’a created an accumulating mud bank over the original profile of sand. The elevation of Seal Sands continued to rise, although at a reducing rate as shallower water increased the local wave erosion. On the other hand, the shelter offered by the training wall along Seaton Channel, the artificial spit along the Philips oil terminal and the reclaimed area reduced wave fetch and wave erosion. Algal mats established and have spread lately, further stabilising the sediments. The supply of sand has increased. Adding to this, the general deposition rate of say 1.35 Mm^3/y (post-barrage) being in excess of the 1 Mm^3/y dredged, it is clear that the estuary is silting up. Although not an immediate danger, without intervention Seal Sands may in long terms be transitioned into a salt marsh.

Further detailed points from the study:

- Sand and silt are carried into the Tees estuary from the sea during storms. Annual rates are in the order of 1.5 Mm^3/y or 700,000 tonnes.
- Sand settles out in the lower parts of the estuary
- Silt and clay may be carried further upstream by gravitational action (tidal undercurrent) and re-suspension by dredging and shipping activities
- Only 40,000 tonnes/year originate from the river, with some sand settling out in upper reaches and silt being carried further downstream.
- The recent increase in deposition of sand fractions on Seal Sands may stem from North Gare Sands where sand is bypassing the breakwater to ”spill” further into the estuary
- Other reasons may be changes in coastal drift due to changes in wave climate; breakdown of a slag shoal off North Gare Breakwater; breaches in the slag embankment protecting Seaton Channel and the turning circle
- The trend of sand accretion at Seal Sands may be stemmed by dredging of Seaton Channel, creating a sediment trap.

6.2 Durham University 2003 /1/

A study of the sediment dynamics in the lower Tees was commissioned by the Environment Agency in 2003. The work was aimed at providing a base for reviewing policies and applications for trade effluent and sewage discharges into the estuary. Sediment dynamics between June 2003 and March 2004 were studied.

Based upon repeat sampling of the upper 2 cm of intertidal sediments on 70 sites on Seal Sands from 1992 to 2003, a systematic change in grain size distribution is evident. Seal Sands have evidently been accreting sediments since the 1970's. Predictions from HR Wallingford from 1966 regarding sedimentation rates and characteristics have come true. Since 1992 sampling shows a trend towards finer sediments, possibly from dredging operations. This is somewhat in contradiction to the findings from HR Wallingford presented in Section 6.1 above (although this also mentions that theoretically, the impacts of the barrage, changes in maintenance dredging etc. could cause sediment fractions to become finer).

Mapping of algal mats shows that areas covered by *Enteromorpha Sp.* have increased from 10 % in 1992 to 50 % of the Seal Sands intertidal area in 2003. The spreading of the algal mats may have been aided by detachment and transportation by wave action.

Six sediment cores were analysed to reconstruct the sediment history of Seal Sands. Sedimentary sequences obtained were analysed by transecting ^{137}Cs and ^{210}Pb levels through the cores. All cores showed net accretion since the beginning of the 20th century. Some showed sediment disturbance events believed to be man-made, as no major natural changes have occurred in the estuary lately.

Three locations were analysed for diatom records, indicating that before 1964, some areas were soft mudflats, and one area was firmer. All areas have gradually become elevated, better drained and firmer. The high abundance of epiphytic diatoms in sediments predating 1950 showed that macro algae were present at this time. Around 1960 macro algae density was drastically reduced, but levels have risen since then. Conditions for macro algae were evidently severely impacted in the 1960-70's, most likely by land reclamation programmes.

Levels of heavy metal pollution were high from 1920 to 1970, most elements have declined since then. Vanadium and Chromium peaked in the 1970's, and Titanium levels remain high today. Fine grain sediments buried beneath the surface on Seal Sands contain significant concentrations of heavy metals that may be toxic to flora and fauna if disturbed.

6.3 Other data sources

In June 1995 Zeneca /3/ undertook a survey of the Tees estuary to map the following data at five locations:

- Current speed and direction
- Salinity, temperature, dissolved oxygen and pH at the surface, at 0.5 m depth and at every 1.0 m interval to the bed, at half hourly intervals for a period of 12.5 hours for each day in a full tidal cycle
- Meteorological observations, tidal height and freshwater flow data for the period in question
- Suspended solids samples hourly for two days, at 1 m intervals to the bottom

- Inorganic nitrogen ½-hourly at 0.5 m depth, mid depth and 1.0 m off the bottom on 4 days
- Biological oxygen demand hourly at 0.5 m depth and 1.0 m off the bottom on 2 days
- Dissolved metals at 0.5 m depth, ½-hourly on one day
- Cyanide at 0.5 m depth hourly on one day
- Volatile organics at 0.5 m hourly on 2 days

The survey locations were Teesport, Smiths Dock, Transporter Bridge, Billingham Reach and Old River Tees, representing various locations along the River Tees and the estuary.

Data were tabulated for neap and spring tidal cycles.

The Environment Agency /7/ supplied further base data regarding bathymetry, currents, sediment distribution and quality, suspended sediment, temperature, salinity, tidal elevation and water quality.

PD Teesport /6/ provided access to the most recent dredging control charts for a detailed bathymetry of the dredged areas. The bathymetry was supplemented by the EA bathymetry data /7/, by digitizing areas of the Chart 2566 – Tees and Hartlepool Bays /8/, and from other maps of land areas.

7 MODELLING OF DREDGING OPERATIONS - SSFATE

For the backhoe dredging, four separate locations of the dredging were assumed. Location 1 was set to be in the back end of the dredging area labelled 1 in Figure 3-1. Location 2 was taken near the middle of Area 1. Location 3 was taken in the middle of Area 2 in Figure 3-1 and location 4 was taken in the middle of the area labelled 4. These four locations should yield results fairly representative of dredging using a backhoe. The hopper dredge operates along the dredging line shown in Figure 4-9. With the four locations for the backhoe dredging and the hopper line location, 5 dredging operations were simulated. With each simulation being conducted during first a neap tide and then during a spring tide, a total of 10 different SSFATE simulations were made.

SSFATE provides several type of output. These include animations of suspended sediment concentrations and particle movements for each individual sediment fraction as well as for all fractions taken together. Animations are an extremely effective way of looking at model results, however, unless AVI files are made, one needs the SSFATE model to view the animations. For this report it was decided that the most meaningful way of illustrating the model result was a picture of the suspended sediment plume showing the maximum concentrations computed anywhere in the water column during the simulation for all sediment fractions taken together. As one moves away from the dredging source, the plume is composed of only fine silt and clay particles, with the coarser material being deposited near the dredging site. Pictures of the bottom deposition contours are also presented for each scenario.

7.1 Backhoe Dredge Results

Figure 7-1 shows the maximum sediment concentrations in the plume resulting from dredging at Location #1, i.e., in the back of Area #1 during a neap tide. Since flow velocities are very small in this area, the plume is of limited extent. It can be seen that maximum total suspended sediment concentrations of 1000 mg/l are exceeded very near the source. With the plume being defined by concentrations greater than 5-10 mg/l, it can be seen that the plume extends for about 60 m from the dredge. Figure 7-2 shows the bottom deposition of the released sediments as a mass per unit area. Figure 7-3 shows the same simulation during a spring tide period. Although the plume is still fairly small (maximum extent of 125 m), with the larger velocities generated during a spring tide the plume is larger than that generated during a neap tide. The maximum concentration for the spring tide plume is also greater than 1000 mg/l very near the dredge. Bottom deposition is shown in Figure 7-4.

Figure 7-1 Maximum total suspended sediment concentrations (mg/l) for backhoe at location 1 in Area #1 during a neap tide

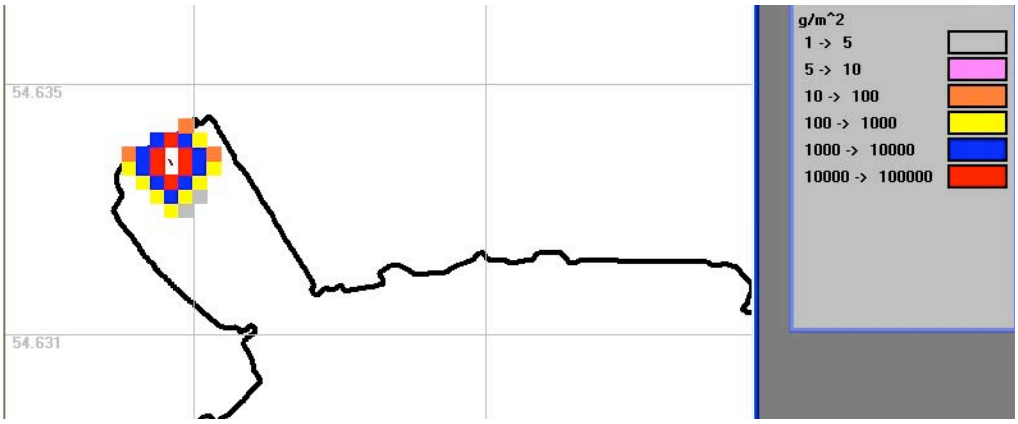


Figure 7-2 Bottom deposition (g/m^2 after 2 days of dredging) for backhoe at location 1 in Area #1 during a neap tide

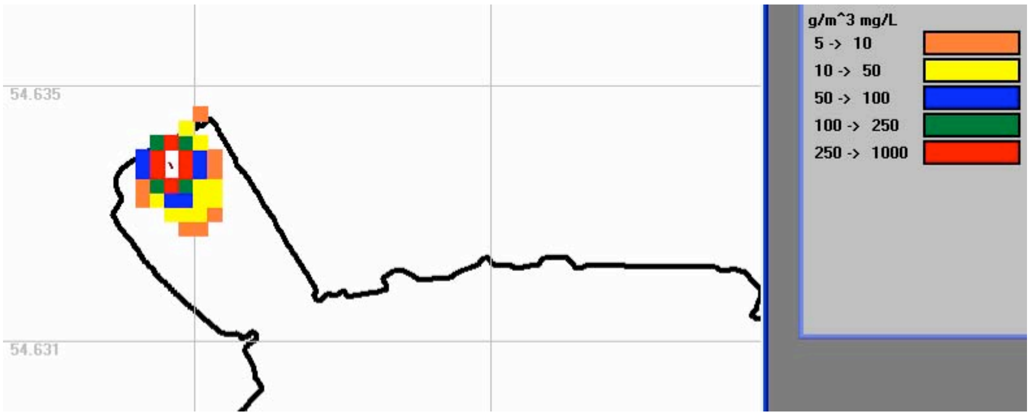


Figure 7-3 Maximum total suspended sediment concentrations (mg/l) for backhoe at location 1 in Area #1 during a spring tide

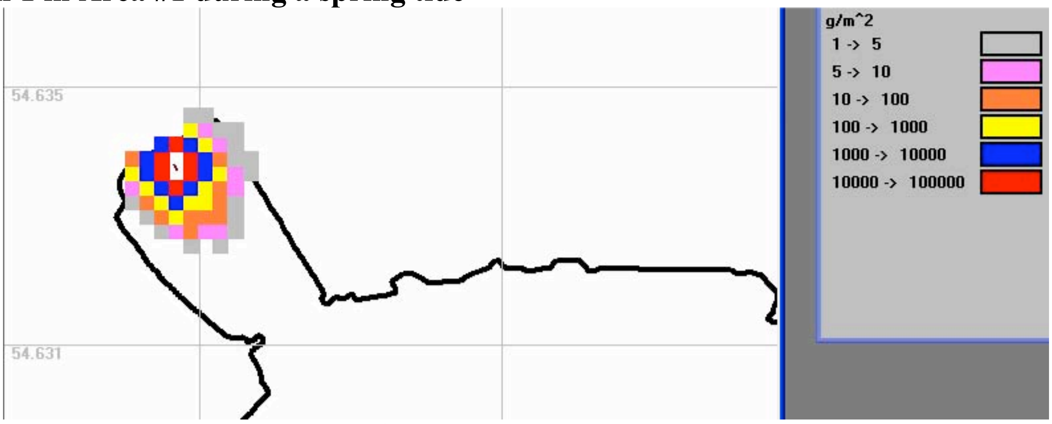


Figure 7-4 Bottom deposition (g/m^2 after 2 days of dredging) for backhoe at location 1 in Area #1 during a spring tide

As the dredging proceeds toward the middle of Area #1, Figure 7-5 shows that for a neap tide the plume is contained within Area #1 with a maximum extent of 170 m and maximum concentrations near the dredge in excess of 1000 mg/l. Figure 7-6 illustrates the bottom deposition. For dredging during a spring tide, Figure 7-7 displays the suspended sediment plume of maximum concentrations. Note that now the plume is very much larger and moves out of Area #1. Maximum concentrations near the dredge are still higher than 1000 mg/l, with the extent of the plume being about 1000 m. The bottom deposition is shown in Figure 7-8.

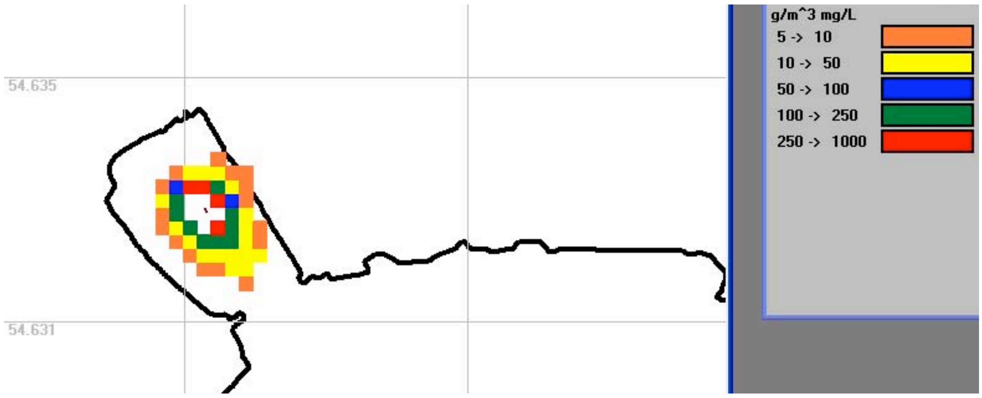


Figure 7-5 Backhoe dredging, Location #2, neap tide, max sediment concentrations mg/l.

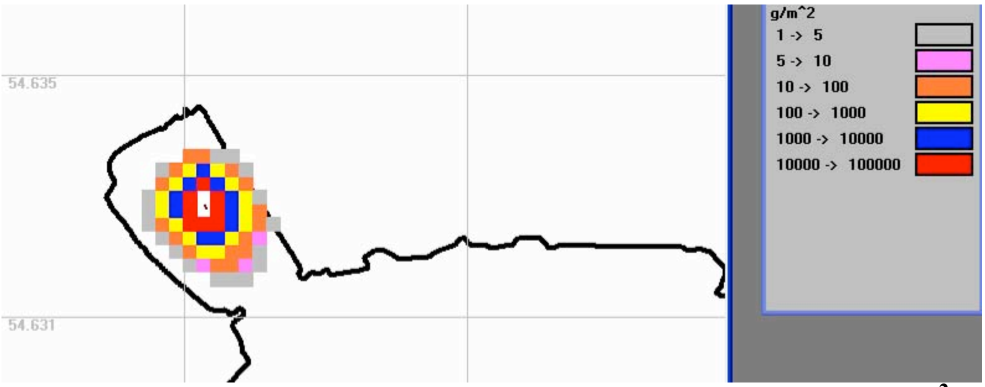


Figure 7-6 Backhoe dredging, Location #2, neap tide, sediment deposition g/m^2 after 2 days of dredging.

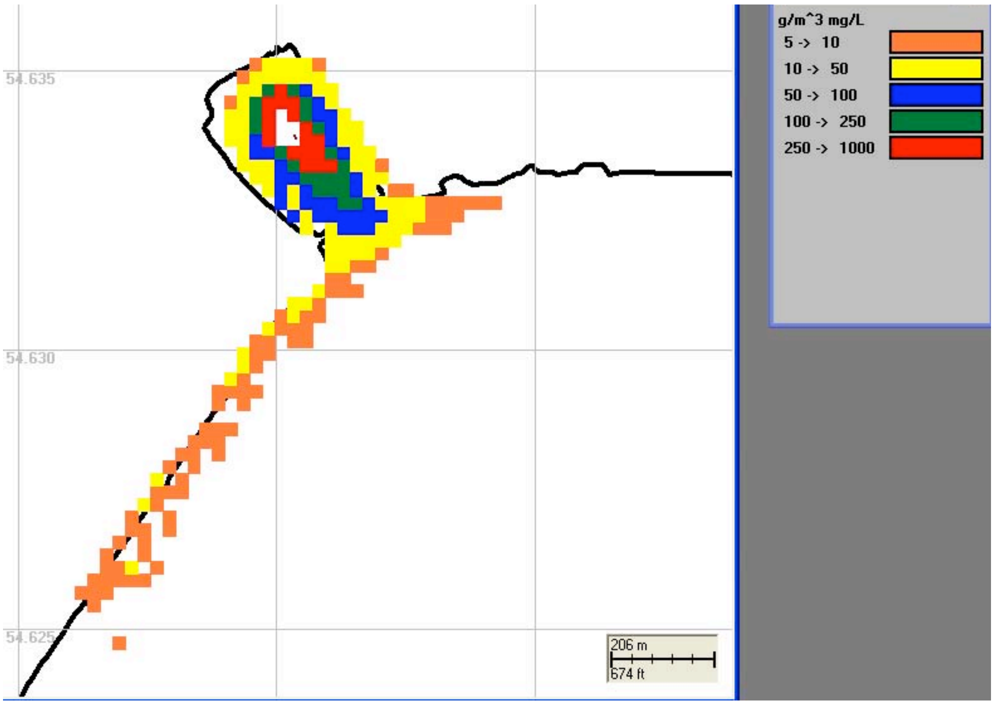


Figure 7-7 Backhoe dredging, Location #2, spring tide, max sediment concentrations mg/l.

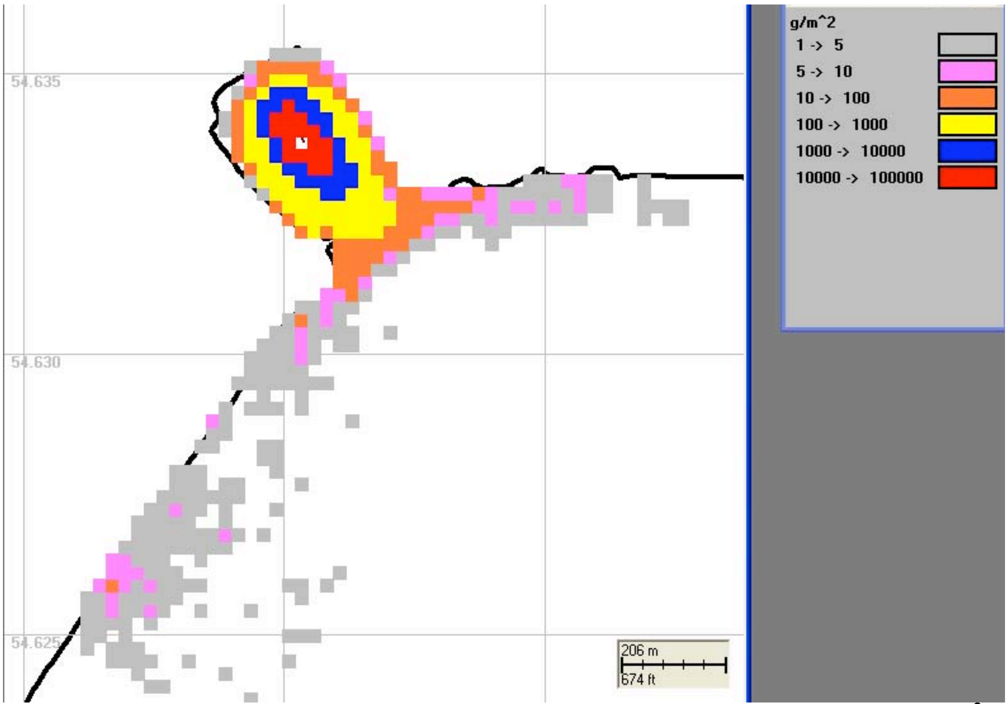


Figure 7-8 Backhoe dredging, Location #2, spring tide, sediment deposition g/m^2 after 2 days of dredging.

For dredging in Area #2, both the neap and spring tide simulations generate significant plumes, shown in Figure 7-9 and Figure 7-11 respectively. Maximum concentrations very near the dredge are again in excess of 1000 mg/l for both plumes. Again, due to much larger currents, the spring tide plume extends much farther than the neap tide plume, e.g., 1000 m versus 400 m. Bottom deposition contours for both plumes are shown in Figure 7-10 and Figure 7-12, respectively.

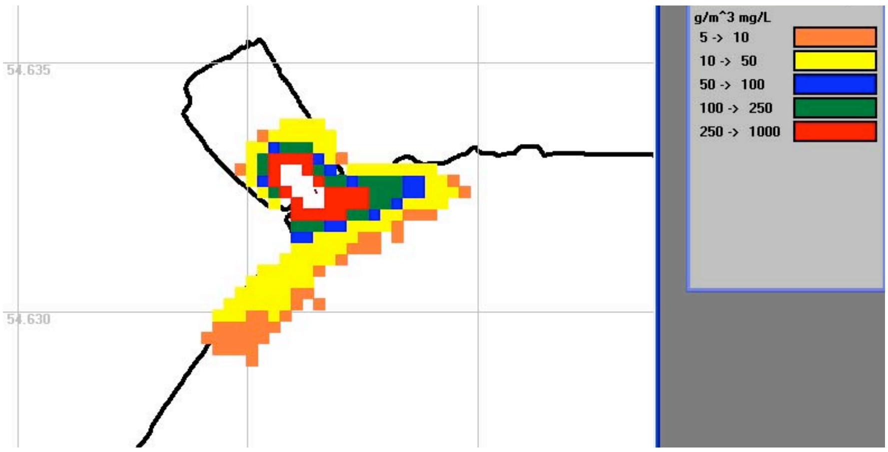


Figure 7-9 Backhoe dredging, Area 2, neap tide, max sediment concentrations mg/l

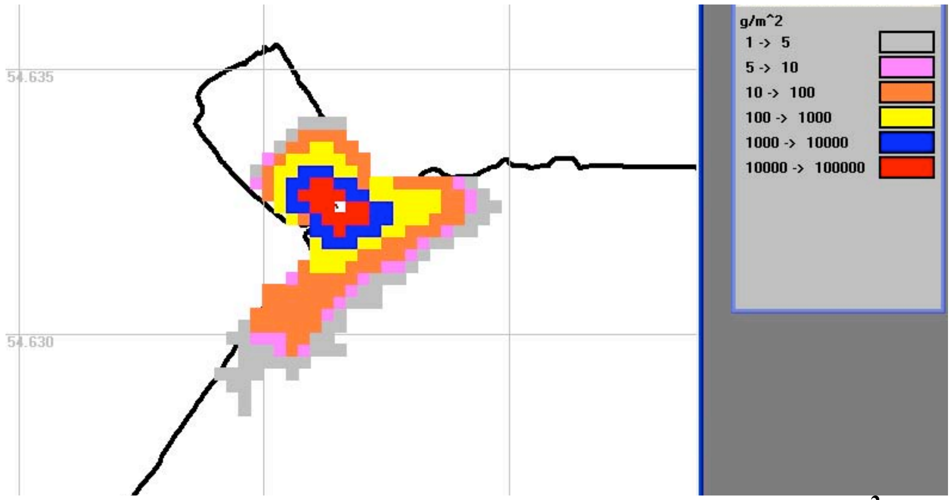


Figure 7-10 Backhoe dredging, Area 2, neap tide, sediment deposition g/m^2 after 2 days of dredging.

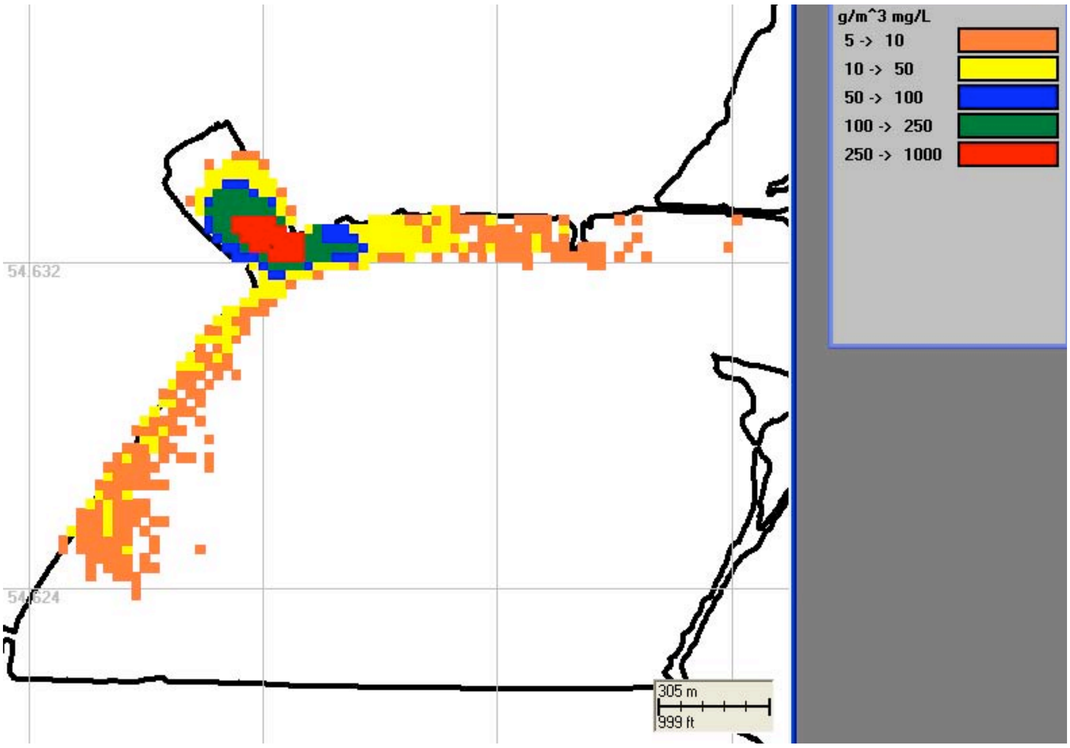


Figure 7-11 Backhoe dredging, Area 2, spring tide, max sediment concentrations mg/l.

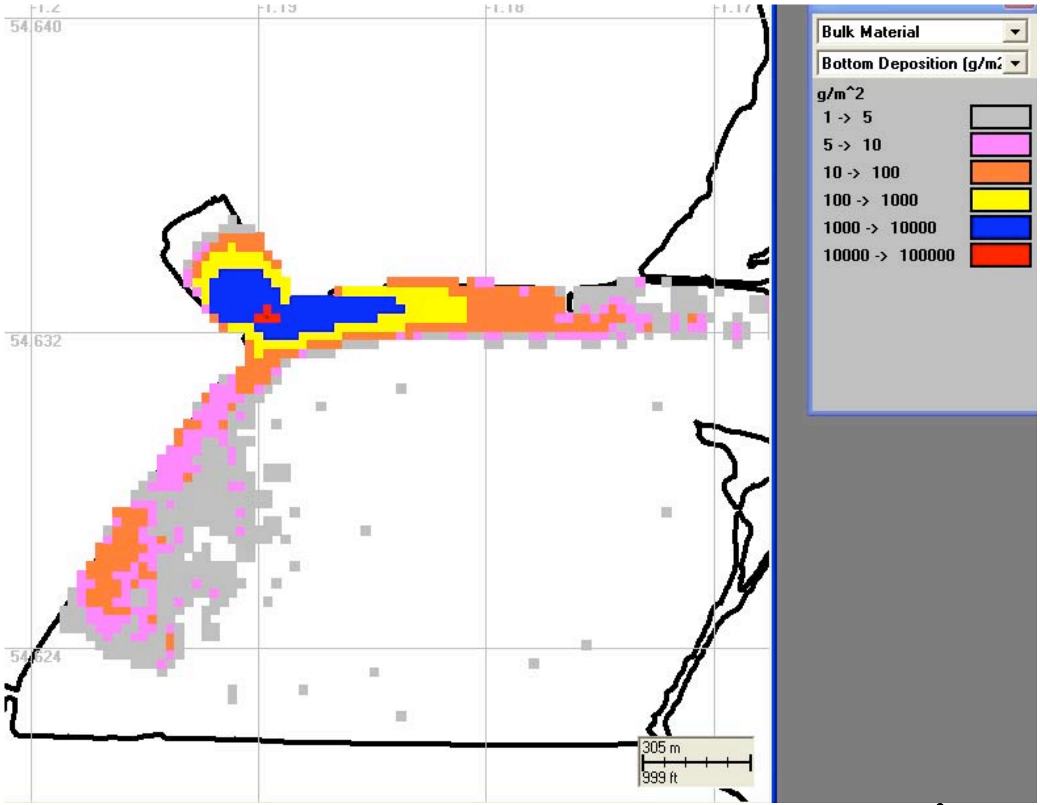


Figure 7-12 Backhoe dredging, Area 2, spring tide, sediment deposition g/m^2 after 2 days of dredging.

Results from dredging with a backhoe in Area #3 are shown in Figure 7-13 to Figure 7-16. Again, as would be expected, the spring tide plume is much longer (1100 m versus 350 m) and larger than the neap tide plume. Maximum concentrations are now less than 1000 mg/l very near the source for both plumes.

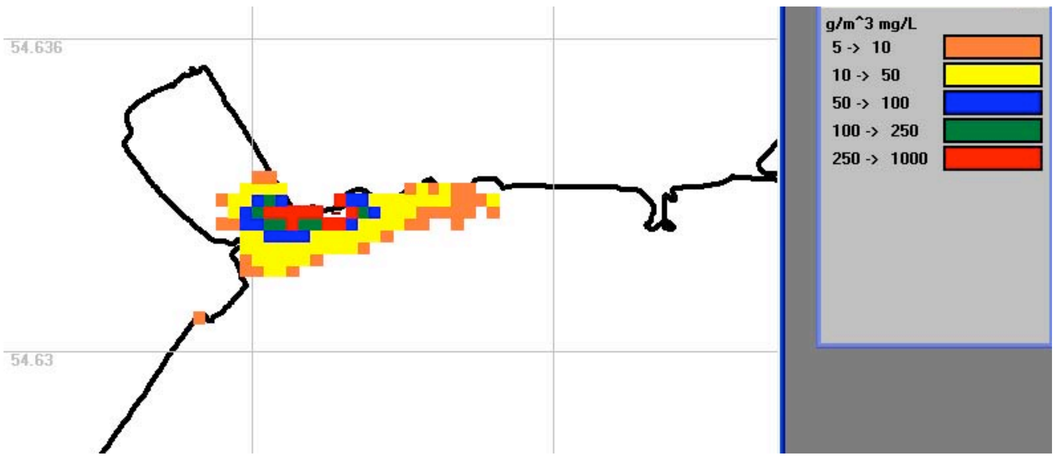


Figure 7-13 Backhoe dredging, Area 3, neap tide, max sediment concentrations mg/l.

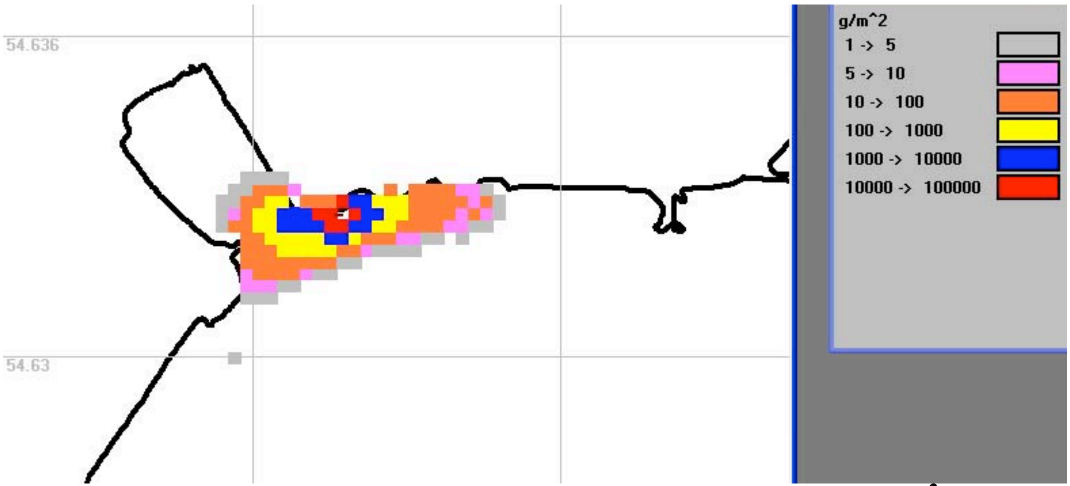


Figure 7-14 Backhoe dredging, Area 3, neap tide, sediment deposition g/m^2 after 2 days of dredging.

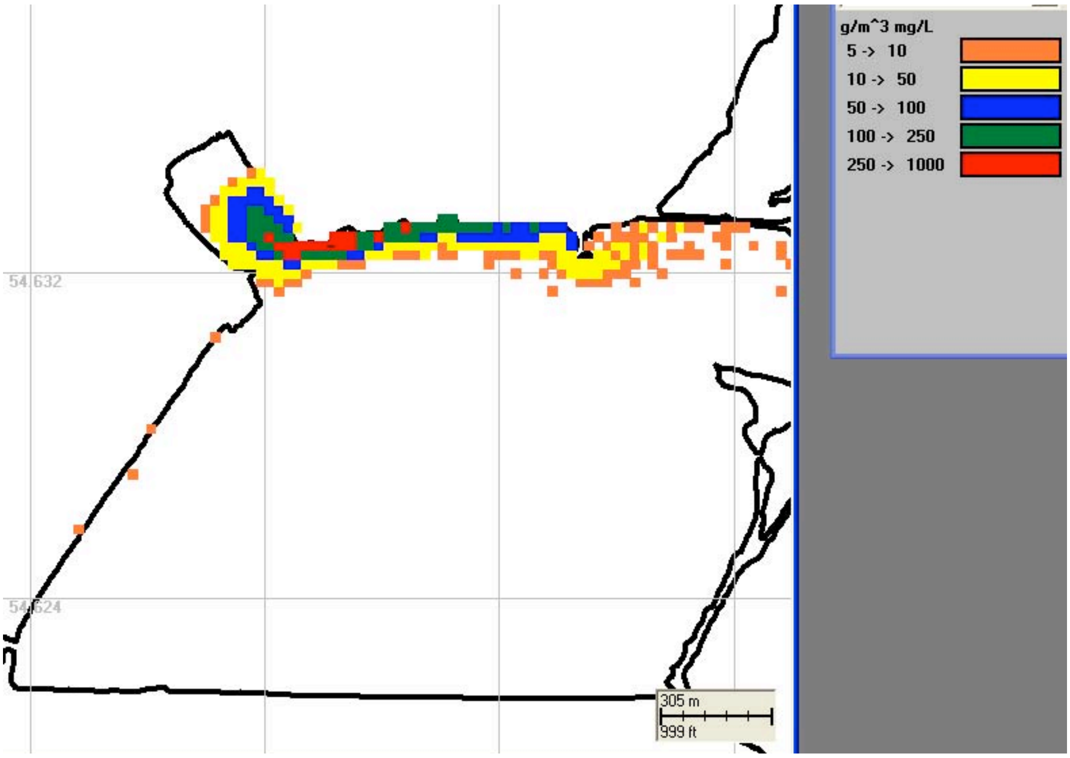


Figure 7-15 Backhoe dredging, Area 3, spring tide, max sediment concentrations mg/l.

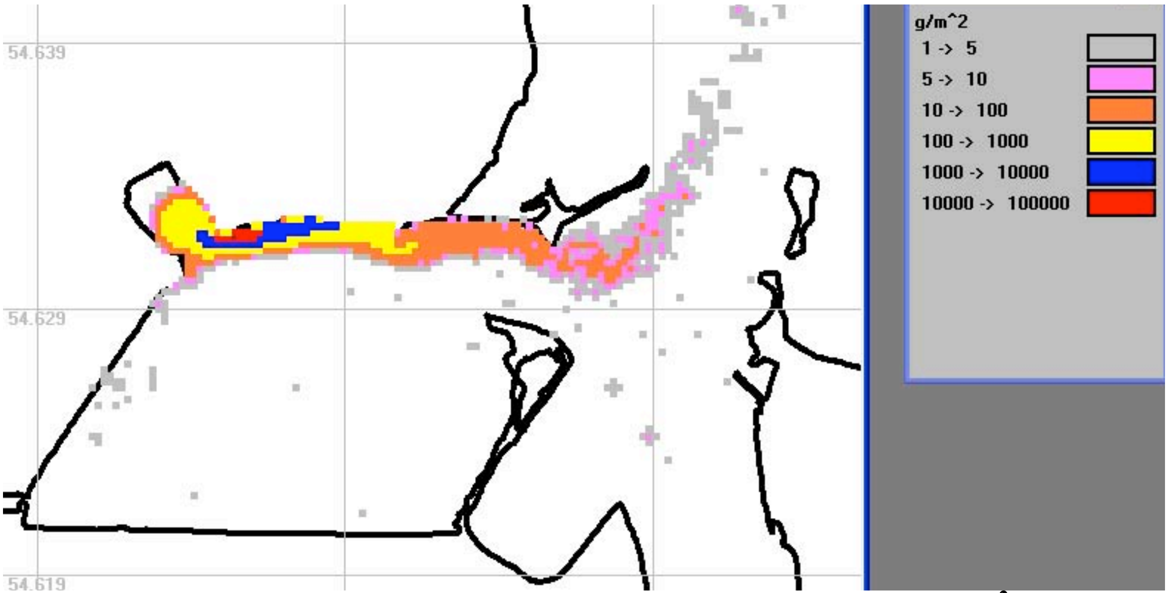


Figure 7-16 Backhoe dredging, Area 3, spring tide, sediment deposition g/m^2 after 2 days of dredging.

7.2 Hopper Dredge Results

Figure 7-17 and Figure 7-19 show the maximum concentration of suspended sediment plumes generated from the hopper dredging during a neap and spring tide, respectively. As for the backhoe dredge, the plume created during spring tide dredging is much larger than that created during a neap tide. Maximum concentrations are less than 1000 mg/l for both plumes along the dredging line. The spring tide suspended sediment plume extents all the way to the boundary of the RMA2 model grid. Some intrusion into the Tees River can be observed for the spring tide plume. Bottom deposition for both plumes is shown in Figure 7-18 and Figure 7-20, respectively.

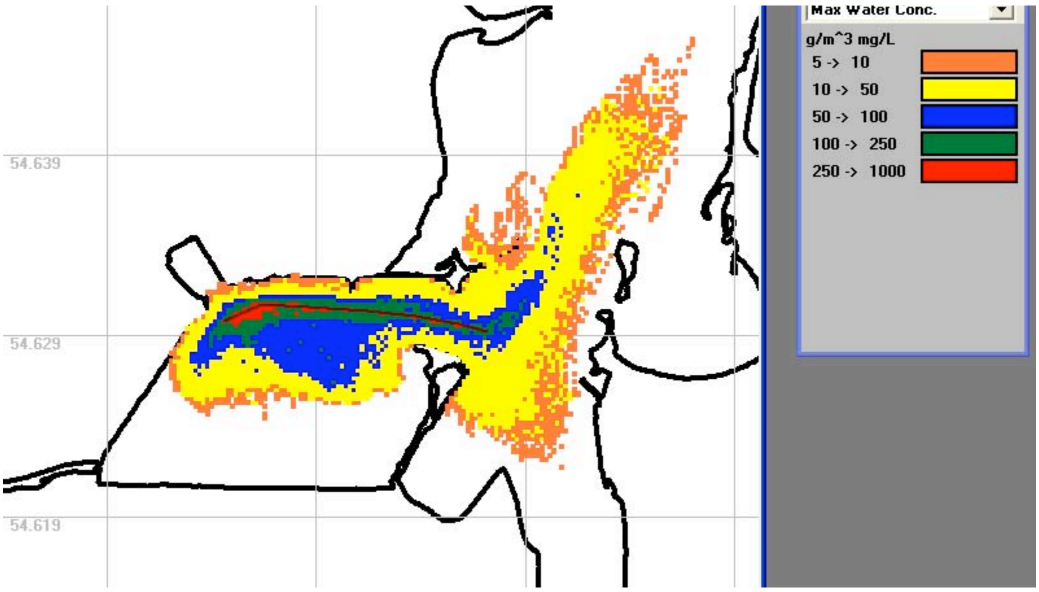


Figure 7-17 Hopper dredging, neap tide, max sediment concentrations mg/l

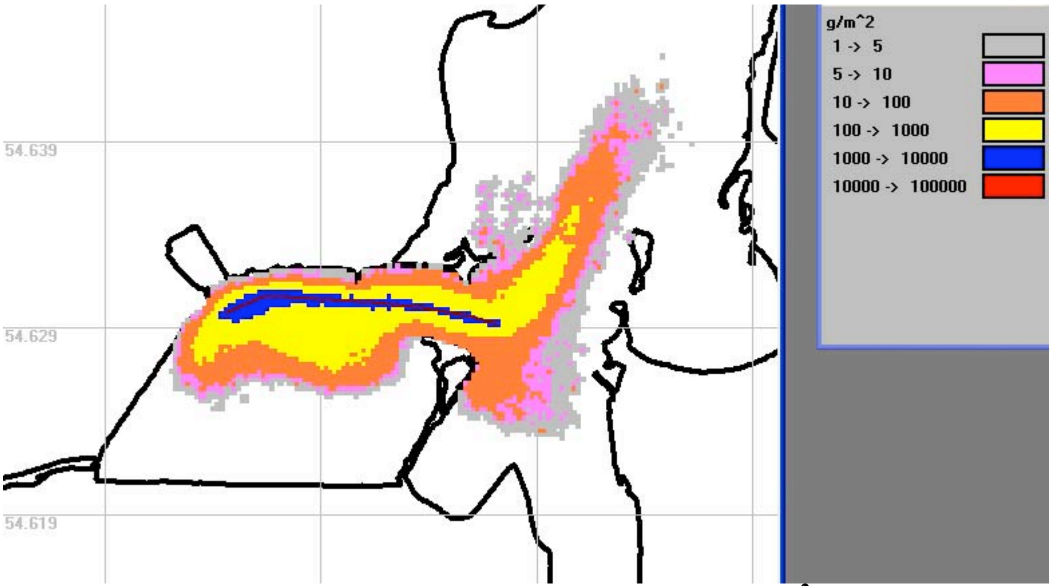


Figure 7-18 Hopper dredging, neap tide, sediment deposition g/m^2 after 2 days of dredging.

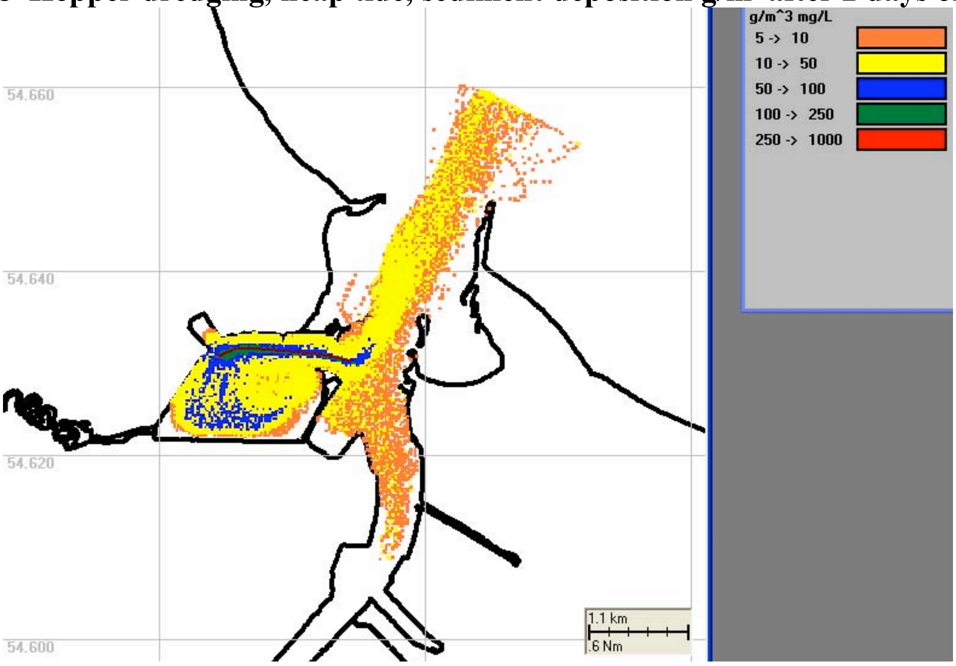


Figure 7-19 Hopper dredging, spring tide, max sediment concentrations mg/l

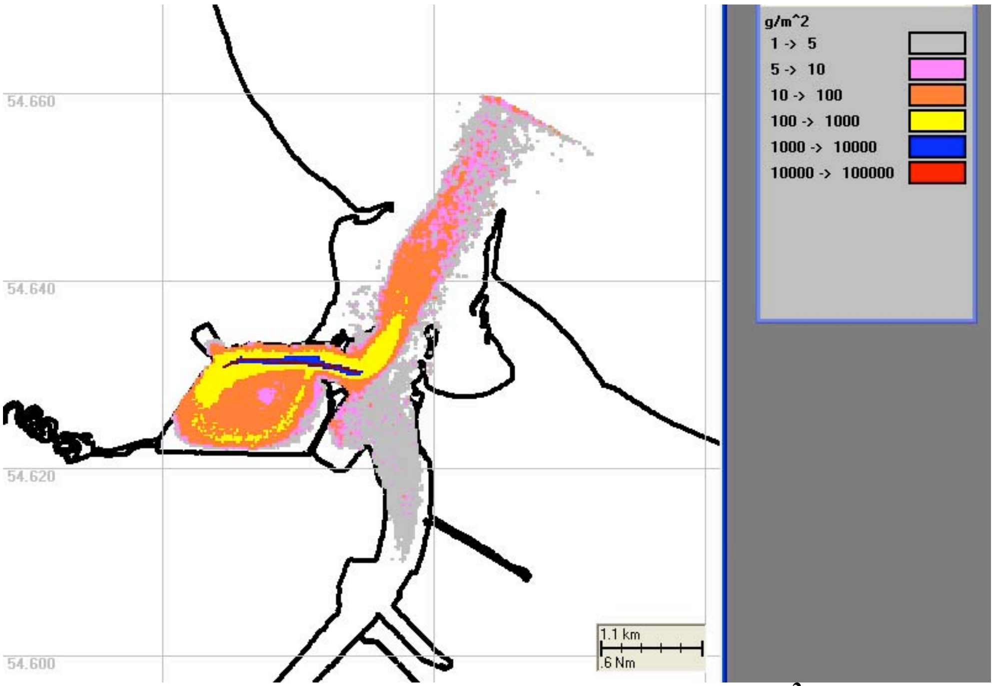


Figure 7-20 Hopper dredging, spring tide, sediment deposition g/m^2 after 2 days of dredging.

7.3 Backhoe and hopper dredges operating simultaneously

Figure 7-21 shows a superposition of the maximum concentration plumes when the hopper dredge and the backhoe dredge are both operating at the same time. It can be seen that little interaction occurs when the backhoe operates in Area #1. Some interaction does occur when Areas #2 and #3 are being dredged while the Seaton Channel is being dredged, but the interaction doesn't significantly increase the maximum concentrations of the suspended sediment plume generated from only one dredge operating at a time.

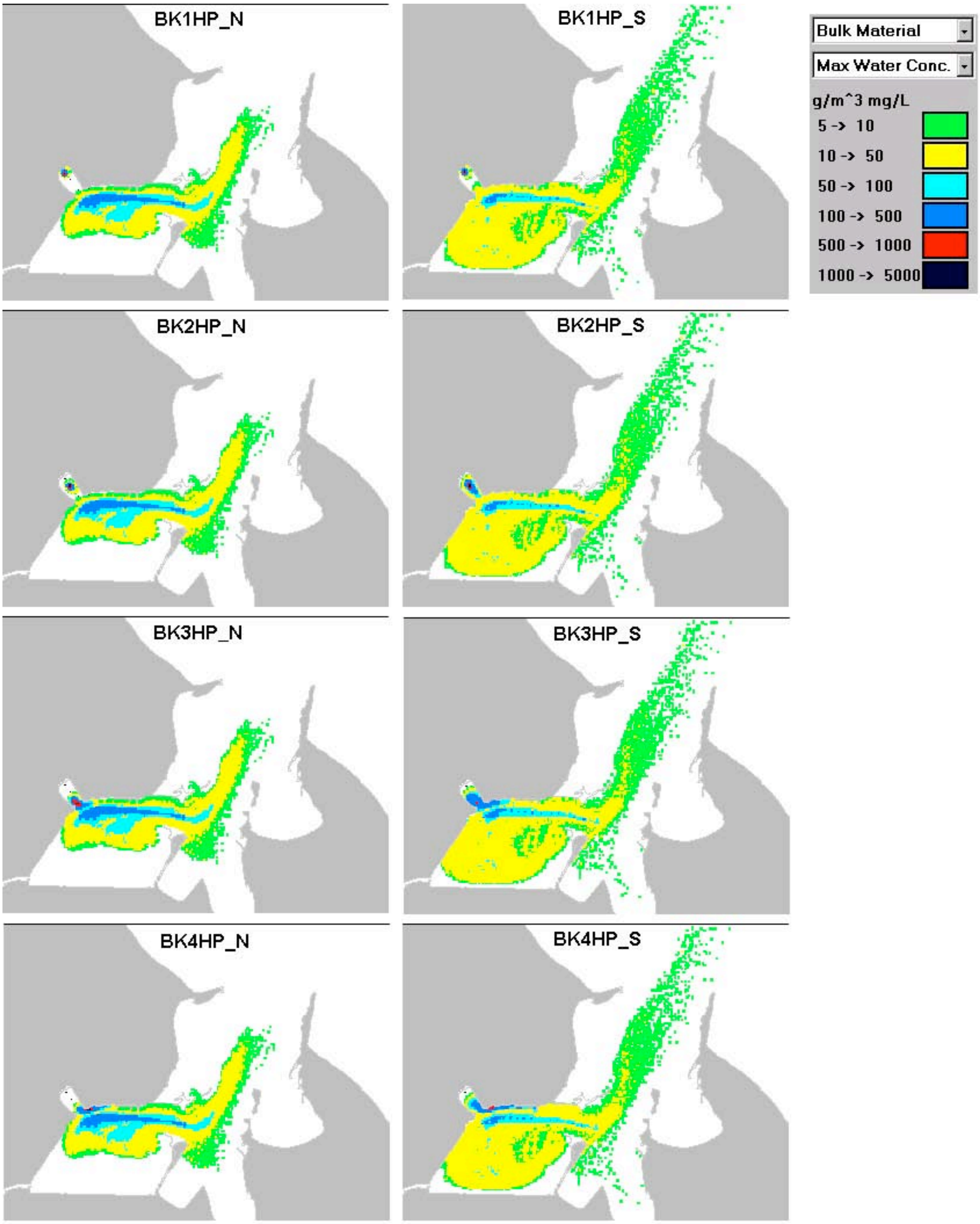


Figure 7-21 Superposition, max concentration plumes hopper operating in Seaton Channel and backhoe in dredging area 1 to 4 on neap (N) and spring (S) tides

8 DESCRIPTION OF NATURAL RESOURCES

8.1 Important areas

The Teesmouth NNR covers an area of about 355 ha on the northern side of the Tees Estuary. It comprises the North Gare Sands, Seaton Common and the Seal Sands mudflats. The North Gare has an extensive sandy beach and dunes protected by an artificial breakwater. During spring and summer, the dunes are studded with brightly-coloured flowers. Large numbers of wading birds, including Knot, are seen for much of the year. In winter Snow buntings are found in the sand dunes and Short-Eared Owls are occasionally seen hunting.

To the south lie the tidal mudflats of Seal Sand, the largest area of intertidal mud between the Humber estuary and Holy Island. Thousands of waders and ducks feed here during low tide and seals bask on sunny days. The Reserve boasts the only regular breeding colony of common seals on the north-east coast of England. The mudflats are too dangerous for human access.

COATHAM MARSH, REDCAR

Coatham Marsh is a 134 acre nature reserve established in 1982 by the Tees Valley Wildlife Trust on land leased from British Steel. The reserve comprises 50 acres of ancient marsh traversed by a freshwater fleet, which flows into the Tees at Bran Sands, and is bounded by 80 acres of grazed meadows, artificially created mounds and two freshwater lakes. The range of habitats and the reserve's proximity to the Tees Estuary has attracted over 200 species of birds and a rich diversity of flora. A 'scrape' (or pool) has been created on the west marsh to yield an additional feeding area for wetland birds, particularly during the migration periods in the winter.

Adjacent coastal habitats at Coatham Sands and the South Gare include nationally important sand dune habitats and are of international importance for bird life.

RAMSAR SITES

The Teesmouth and Cleveland Coast Ramsar are important for supporting substantial numbers of waterfowl, with about 1 % of the British population. The nearest Ramsar site to the north is the Firth of Forth and to the south the Humber Estuary.

8.2 Invertebrates, benthic fauna

The benthic community has three claims to importance for environmental monitoring. It is in close contact with the sediment, in and on which many pollutants accumulate (heavy metals, organic particles and some organic compounds). These contaminants can directly inhibit the growth or survival of the more sensitive species, thus reducing species diversity, abundance or biomass.

Secondly, the benthos provides the main food source for the more visible animals which exploit an aquatic habitat, such as wading birds and fish. It follows that the greater the productivity and biodiversity of the benthos in the Tees estuary, the greater will be the numbers and variety of birds and fish which it can support. Finally, the benthos can accumulate contaminants from its environment which may then be concentrated at higher levels in the food chain.

At least 90 species have been identified, with an average of 70 being present at any one time. Some of these, particularly the marine and estuarine worms, may be present at high densities.

There has been an unmistakable increase in the biodiversity of the estuarine macro fauna since 1979. The number of species present in any particular area tends to fluctuate from year to year, but over a period of time each area of the Tees estuary has become more biodiverse.

Nematodes are a major component of the benthic meiofauna. Historically, a few tolerant nematode species have dominated the communities present in the Seaton Channel sediments. The population densities of these species have declined as conditions have improved and the communities have usually increased in species richness with the appearance of more sensitive estuarine species.

8.3 Fish

There is no quantitative information available on the fish populations of Teesbay. The number of fish species present in the upper (tidal and brackish) regions of estuaries is naturally low. However, the potentially high benthic productivity within an estuarine environment can support a large biomass of fish coupled with a relatively low diversity of species.

Six groups of fish can be defined on the basis of their behaviour in estuaries:

- Freshwater fish that occasionally enter brackish water.
- Estuarine species that spend their lives in the estuary.
- Migratory species (Eel, Salmon, Sea trout)
- Marine species that pay regular seasonal visits to the estuary (usually as adults)
- Marine species that use the estuary primarily as nursery ground
- Opportunistic visitors that appear irregularly and with no apparent necessity to do so

The Tees estuary is an important habitat for many fish species for different reasons. The estuary provides a large sheltered area of shallow water exploited by juvenile fish such as plaice which graze the intertidal and sub-tidal benthic invertebrates. It also provides a potentially productive source of epibenthic invertebrates which feed juvenile and adult demersal fish. Finally, the estuary is an extensive area through which migratory fish must move between the sea and the freshwater reaches of the Tees.

The Tees estuary has three fish communities that can be recognised.

- The Coastal and Lower estuary communities- represented by the largest number of species, both inshore fish and invertebrate species such as Red Gurnard, Dragonet, Pink Shrimp, Edible Crab, and more typical estuarine residents such as the Viviparous Blenny (eelpout) and Flounder.
- The Middle estuary communities- dominated by fewer species such as Dab and Plaice. Also, in the case of the Tees estuary, those versatile species able to tolerate stressful conditions e.g. Flounder, Brown shrimp and Shore Crab.
- The upper estuary communities- fewer species, limited to fish such as eel and flounder which are able to tolerate low salinities- from brackish water to freshwater. Intrusion by freshwater fish in the uppermost tidal reaches, e.g. Dace, Eel and Roach.

Changes in fish populations with time are difficult to detect with the relatively small trawl samples from the Tees area.

8.4 Birds

The coastal marshes and intertidal mudflats of the Tees estuary support populations of waterbirds which are of national and international importance. The Teesmouth area supports populations of a lot of different species of waders, including Ringed Plover *Charadrius hiaticula*, Knot *Calidris canutus*, Redshank *Tringa totanus*, Sanderling *Calidris alba*, Lapwing *Vanellus vanellus*, Dunlin *Calidris alpine*, Bar- tailed Godwit *Limosa lapponica* and Curlew *Numenius arquata*.

The site comprises mudflats that are of great ornithological importance attracting large numbers of migratory wildfowl birds. Of internationally importance is Shelduck *Tadorna tadorna.* In addition, sizeable flocks of Mallard *Anas platyrhynchos*, Teal *Anas crecca*, Wigeon *Anas Penelope*, Pochard *Aythya ferina*, Goldeneye *Bucephala clangula* and Tufted Duck *Aythya fuligula* congregate to roost and feed during cold spells. Different species of Gulls and two species of tern, Common Tern *Sterna hirundo* and Little Tern *Sterna albifrons*, nest regularly around the Tees Estuary and several other Terns are regular visitors. All are migrants.

Total wader populations are generally greater on larger estuaries, whereas bird densities are greater on smaller estuaries. Teesmouth has followed the general trend with wading bird densities increasing as the remaining area of mudflats decreased. Food availability is a major factor in the ability of the estuary to support a large and diverse waterbird population. The birds need a minimum daily energy intake to survive. This means that there must be adequate sustainable populations of invertebrate prey. These prey items in turn are dependent on such parameters as the particle size of the mudflat substrate, pollution levels, its exposure, food availability and salinity.

Another change which has possibly affected Dunlin feeding areas is the increasing firmness of the sediments and increase in coverage of green algae, especially *Enteromorpha* over parts of Seal Sands. Dunlin seldom feed on algae-covered areas (/30/).

Despite the recent decline in Knot populations at Teesmouth, the five-year average of maximum counts is still above the accepted international level.

Although land claim in the 19th an early 20th century almost certainly reduced water-bird populations by eliminating their habitat, since 1960 man has directly had only a limited detrimental effect on the bird populations of the Tees estuary. In contrast, industrial sites have provided formerly limiting habitat requirements for a number of bird species.

8.5 Seals

Two species of seal are common in the Tees area, the Common Seal *Phoca vitulina* and the Grey Seal *Halichoerus grypus*. The Common Seal frequents estuaries and sheltered coastlines hauls out on sandbanks on a falling tide and pups in June or July on intertidal sandbanks. The Grey Seal tends to frequent rocky coast, but may also haul out on sandbanks. Grey Seals tend to be wide ranging but Common Seals usually feed close to their haul-out sites. Data from INCA show a steady increase in the seal population during the last 15 years. In the last 5 years the Common Seal population have been steady with small fluctuations. Each year Common Seal pups are born on Seal sands and successfully weaned.

Table 8-1 Maximum numbers of Common Seals, Common Seal pups and Grey Seals recorded on Seal Sand from 1999- 2003.

Year	No. of Common Seal	No. of Common Seal pups	No. of Grey Seal
1999	56	5	28
2000	70	4	27
2001	71	5	27
2002	71	6	30
2003	58	5	26

8.6 Contamination in the study area

8.6.1 Definitions

MPC — Maximum Permissible Concentration. Concentration above which the risk for the ecosystem is considered unacceptable, i.e. a concentration above which more than 5% of the species in the ecosystem might be affected (/20/).

NC — Negligible Concentration. Concentration below which the risk of the ecosystem is considered negligible (/20/).

ISQG — Interim Sediment Quality Guidelines according to the Canadian Environmental Quality Guidelines (/21/). Concentration below which the risk of the ecosystem is considered negligible.

PEL — Probable Effect Level according to the Canadian Environmental Quality Guidelines (/21/).

Acceptable risk limit — Concentration above which the risk for the ecosystem is considered unacceptable, i.e. a concentration above which more than 5% of the species in the ecosystem might be affected (/24/).

8.6.2 Contamination level

The level of contamination in the dredging areas and at Seals Sand has been mapped and compared with international sediment quality standards. Levels have been mapped for several metals (Ar, Cd, Cr, Cu, hg, Ni, Pb and Zn), PCBs, PAHs and TBT in dredging area 1 to 4 (see Appendix A, Appendix B, Appendix C and Appendix D. On Seals sand the level of metals mentioned above have been mapped.

The sediment quality standards that have been used for metals, PCBs, PAHs and TBT are presented in Table 8-2, Table 8-3,

Table 8-4 and Table 8-5 respectively. Concentrations of contaminants are generally below recommended risk limits for effects on the ecosystem. The exceptions are for the following PAHs: benzo(a)pyrene, Acenaphthylene, Anthracene and Benzo(a)anthracene (see Appendix D). These PAHs are found in concentrations that exceeds the Probable Effect Level (PEL) according to the Canadian Environmental Quality Guidelines (/21/).

Table 8-2 Maximum Permissible Concentrations (MPC) and Negligible Concentrations (NC) for metals in sediments (/20/). Values are given in mg/kg in standard sediments (10% organic matter and 25% clay).

Metals	MPC mg/kg	NC mg/kg
Arsenic (Ar)	190	31
Cadmium (Cd)	30	1,1
Chromium (Cr)	1720	116
Copper (Cu)	73	36
Iron (Fe)		
Mercury (Hg)	26	0,56
Nickel (Ni)	44	35
Lead (Pb)	4800	132
Zink (Zn)	620	145

Table 8-3 Maximum Permissible Concentrations (MPC) and Negligible Concentrations (NC) for PCBs in sediments (/23/).

PCB	MPC µg/kg o.c.	NC µg/kg o.c.	Acceptable risk limit µg/kg
CB#105	26	0,26	
CB#118	25	0,25	
CB#153	151	1,51	
CB156	55	0,55	
Planar PCBs (CB#118)	5	0,05	

Table 8-4 Probable Effect Level (PEL) and Interim Sediment Quality Guidelines (ISQG) for PAHs in sediments according to the Canadian Environmental Quality Guidelines (/21/). Values are given in mg/kg dry weight.

PAH	PEL mg/kg	ISQG mg/kg
Acenapthene	0,0889	0,00671
Acenapthylene	0,128	0,00587
Anthracene	0,245	0,0469
Benzo(a)anthracene	0,693	0,0748
Benzo(a)pyrene	0,763	0,0888
Chrysene	0,846	0,108
Dibenz(a,h)anthracene	0,135	0,00622
Fluoranthene	1,494	0,113
Fluorene	0,144	0,0212
Naphthalene	0,391	0,0346
Phenanthrene	0,544	0,0867
Pyrene	1,398	0,153

Table 8-5 The acceptable risk limit for TBT is proposed by Breedveld (/24/). Values are given in µg/kg dry weight (sediments with 1% organic carbon).

Organotins	Acceptable risk limit, µg/kg
TBT	35

9 IMPACT ON SHIP MOVEMENTS

See Section 3.2 above regarding maintenance dredging of Seaton Channel including the holding basin, and the dry dock.

In order to ensure safe navigation for ships, changes in channel geometry should be monitored regularly. In order to maintain depths as described in Section 3.1, an estimated 23,000 m^3 must be dredged annually from Seaton Channel and the holding basin. The dry dock, when open, requires dredging of a further 12,500 m^3.

The sedimentation rate in Seaton Channel, the holding basin and the dry dock may rise when the bed level is lowered. Lower water velocities and shear stress will promote settling and reduce any erosion. It is also possible that finer sediments settle upstream, and Seaton Channel may act as a sand trap for sand currently reaching Seal Sands from North Gare Sands /2/.

Any vessel entering the channel must have at least 0.5 m under keel clearance /19/. Figure 4-3 shows levels of Mean High Water Spring 5.5 m LAT and Mean High Water Neap (4.3 m LAT).

At present, the depth in Seaton Channel is -3.5 m LAT /19/. At Mean High Water Spring a vessel with draft

$$3.5 + 5.5 - 0.5 = 8.5 \text{ m}$$

may enter the channel. Assuming the level in the holding basin is the same as in the channel, however, the vessel must satisfy 0.5 m under keel clearance at the Lowest Astronomical Tide (LAT = O), such that the maximum draft for mooring vessels in the Holding Basin at present is

$$3.5 + 0 - 0.5 = 3.0 \text{ m}$$

Seaton Channel is proposed dredged to -8.5 m LAT, such that a vessel with draft

$$8.5 + 5.5 - 0.5 = 13.5 \text{ m}$$

may pass at Mean High Water Spring.

The Holding Basin is proposed dredged to -9.5 m, such that a vessel with draft

$$9.5 + 0 - 0.5 = 9.0 \text{ m}$$

may be anchored there at the Lowest Astronomical Tide.

Quay 10 and 11 are proposed to be dredged to -12 m LAT, such that a vessel with draft

$$12.0 + 0 - 0.5 = 11.5 \text{ m}$$

may be moored there at the Lowest Astronomical Tide.

The dry dock is proposed dredged to -6.65 m LAT, so that a vessel with draft

$$6.65 + 5.5 - 0.5 = 11.65 \text{ m}$$

may be floated in at the Mean High Water Spring, provided it can be positioned such that it is not damaged creating a hazard when the high water recedes. If securing of the vessel will take considerably longer, it may be floated in at Mean High Water Neap and must have a draft of

$$6.65 + 2.0 - 0.5 = 8.15 \text{ m}$$

in order to stay safely afloat for securing during Mean Low Water Neap. A vessel with draft

$$6.65 + 0 - 0.5 = 6.15 \, m$$

may be moored in the dry dock during the Lowest Astronomical Tide.

In short, after the proposed modifications to the channel and dry dock, a vessel with draft 11.5 m may be towed in Seaton Channel at Mean High Water Spring, be moored at Quay 10 or 11 during the Lowest Astronomical Tide for partial dismantling, and may be floated into the dry dock at Mean High Water Spring provided the vessel can be positioned and secured safely to chocks at the sea bed immediately before the high water recedes.

10 DISCUSSION

10.1 Sediment transportation

The hydrodynamic and sediment transportation processes predicted by the computer model has been discussed in Section 5.3 above, but is recapitulated here, expanded with considerations related to other natural processes not included in the computer model.

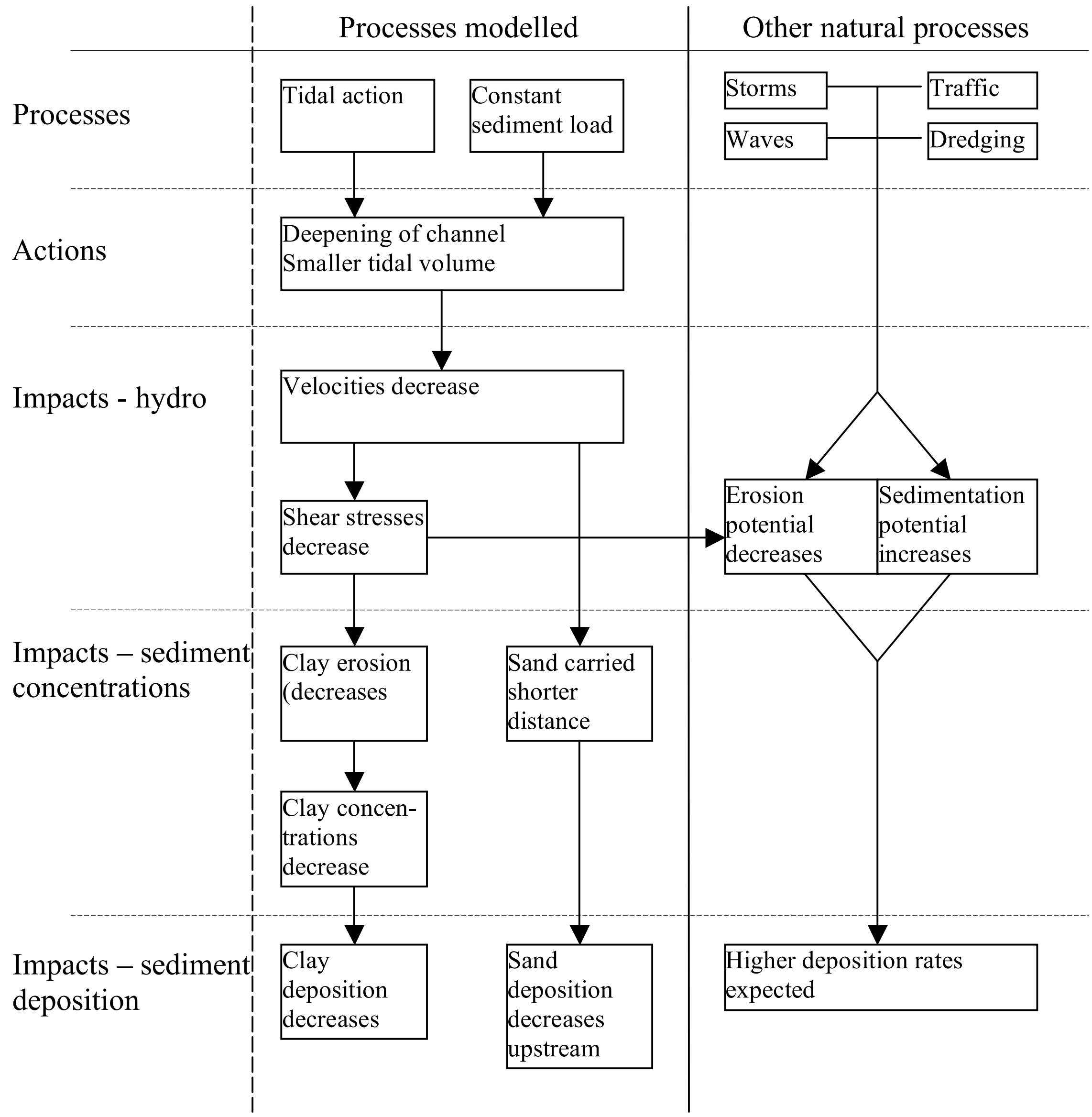


Figure 10-1 Expanding dynamics of model to other natural estuarine processes

The hydrodynamic and sediment transportation processes predicted by the computer model has been discussed in Section 5.3 above, but is recapitulated here, expanded with considerations related to other natural processes not included in the computer model.

The hydrodynamic model predicted lower velocities in certain areas due to lower tidal volume when closing the dry dock, and due to a larger cross-sectional area in which to convey the tidal volumes when the channel bed was lowered. A corresponding decreased shear stress was found to decrease (false) erosion, with lower concentrations of clay in the water column and ultimately lower deposition of clay in general. Sand was found not to be affected to a great degree, if anything it was not carried so far upstream.

The decrease in velocity, and as a result a decrease in shear stress, will decrease the potential for erosion, and increase the potential for sedimentation. Although little or no clay sediments are present in the high shear areas, as the model shows, if clay is introduced it will probably erode. The potential for erosion is there, but will decrease. Correspondingly, the potential for sedimentation will change. Even if no sediment is present in the water column, the potential for deposition increases with decreasing shear stress. This increase in sedimentation potential is not correctly presented in the modelling results, as the decrease in erosion decreases the amount of sediment available in the water column for deposition.

See Figure 10-1 when considering other natural sediment sources and processes in the estuary, the sedimentation pattern may change. Suspended sediment is in reality not only introduced by tidal processes, but also from more unpredictable events like storms, wave erosion, local sedimentation patterns, traffic and dredging. Dredging operations, as modelled in Section 7 above, produce far higher concentrations of suspended sediment that, dependent on the tidal condition, may extend considerable distances. Indeed, dredging of the Tees estuary is a “continuous operation” /2/, so higher concentrations of suspended sediment may be expected over time, see Figure 5-2 and Figure 5-3.

As the sedimentation potential increases, the suspended sediments not considered in the computer model will take advantage of this potential and settle in areas where the shear stress is lowered, see Figure 5-14. Seaton Channel, and to a lesser extent Seal Sands, may experience a higher sedimentation rate.

The sediment “fractions” may also change from sand to finer sand, silt and clay. The boundary for where clay and silt can be present will probably be shifted downstream.

More sand may be trapped in Seaton Channel, stemming the present migration of sand to Seal Sands, which has been identified as a possible cause of loss of bird feeding capacity /2/.

It is important to realise that the Seaton Channel with Seal Sands, the TERRC dry dock and Greatham Creek form a semi-closed hydrodynamics and sediment “sub-cell” within the Tees estuary. The artificial barriers at the north of Seaton Channel and at the east of Seal Sands enclose the bay and all water and sediment interchange has to come through a relatively narrow channel. Seaton Channel and Seal Sands receive sediments largely from North Gare Sands and the sea /3/.

It is seen that the hydrodynamic characteristics and corresponding sediment transportation processes are influenced to some within the bounds of Seaton Channel. Out with the bounds of Seaton Channel the hydrodynamics and sand transportation regime are unchanged.

10.2 Dredging

It is believed that for the assumptions made concerning the sediment source strengths and grain size fractions SSFATE computations realistically represent suspended sediment plumes that will be generated by the two dredging operations; namely, a backhoe and a hopper dredge. Maximum total suspended sediment concentrations can exceed 1000 mg/l for the backhoe dredge, but are less for the hopper dredge. In all cases, the concentrations drop off quickly away from the dredge.

The size of the sediment plumes are significantly larger when dredging during a spring tide versus dredging during a neap tide. The size of the plumes generated by the hopper dredge can be an order of magnitude larger than those generated by the backhoe.

For the case of both dredges operating simultaneously, there will be little interaction of the suspended sediment plumes when the backhoe is operating in Area #1. However, some interaction will occur when dredging Areas #2 and #3 with a backhoe with the hopper dredge operating at the same time.

Some of the released sediments for both the backhoe and the hopper dredge are transported into the shallow areas south of the Seaton Channel. There is very limited intrusion of sediments into the Tees River for any of the scenarios simulated. However, during the ebb portion of a spring tide, suspended sediments can be transported out to the sea as a result of the hopper dredge activity.

10.3 Impact on marine life

10.3.1 Impact of changes in hydrodynamics and sediment transportation

As described above in chapter 10.1 the different scenarios that have been modelled predicted lower water velocities and a corresponding decrease in shear stress within the bounds of Seaton Channel. As a result of this the potential for erosion decreases and the potential for sedimentation increases in this area. Outward the bounds of Seaton Channel the hydrodynamics and sediment transportation regime are not significantly changed.

At the same time it can be seen from the model runs that the maximum shear stress is below 0.1 N/m^2 on Seal Sands, in the inner reaches of Seaton Channel, and on most mudflats. This means that the shear stress magnitude on Seal Sands is below the values required to initiate erosion, and also low enough for both sand and clay to deposit. In Seaton Channel, especially in the lower parts, the shear stress is high (above 0.5 N/m^2) at high water velocities and silt/clay will probably not deposit over long periods.

The modelling results also show lower maximum and average clay concentrations in the water column within the bounds of Seaton Channel, and lower annual deposition rates for clay compared to baseline. The changes in sand concentrations and deposition rates are very limited. This means a total reduction in average sediment concentration and annual deposition rates, but also a proportionate increase in the percent of sand and larger fractions in the total sediment load. The reality in these results can be questioned as several other processes as storms, waves, traffic and dredging contribute to the sediment load in the water column and thereby the annual deposition rates of both clay and sand. Looking at the contribution to the sediment load in the water column from the proposed dredging operations these are by far dominating compared to the sediment loads generated from the natural processes that were modelled. As the heavier fractions are settling out relatively quickly, the silt and clay fractions are those that are contributing to the increased sediment loads over the largest areas. Dredging is taking place almost continuously in the Tees estuary due to i.e. maintenance dredging. As a result of this it is very difficult to conclude on the effects of changes in sediment load and deposition rates due to the modelled changes in hydrodynamics. But in general changes in sediment concentrations and annual deposition rates as predicted in the model will not have significant effects on the benthic fauna that are an important food source for both fish and birds. A general reduction in annual deposition rates may have positive effects by slowing down the accretion of sediments on Seal Sands that has been observed since the 1970ties (/1/ and /2/).

Based on the reduced potential for erosion and an increased potential for sedimentation, especially in the outer parts of Seaton Channel, it is possible that the sediment trapping efficiency of Seaton Channel will increase. This was also predicted by HR Wallingford (/2/). The sediment trapping efficiency in this area will increase for the larger fractions as sand due to the generally high shear stress in the area. This may decrease the amount of sand entering into the inner parts of Seaton Channel and Seal Sand and thereby have a positive impact on the sedimentation regime at Seal Sands, as bird feeding conditions on Seal Sands have been deteriorating due to the more recent accretion of sand fractions (/2/).

10.3.2 Impact of dredging operations

Maximum concentration of sediments in the water column within the bounds of Seaton Channel predicted by the modelling of the hydrodynamics was 22 mg/l. The average sediment concentrations in the baseline and after any modelled scenario, was in the range from 2-8 mg/l within the bounds of Seaton Channel. The dredging operations are modelled to yield sediment concentrations up to 1000 mg/l close to the source of the plume, but the concentrations drop quickly below 100 mg/l as the heavier fractions settles out. These results show that the sedimentation regime and the sediment load in the water column within the bounds of Seaton Channel will be dominated by the dredging operations as long as these are undertaken.

The backhoe dredging operations generally affect Seaton Channel, both the inner and outer parts, but mainly on the north side of the channel. Areas affected by sediment concentrations above 50 mg/l are limited.

The hopper dredge operation will affect both inner and outer parts of Seaton channel, the whole of Seal Sands and parts of Tees river. In large areas of Seaton Channel the sediment concentrations will be between 50-100 mg/l. Centrally in the channel the concentrations will be over 100 mg/l and up to 1000 mg/l. On Seal Sands the dredging operations are modelled to yield concentrations up to 100 mg/l in the water column, but in general the sediment concentrations are modelled to be in the range of 10-50 mg/l. For the case of both dredges operating simultaneously, there will be little interaction of the suspended sediment plumes when the backhoe is operating in dredging Area 1. However, some interaction will occur when dredging areas 2 and 3 with a backhoe with the hopper dredge operating at the same time. But the interaction doesn't significantly increase the maximum concentrations of the suspended sediment plume generated from only one dredge operating at a time.

Different species of fish have a varying ability to withstand high concentrations of inert suspended material. Experiments with marine fish have shown that demersal fish are more tolerant whereas filter feeding species are more sensitive. (/28/). Hessen (/24/) concluded that fish, focusing on trout, can withstand considerable acute particle exposure (~1000 mg/kg) without effects like higher mortality or gill damage occurring. But in marine waters several species of fish have been observed to avoid areas of high particle concentrations (/25/). The high concentrations of sediments in the water column during the dredging operations may cause resident and/or migratory fish species to avoid Seaton Channel in this period.

Common Seal and Grey Seal are not believed to be directly affected by the increase in sediment concentrations in the water column (/27/), but may be indirectly affected if fish is avoiding the area. The area affected by the increased sediment concentrations is in general limited to Seaton Channel and Seal Sands. Grey Seals tend to be wide ranging in their search for food and are not believed to be significantly affected by fish avoiding this area. Common Seal usually feed closer to their haul-out sites. But studies show that Common Seal have 95% of their activity within an area of 10 km^2, and that the size of their home range is dependent on where the seals normally find their food and weather conditions (restricted movement during periods of bad weather). If there are other areas than Seaton Channel where the food availability is sufficient within their home range, as is most probably the case here, the Common Seal is not believed to be directly or indirectly affected by the increased sediment concentrations. Effects of noise and visual disturbance are not evaluated in this report.

Dredging area 4 and 5 with the hopper dredge will lead to a significant increase in sediment load in the water column in Seaton Channel and on parts of Seal Sand. As the more coarse particles are settling out quickly, the sediments load affecting Seal sands will mainly be finer sediments as silt and mud. The deposition rate on Seal Sands will generally be in the range of 5-50 gram/m^2 per day (see Figure 7-18 and Figure 7-20). After 12 weeks of dredging this is equivalent to 420-4200 g/m^2. Only the lighter fractions of the sediments are anticipated to deposit on Seal Sands. These findings support the results in (/1/) where the authors describe a trend towards finer sediments on Seal sands, possibly from dredging operations. Dredging operations in general always have an impact on the benthic fauna. The fauna in the dredging areas are removed and the fauna in areas of high sedimentation due to the dredging operations are disturbed, significantly in the near proximity of the operation. Close to the operation where the deposition rates are high, the fauna will most probably be buried by the depositing sediments. Further away the fauna will be disturbed. Re colonization of less disturbed areas are normally a relatively rapid process, whereas re colonization of the central parts of Seaton Channel will take longer time. It can be anticipated that the fauna at Seal sand will be disturbed by the increased deposition rates, but it is difficult to say to which degree. To do this it is necessary to have a good knowledge of the existing fauna. As dredging operations have been going on in the area for several years it is probable that the fauna reflect these type of disturbances both in Seaton Channel on possibly on Seal Sands.

Concentrations of several metals (Ar, Cd, Cr, Cu, hg, Ni, Pb and Zn), PCBs, PAHs and TBT in dredging area 1 to 4 has been mapped and compared against international recognised risk limits for effects on the ecosystem. The concentrations of contaminants are generally below recommended risk limits for effects on the ecosystem. The exceptions are for the following PAHs: Acenaphthylene, Anthracene, Benzo(a)anthracene and Benzo(a)pyrene (see Appendix D). This means that there is a high probability of effects on the ecosystem due to the measured PAH contamination. For the above mentioned PAHs, levels above the risk limit have been observed in all dredging areas (bulk samples), generally from the surface down to 1 m sediment depth. Five meters down in the sediments the level of contamination is below the risk limit for effects on the ecosystem. The risk limit is only slightly exceeded for Benzo(a)anthracene, by a factor of max

1,2 for Benzo(a)pyrene, by a factor of max 1,9 for Acenaphthylene and by a factor of max 14,2 for Anthracene. These very high levels of Anthracene are only found in the surface layer of the sediments. Further down (0.5 m and 1 m) the level only exceeded the risk limit by a factor of max 1,7. High levels of Anthracene is generally associated with petroleum related sources, whereas Benzo(a)anthracene and Benzo(a)pyrene are associated with combustion of fossil fuels (/29/).

It is not known whether the high levels of Acenaphthylene, Anthracene, Benzo(a)anthracene and Benzo(a)pyrene in the bulk samples is due to a generally high level in all dredging areas or if only specific areas have these high levels. Nor is it known if the levels of these PAHs also are generally high in Seaton Channel and Seal Sands sediments. The dredging operations will contribute to the spreading of PAH contaminated sediments that have concentrations that exceed the ecosystem risk limit. Data on sediment concentration of organics are however sparse, and nothing is known about the concentration of organics in the areas the sediment will be transported to, for example Seal Sand. Shellfish and other invertebrates generally accumulate PAHs and thereby contribute to the exposure of animals that feed on these organisms. Animals higher up in the food chain, like fish, birds and seals, have the ability to metabolise these compounds and thereby reduce the chance of significant effects.

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/30/ Prater, A.J. 1981. Estuary Birds of Britain and Ireland. Poyser, Calton.

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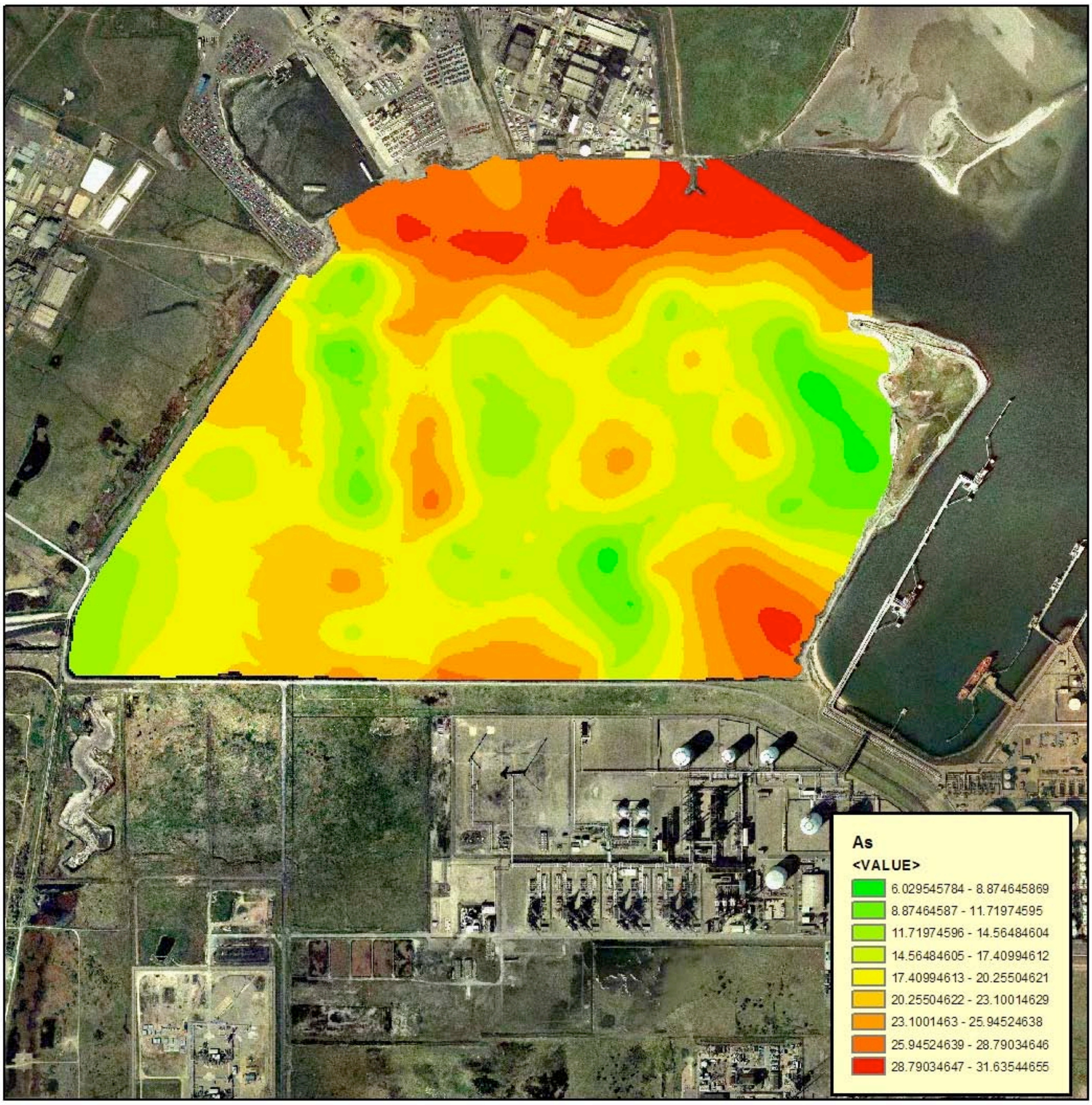
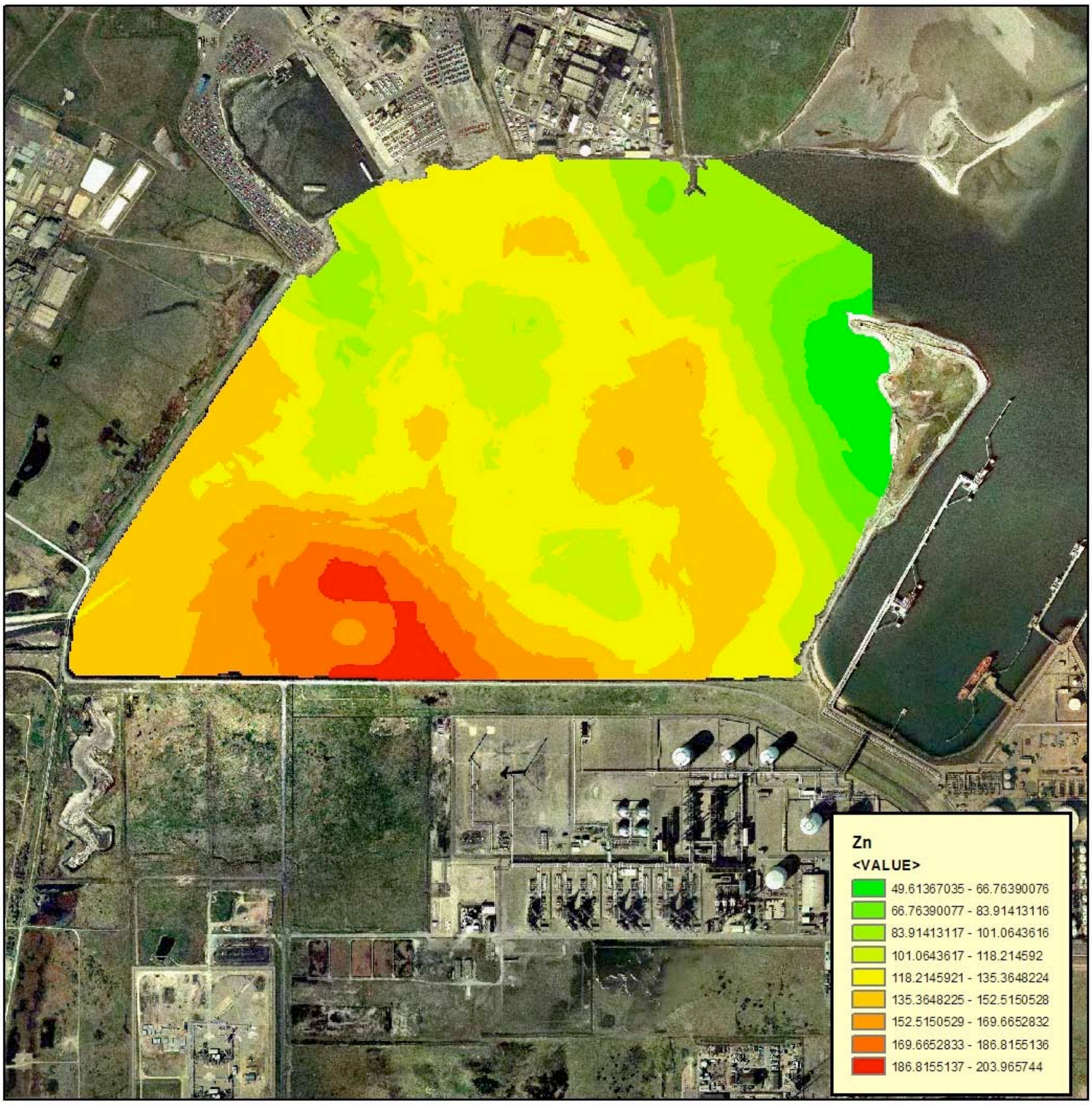
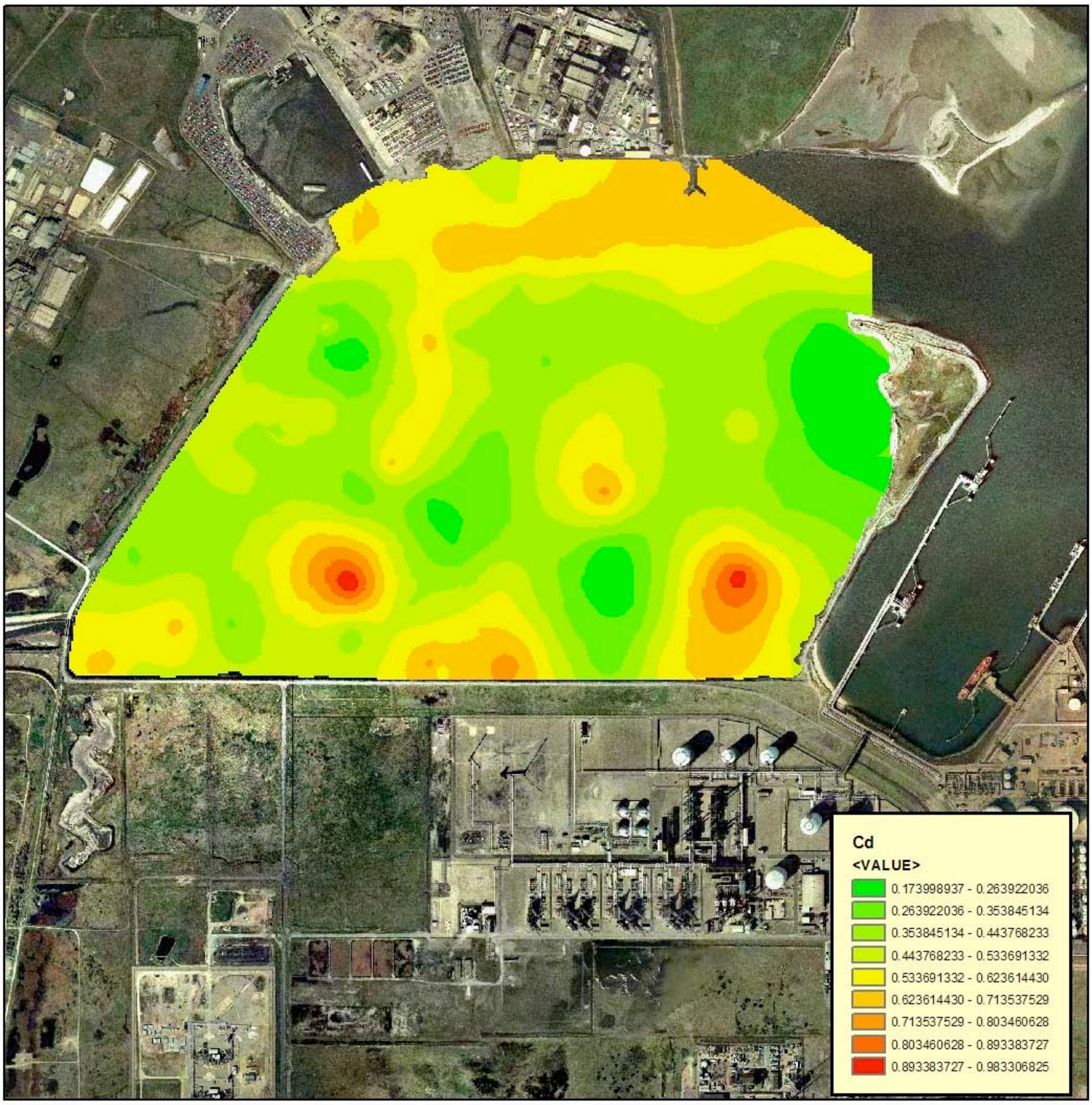
APPENDIX
A
METAL CONCENTRATIONS IN SEDIMENTS



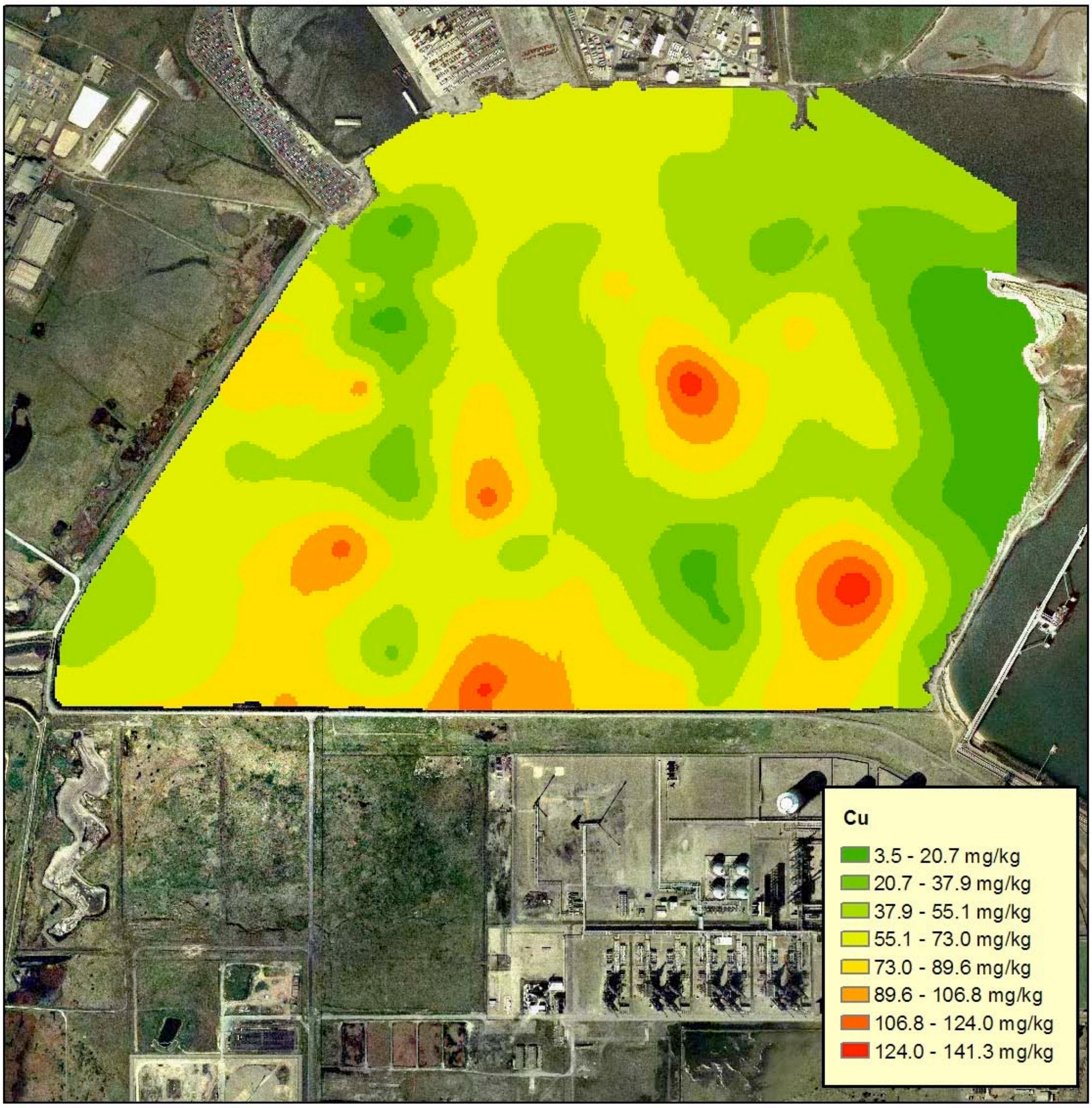
Concentrations of arsenic (mg/kg dry weight) in sediments on Seal Sand and in Seaton Channel (/1/and /7/).



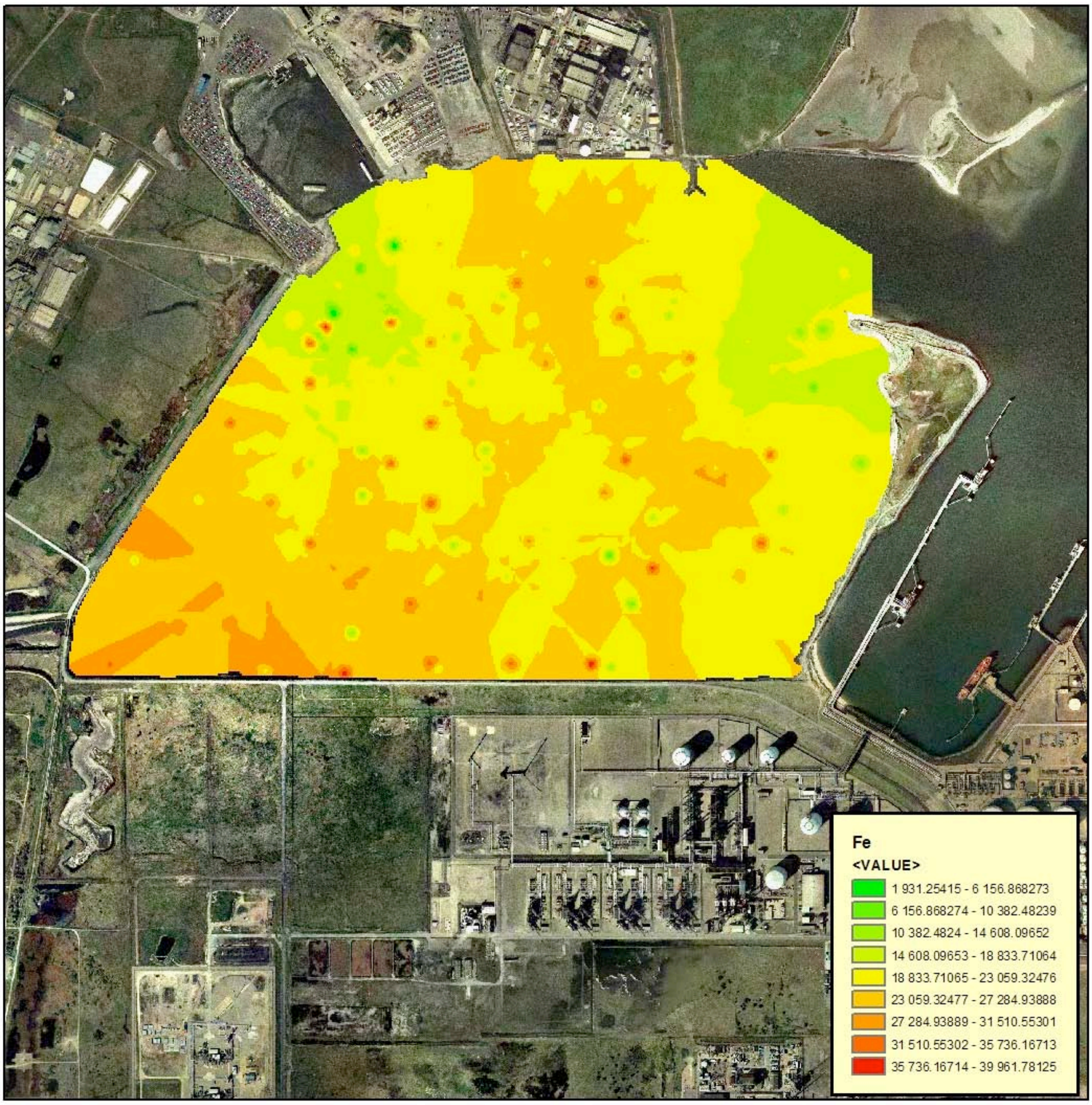
Concentrations of Zink (mg/kg dry weight) in sediments on Seal Sand and in Seaton Channel (/1/and /7/).



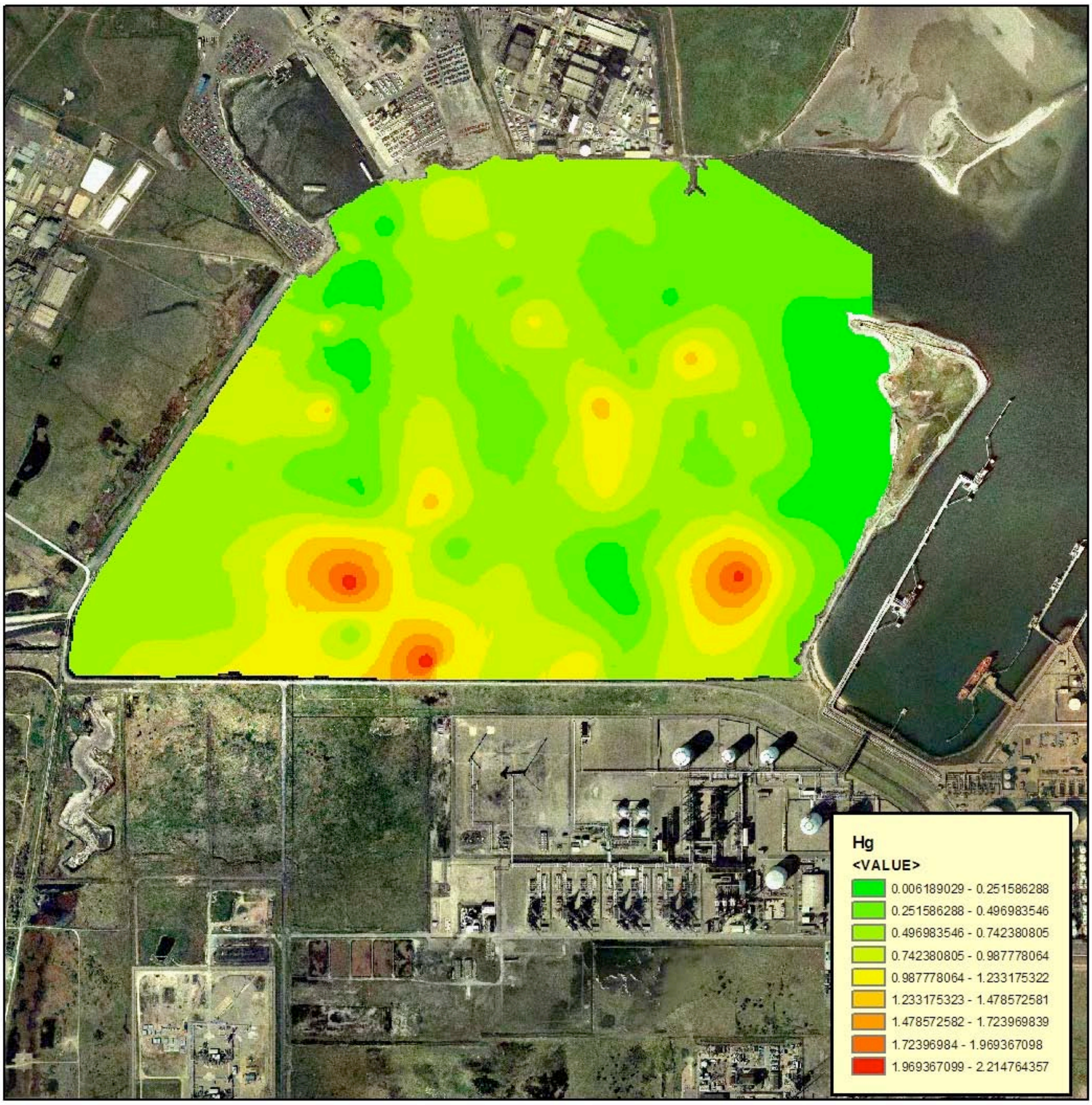
Concentrations of Cadmium (mg/kg dry weight) in sediments on Seal Sand and in Seaton Channel (/1/and /7/).



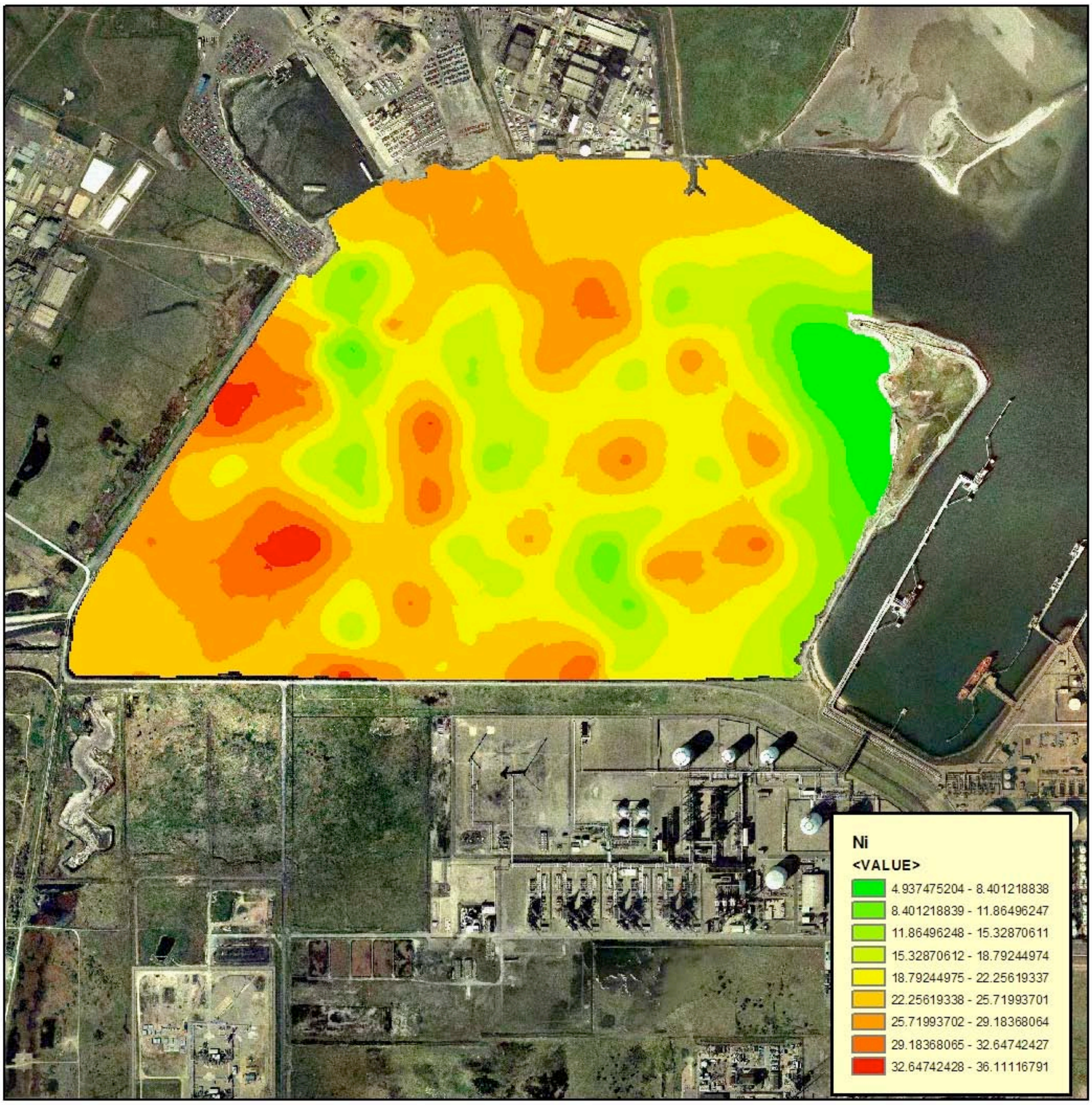
Concentrations of Copper (mg/kg dry weight) in sediments on Seal Sand and in Seaton Channel (/1/and /7/).



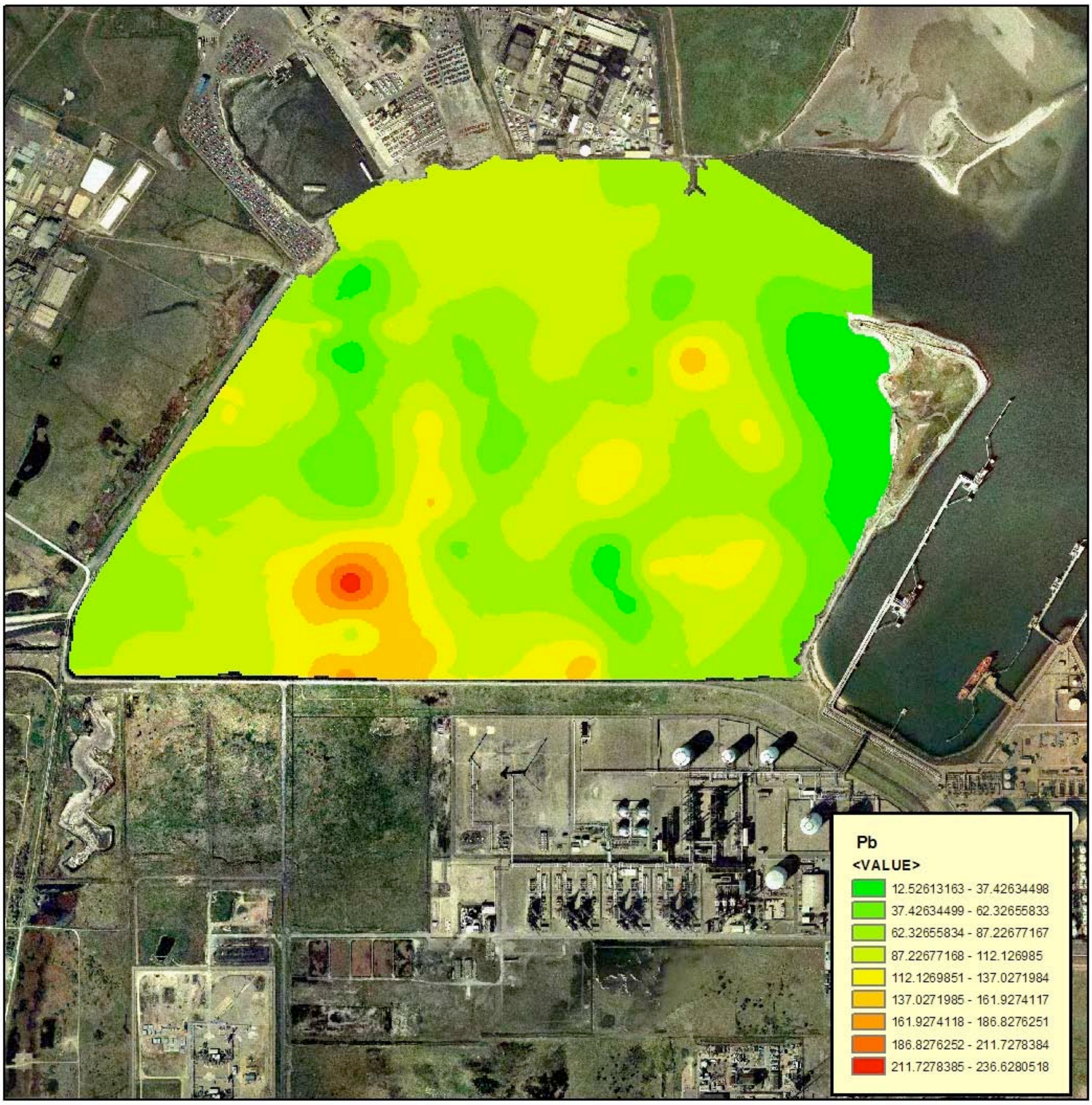
Concentrations of Iron (mg/kg dry weight) in sediments on Seal Sand and in Seaton Channel (/1/and /7/).



Concentrations of Mercury (mg/kg dry weight) in sediments on Seal Sand and in Seaton Channel (/1/and /7/).



Concentrations of Nickel (mg/kg dry weight) in sediments on Seal Sand and in Seaton Channel (/1/and /7/).



Concentrations of Lead (mg/kg dry weight) in sediments on Seal Sand and in Seaton Channel (/1/and /7/).

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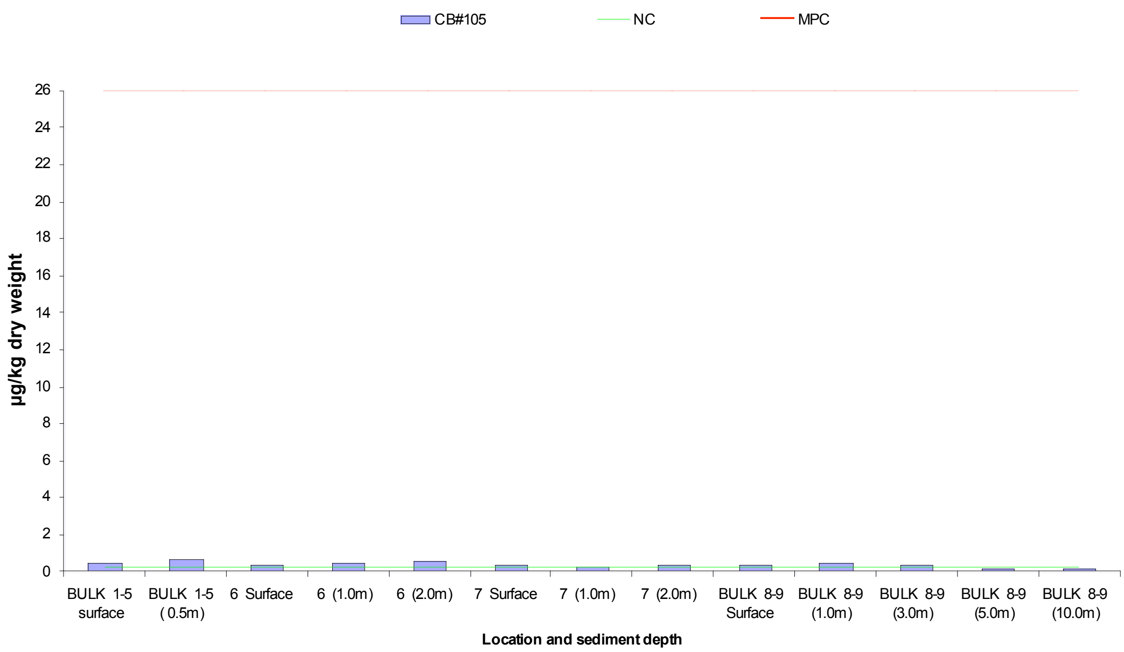
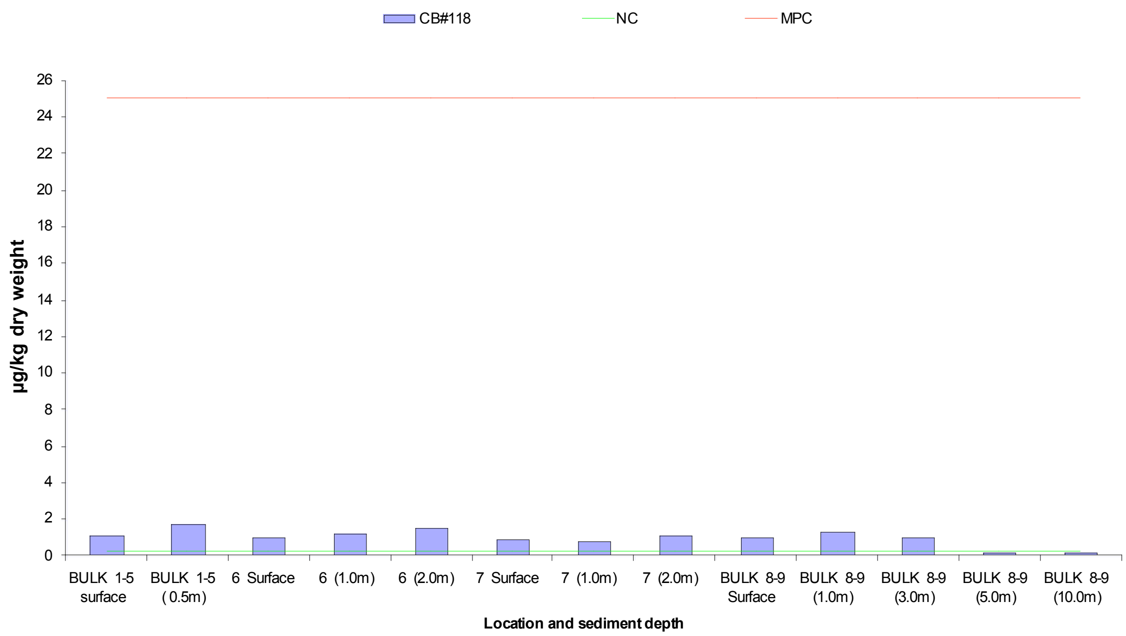
APPENDIX

B

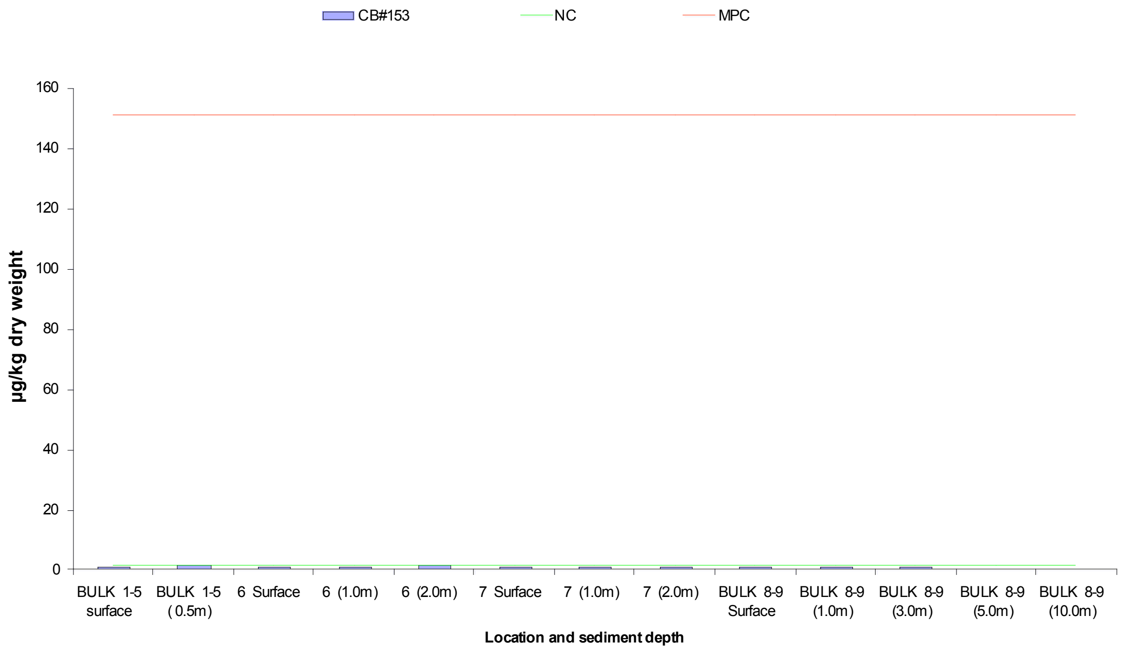
PCB CONCENTRATIONS IN SEDIMENTS



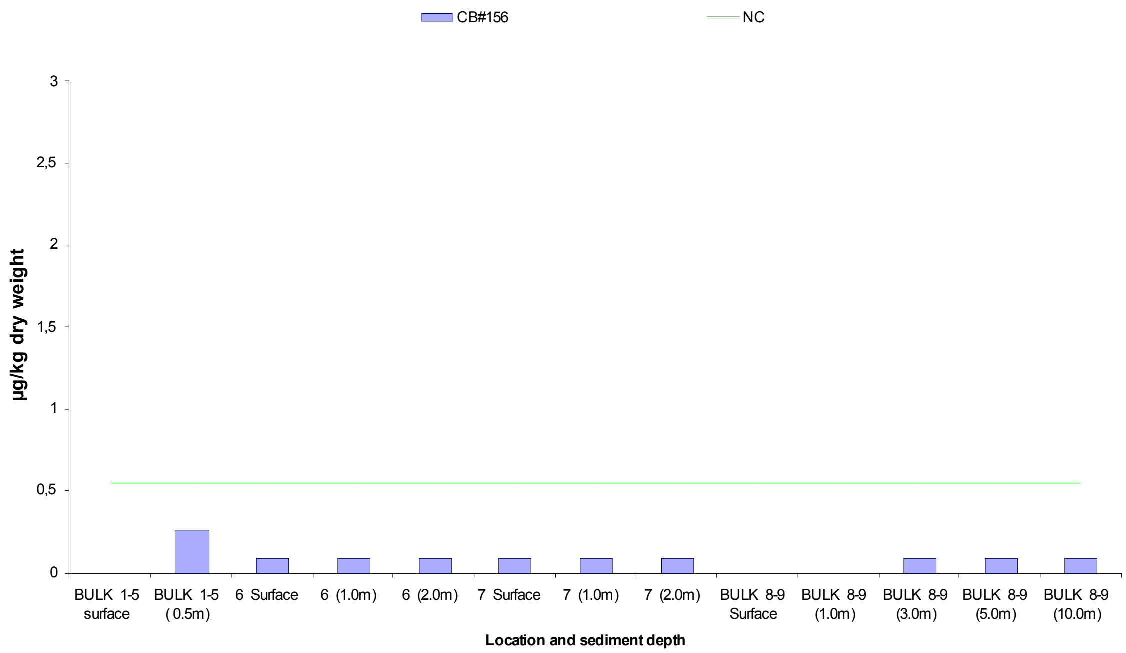
Concentration of CB#105 (µg/kg dry weight) in dredging areas 1 to 4. Sediment quality thresholds are given as Negligible Concentration (NC) and Maximum Permissible Concentration (MPC) according to the Dutch National Institute of Public Health and the Environment (/23/).



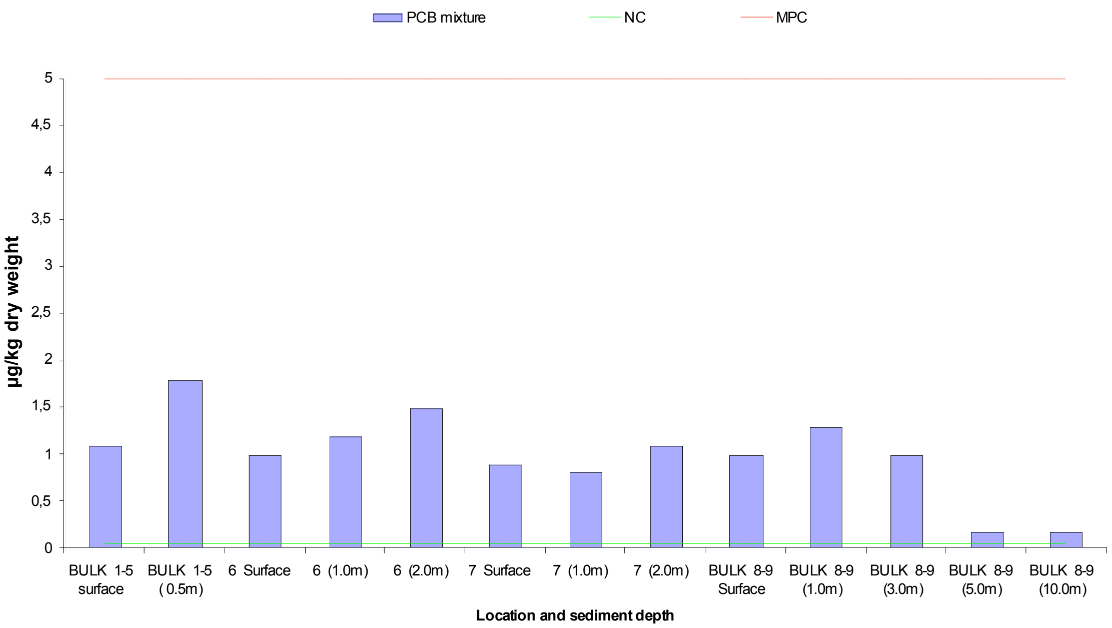
Concentration of CB#118 (µg/kg dry weight) in dredging areas 1 to 4. Sediment quality thresholds are given as Negligible Concentration (NC) and Maximum Permissible Concentration (MPC) according to the Dutch National Institute of Public Health and the Environment (/23/).



Concentration of CB#153 (µg/kg dry weight) in dredging areas 1 to 4. Sediment quality thresholds are given as Negligible Concentration (NC) and Maximum Permissible Concentration (MPC) according to the Dutch National Institute of Public Health and the Environment (/23/).



Concentration of CB#156 (µg/kg dry weight) in dredging areas 1 to 4. Sediment quality thresholds are given as Negligible Concentration (NC) and Maximum Permissible Concentration (MPC) according to the Dutch National Institute of Public Health and the Environment (/23/).



Concentration of CB#118 (µg/kg dry weight) representing the mixture of planar congeners in dredging areas 1 to 4. Sediment quality thresholds for the mixture of planar congeners are given as Negligible Concentration (NC) and Maximum Permissible Concentration (MPC) according to the Dutch National Institute of Public Health and the Environment (/23/).

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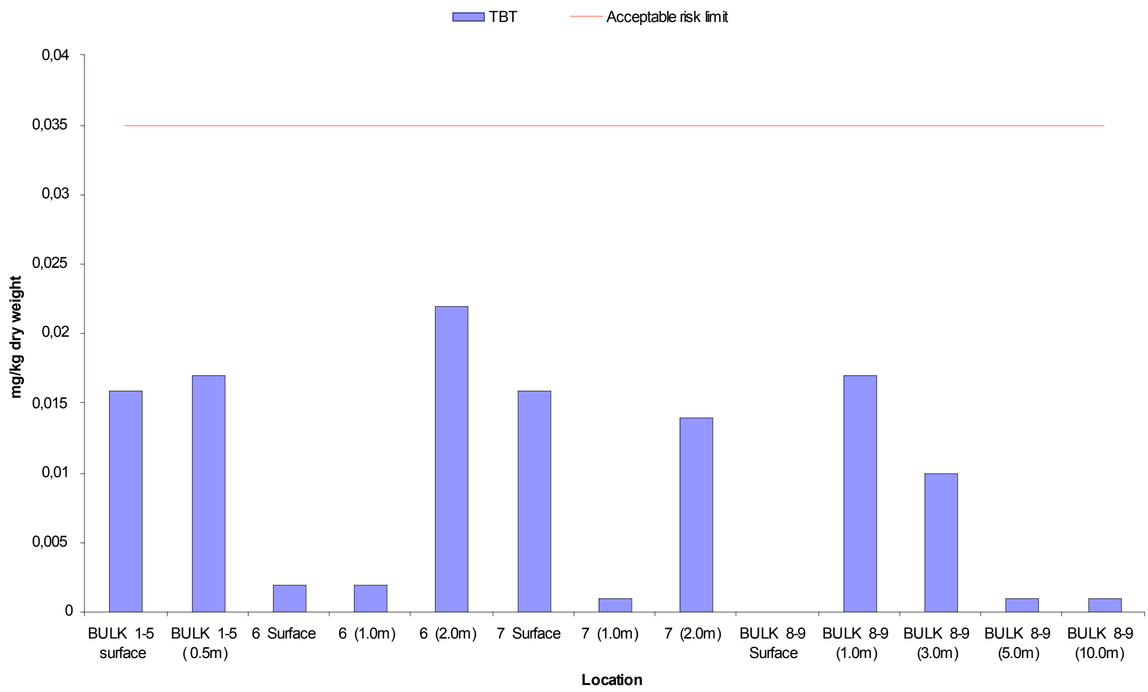
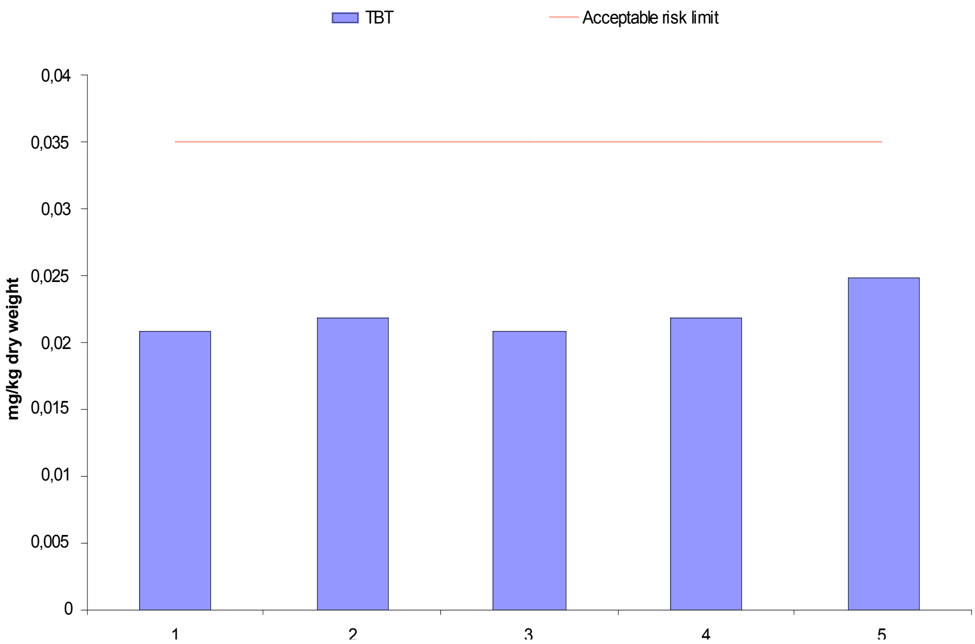
APPENDIX C
TBT CONCENTRATIONS IN SEDIMENTS



Concentration of TBT (mg/kg dry weight) in dredging areas 1 to 4. Sediment quality thresholds are given as Acceptable risk limit proposed by Breedveld (/24/).



Concentration of TBT (mg/kg dry weight) in dredging area 4; Seaton Channel. Sediment quality thresholds are given as Acceptable risk limit proposed by Breedveld (/24/).

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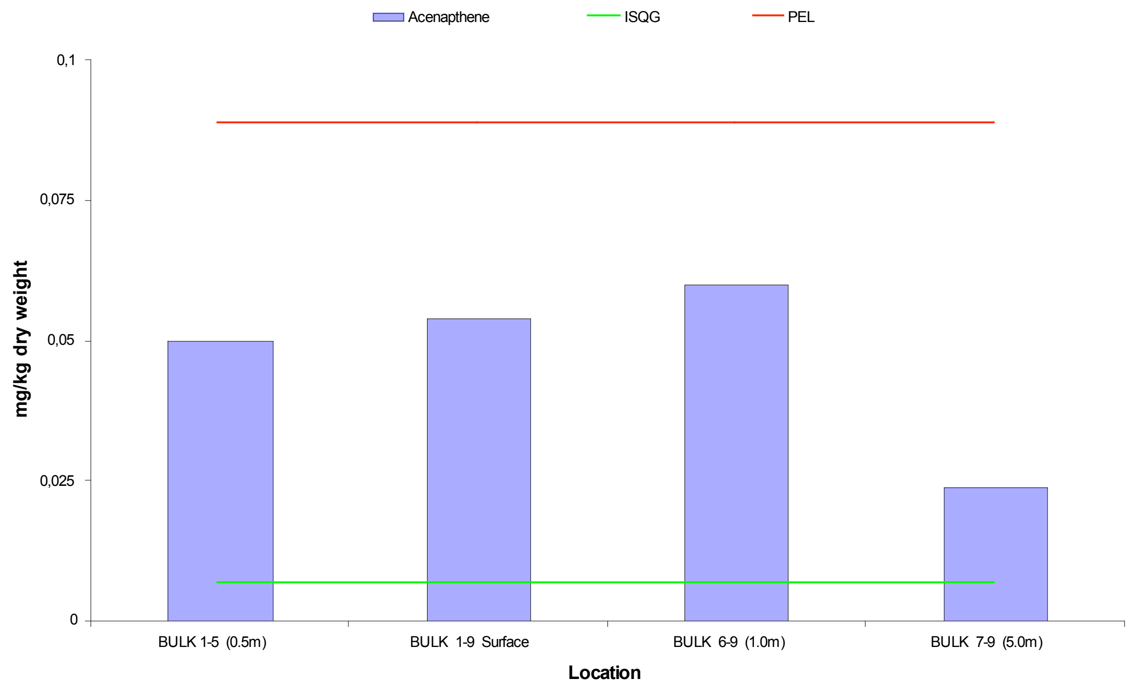
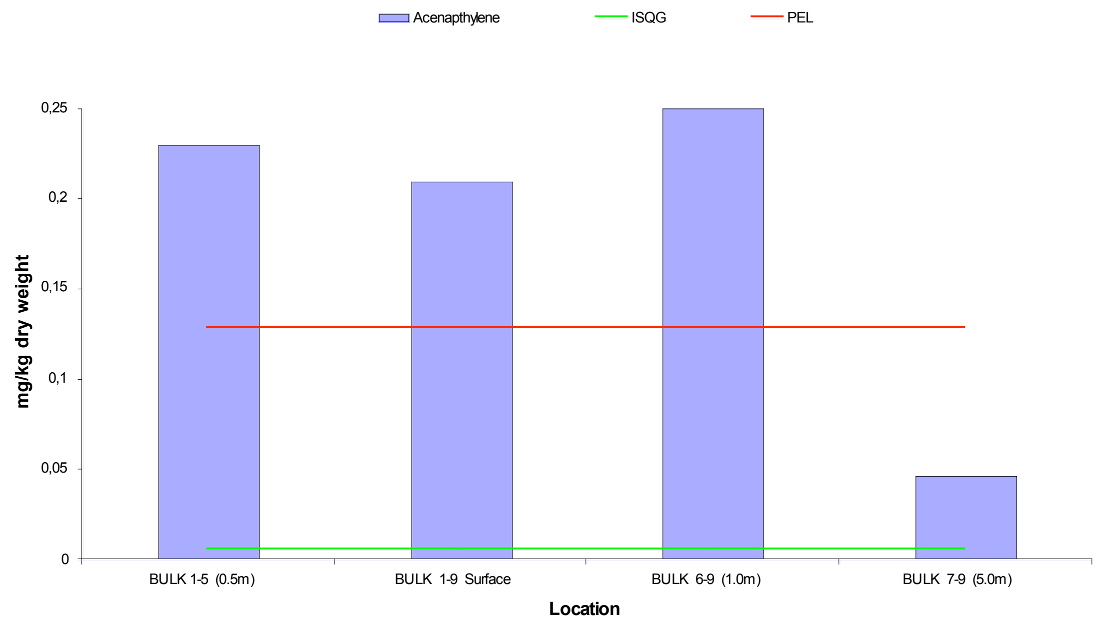
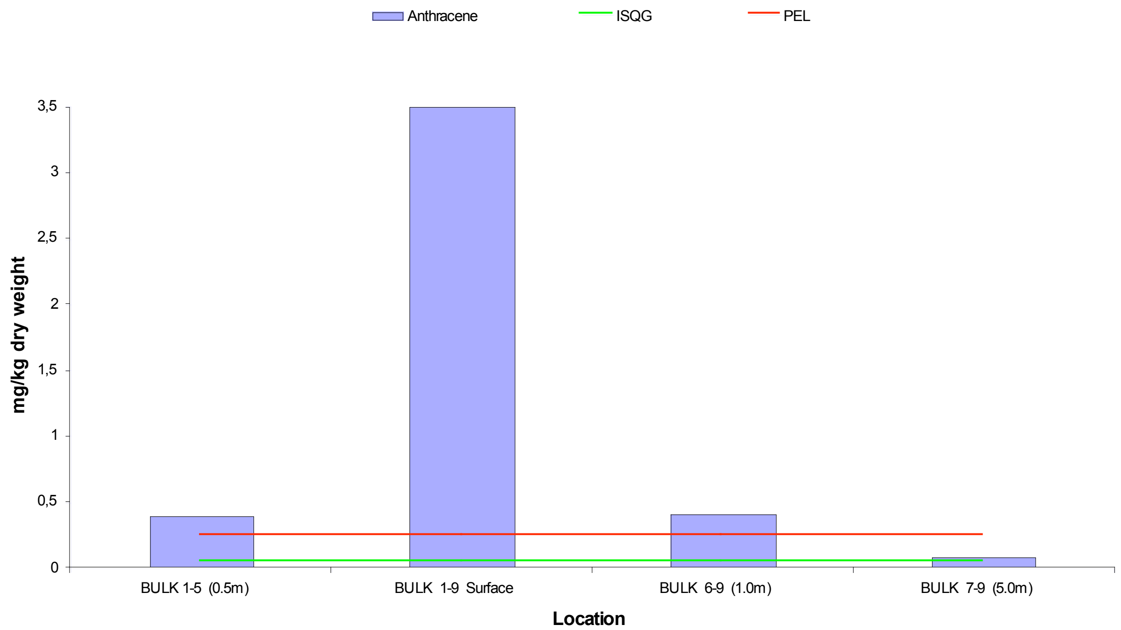
APPENDIX
D
PAH CONCENTRATIONS IN SEDIMENTS



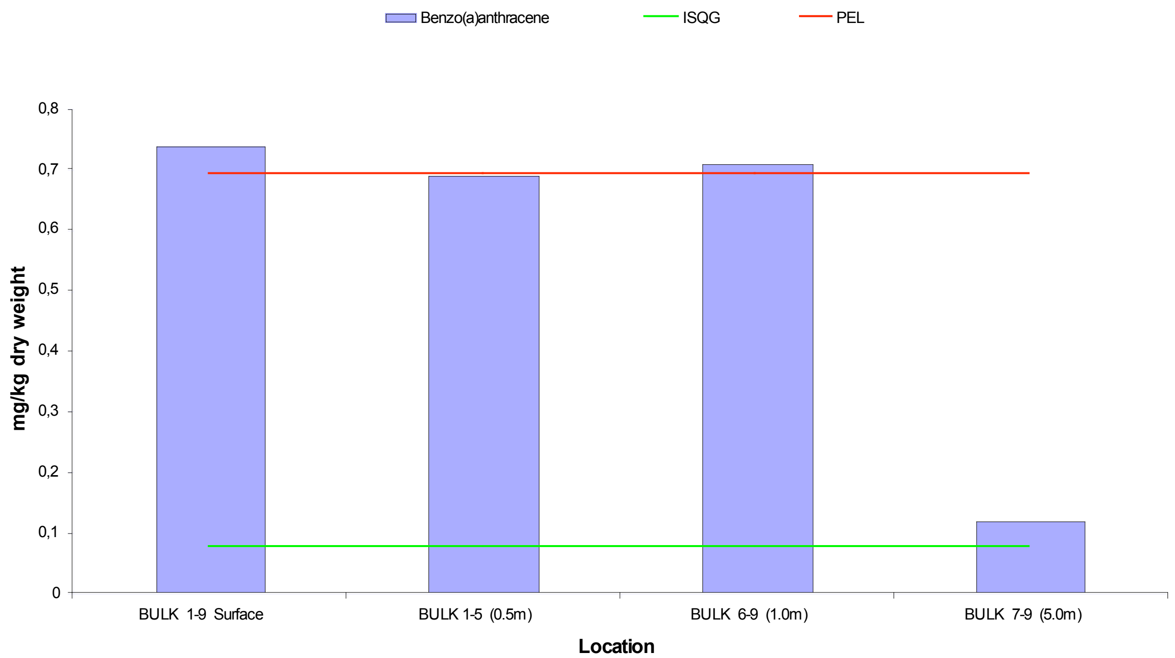
Concentration of Acenaphene (mg/kg dry weight) in dredging areas 1 to 4. Sediment quality thresholds are given as Interim Sediment Quality Guidelines (ISQG) and Probable Effect Level (PEL) according to the Canadian Environmental Quality Guidelines (/21/).



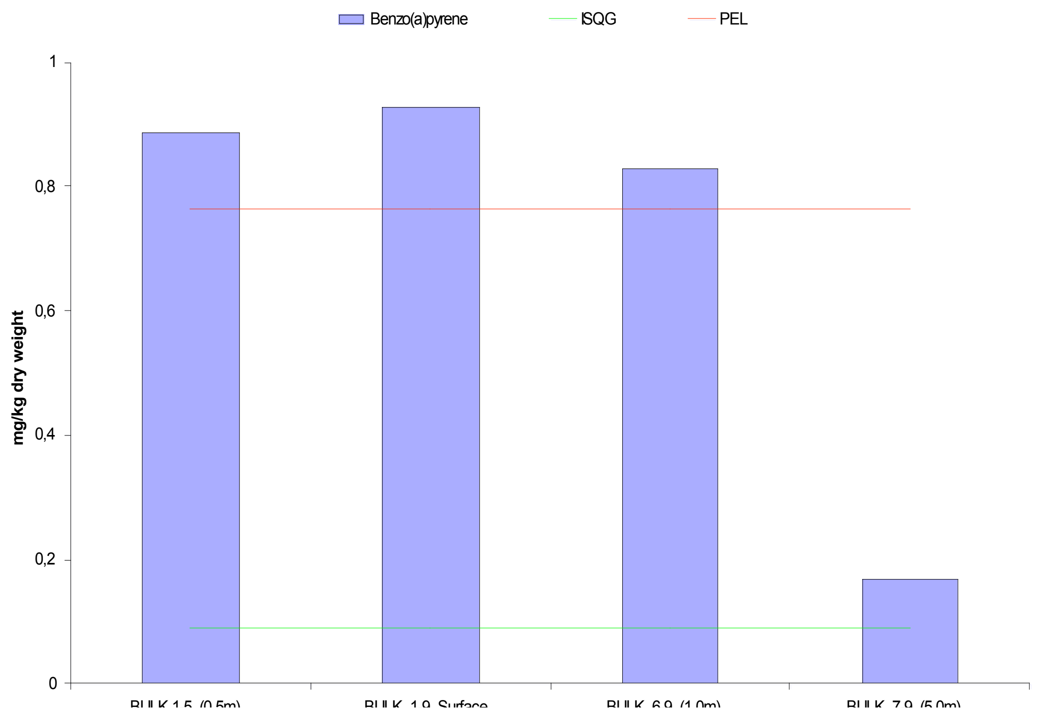
Concentration of Acenaphthylene (mg/kg dry weight) in dredging areas 1 to 4. Sediment quality thresholds are given as Interim Sediment Quality Guidelines (ISQG) and Probable Effect Level (PEL) according to the Canadian Environmental Quality Guidelines (/21/).



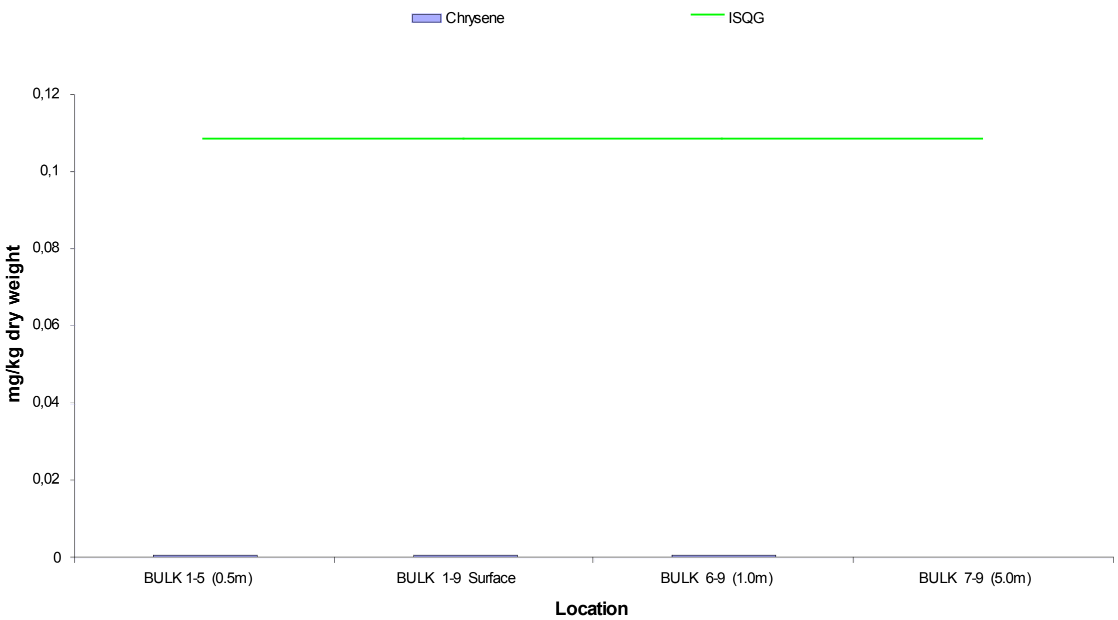
Concentration of Anthracene (mg/kg dry weight) in dredging areas 1 to 4. Sediment quality thresholds are given as Interim Sediment Quality Guidelines (ISQG) and Probable Effect Level (PEL) according to the Canadian Environmental Quality Guidelines (/21/).



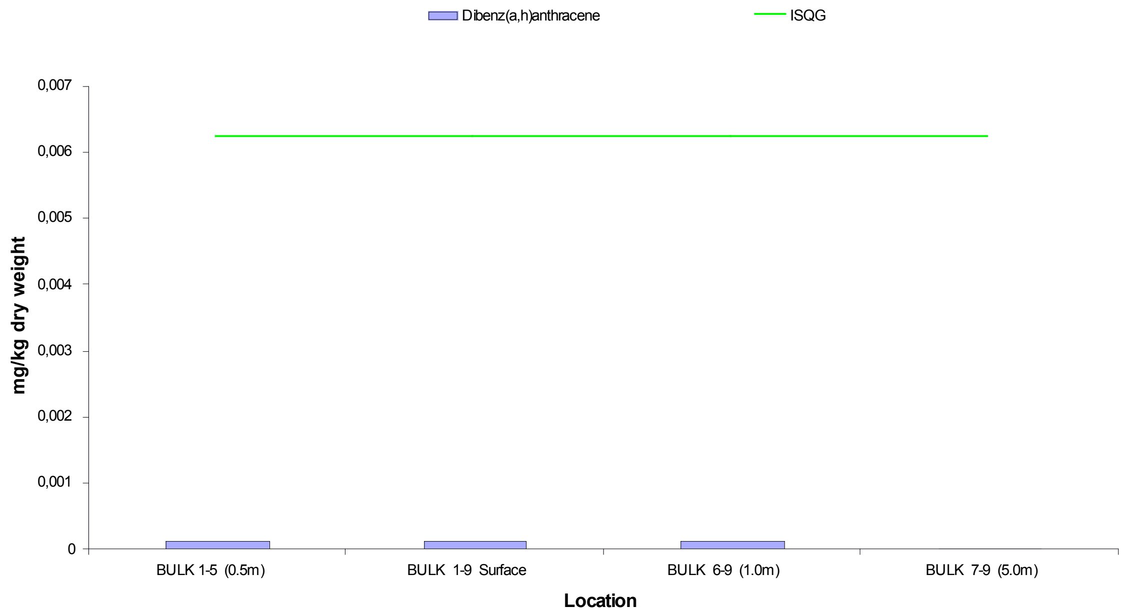
Concentration of Benzo(a)anthracene (mg/kg dry weight) in dredging areas 1 to 4. Sediment quality thresholds are given as Interim Sediment Quality Guidelines (ISQG) and Probable Effect Level (PEL) according to the Canadian Environmental Quality Guidelines (/21/).



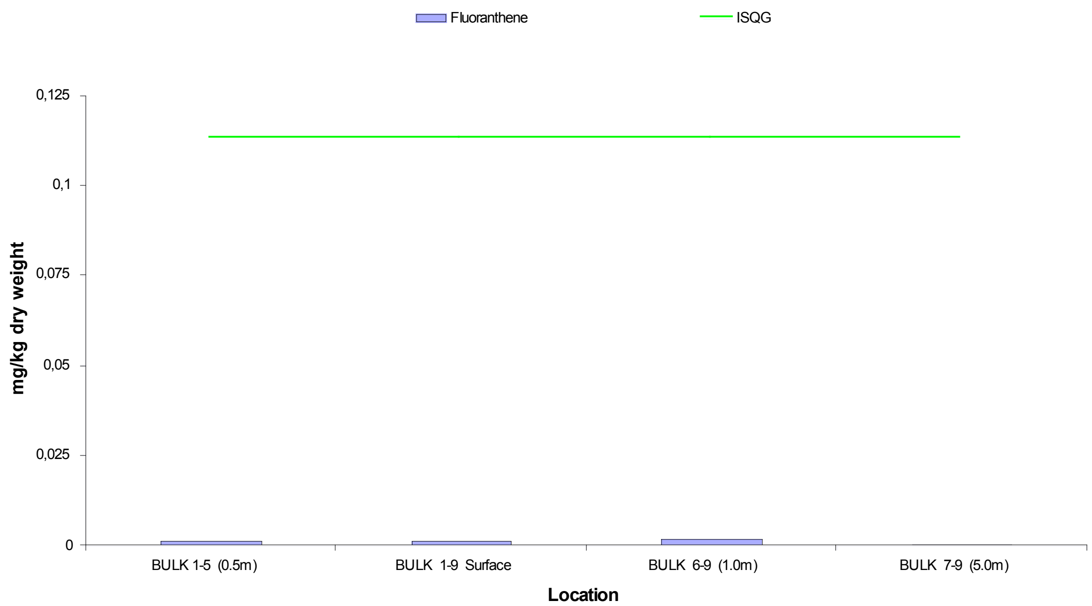
Concentration of Benzo(a)pyrene (mg/kg dry weight) in dredging areas 1 to 4. Sediment quality thresholds are given as Interim Sediment Quality Guidelines (ISQG) and Probable Effect Level (PEL) according to the Canadian Environmental Quality Guidelines (/21/).



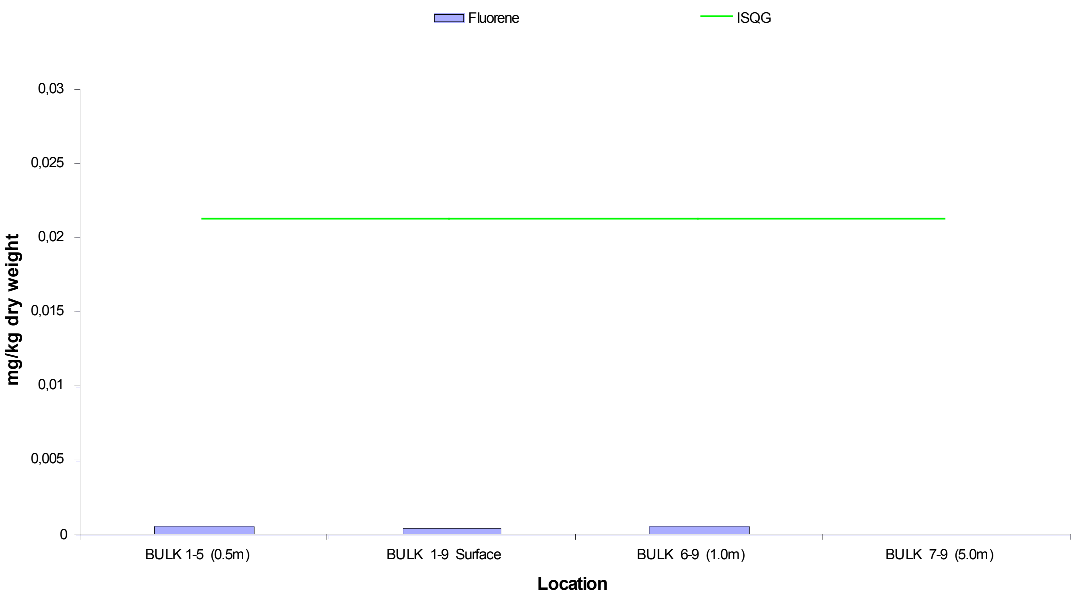
Concentration of Chrysene (mg/kg dry weight) in dredging areas 1 to 4. Sediment quality thresholds are given as Interim Sediment Quality Guidelines (ISQG) according to the Canadian Environmental Quality Guidelines (/21/).



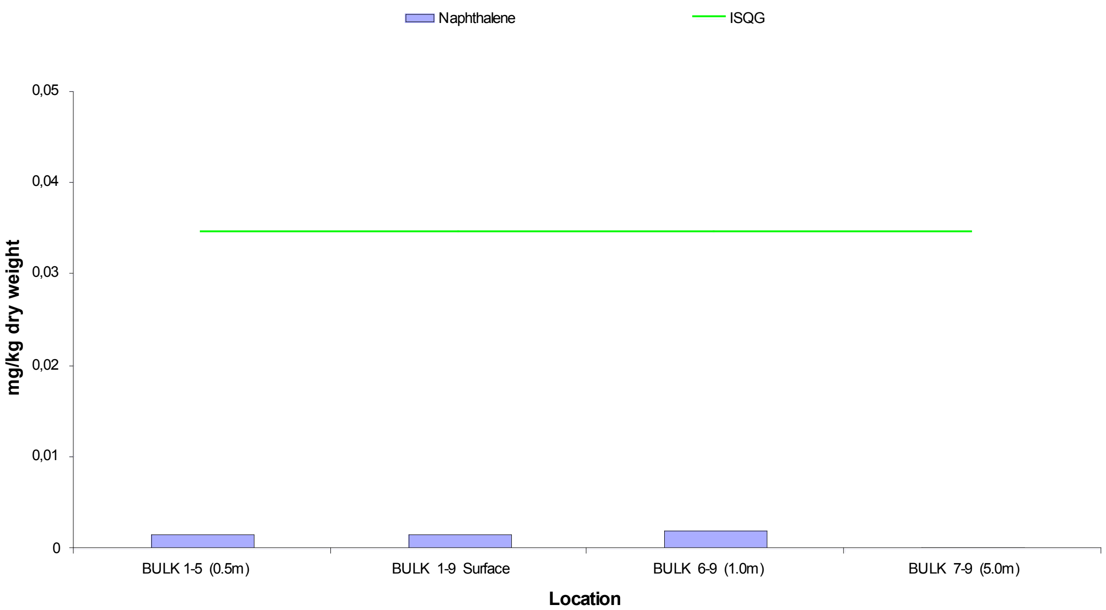
Concentration of Dibenz(a,h)anthracene (mg/kg dry weight) in dredging areas 1 to 4. Sediment quality thresholds are given as Interim Sediment Quality Guidelines (ISQG) according to the Canadian Environmental Quality Guidelines (/21/).



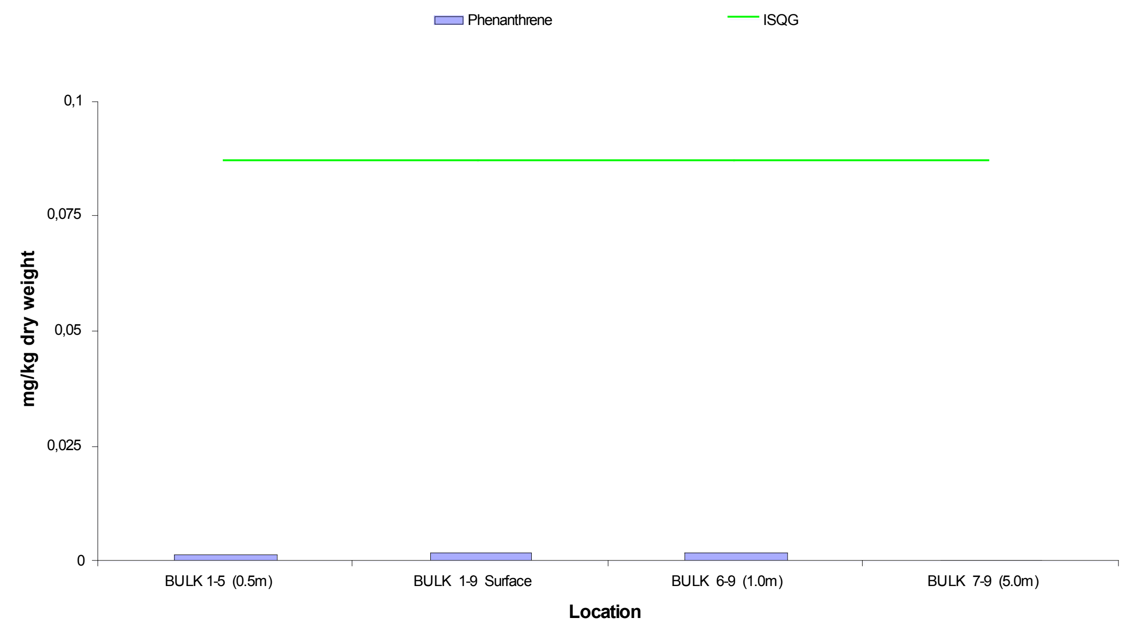
Concentration of Fluoranthene (mg/kg dry weight) in dredging areas 1 to 4. Sediment quality thresholds are given as Interim Sediment Quality Guidelines (ISQG) according to the Canadian Environmental Quality Guidelines (/21/).



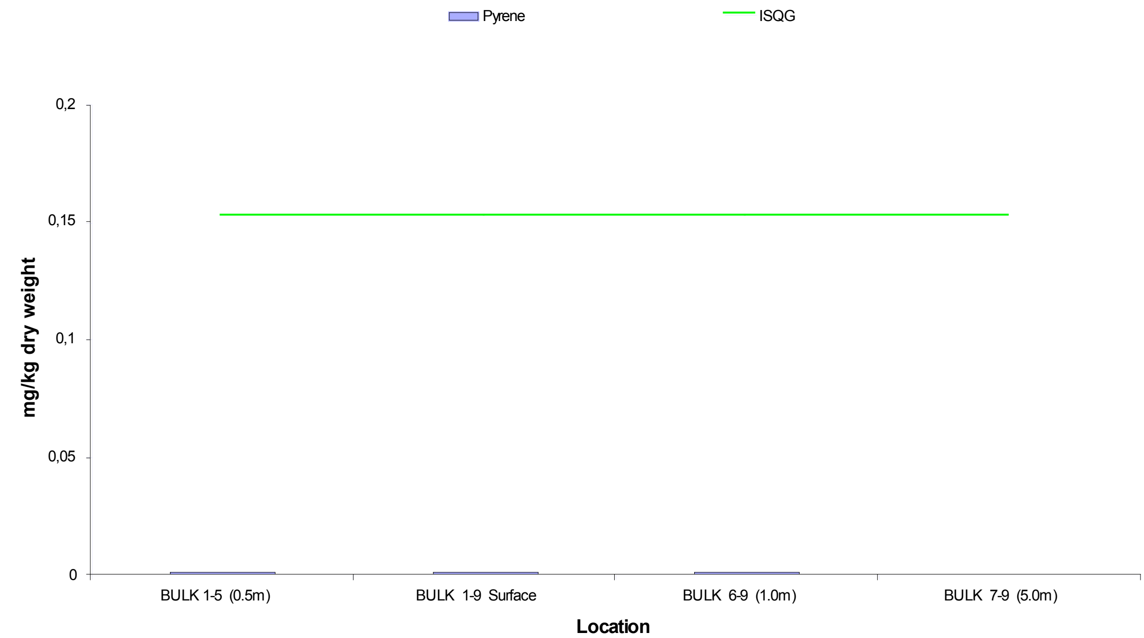
Concentration of Fluorene (mg/kg dry weight) in dredging areas 1 to 4. Sediment quality thresholds are given as Interim Sediment Quality Guidelines (ISQG) according to the Canadian Environmental Quality Guidelines (/21/).



Concentration of Naphthalene (mg/kg dry weight) in dredging areas 1 to 4. Sediment quality thresholds are given as Interim Sediment Quality Guidelines (ISQG) according to the Canadian Environmental Quality Guidelines (/21/).



Concentration of Phenanthrene (mg/kg dry weight) in dredging areas 1 to 4. Sediment quality thresholds are given as Interim Sediment Quality Guidelines (ISQG) according to the Canadian Environmental Quality Guidelines (/21/).



Concentration of Pyrene (mg/kg dry weight) in dredging areas 1 to 4. Sediment quality thresholds are given as Interim Sediment Quality Guidelines (ISQG) according to the Canadian Environmental Quality Guidelines (/21/).

APPENDIX E

HYDRODYNAMIC AND SEDIMENT TRANSPORTATION MODELLING DETAILED IMPACT ON OBSERVATION POINTS

Pt 1 Nuclear power plant intake

Case	Description	V_{max} (m/s)	C_{max} (mg/l)	C_{avg} (mg/l)	Δ depos. rate*
0	Baseline	0.047	0.89 sand 13.1 clay	0.31 sand 4.34 clay	100% sand 100% clay
1	Dredging of dock and holding basin	0.047	0.89 sand 7.21 clay	0.32 sand 2.99 clay	100% sand 64% clay
2	Dredg dock and Seaton Channel	0.049	0.85 sand 6.37 clay	0.30 sand 2.75 clay	97% sand 59% clay
3	Dredg doc, and Q10/Q11	0.046	0.90 sand 7.23 clay	0.32 sand 3.00 clay	101% sand 63% clay
4	Dredg dock, SC and Q10/Q11	0.043	0.85 sand 6.38 clay	0.31 sand 2.76 clay	98% sand 58% clay
5	Dock closed	0.045	0.86 sand 6.67 clay	0.31 sand 2.80 clay	98% sand 60% clay
6	Dock cl, dredged Seaton Channel	0.044	0.86 sand 5.52 clay	0.31 sand 2.49 clay	98% sand 55% clay
7	Dock cl, dredged Q10/Q11	0.043	0.86 sand 6.69 clay	0.31 sand 2.82 clay	99% sand 60% clay
8	Dock cl, dredged SC and Q10/Q11	0.040	0.82 sand 5.99 clay	0.30 sand 2.62 clay	95% sand 55% clay
9	Dock cl, dredged SC and Q10/Q11 extended	0.050	0.84 sand 6.20 clay	0.31 sand 2.55 clay	96 % sand 55 % clay

* in % of deposition rate for Scenario 0

Pt 2 Seal Sands

Case	Description	V_{max} (m/s)	C_{max} (mg/l)	C_{avg} (mg/l)	Δ depos. rate*
0	Baseline	0.096	0.72 sand 11.1 clay	0.25 sand 3.86 clay	100% sand 15.6 clay
1	Dredging of dock and holding basin	0.095	0.71 sand 6.36 clay	0.25 sand 2.62 clay	101% sand 67% clay
2	Dredg dock and Seaton Channel	0.091	0.68 sand 5.64 clay	0.24 sand 2.42 clay	97% sand 60% clay
3	Dredg doc, and Q10/Q11	0.094	0.72 sand 6.38 clay	0.25 sand 2.63 clay	101% sand 67% clay
4	Dredg dock, SC and Q10/Q11	0.091	0.69 sand 5.66 clay	0.24 sand 2.42 clay	98% sand 60% clay
5	Dock closed	0.092	0.69 sand 5.91 clay	0.24 sand 2.47 clay	98% sand 62% clay
6	Dock cl, dredged Seaton Channel	0.092	0.69 sand 4.95 clay	0.24 sand 2.21 clay	98% sand 55% clay
7	Dock cl, dredged Q10/Q11	0.092	0.70 sand 5.94 clay	0.25 sand 2.48 clay	99% sand 63% clay
8	Dock cl, dredged SC and Q10/Q11	0.089	0.67 sand 5.33 clay	0.24 sand 2.30 clay	96% sand 57% clay
9	Dock cl, dredged SC and Q10/Q11 extended	0.090	0.68 sand 5.45 clay	0.24 sand 2.30 clay	96 % sand 57 % clay

* in % of deposition rate for Scenario 0

Pt 3 Seaton Channel

Case	Description	V_{max} (m/s)	C_{max} (mg/l)	C_{avg} (mg/l)	Δ depos. rate*
0	Baseline	0.469	2.12 sand 19.9 clay	0.71 sand 6.65 clay	100% sand 100%**clay
1	Dredging of dock and holding basin	0.470	2.12 sand 11.7clay	0.71 sand 4.88 clay	100% sand 51%** clay
2	Dredg dock and Seaton Channel	0.402	2.07 sand 11.0 clay	0.70 sand 4.63 clay	96% sand 32%** clay
3	Dredg doc, and Q10/Q11	0.470	2.12 sand 11.7 clay	0.71 sand 4.89 clay	100% sand 51%** clay
4	Dredg dock, SC and Q10/Q11	0.402	2.07 sand 11.0 clay	0.70 sand 4.63 clay	96% sand 31%** clay
5	Dock closed	0.449	2.07 sand 11.2 clay	0.70 sand 4.70 clay	98% sand 42%** clay
6	Dock cl, dredged Seaton Channel	0.402	2.07 sand 10.0 clay	0.71 sand 4.35 clay	98% sand 43%** clay
7	Dock cl, dredged Q10/Q11	0.449	2.07 sand 11.2 clay	0.70 sand 4.71 clay	98% sand 42%** clay
8	Dock cl, dredged SC and Q10/Q11	0.383	2.02 sand 10.6 clay	0.69 sand 4.49 clay	98% sand 22%** clay
9	Dock cl, dredged SC and Q10/Q11 extended	0.390	2.05 sand 11.0 clay	0.70 sand 4.65 clay	96% sand 35%**clay

* in % of deposition rate for Scenario 0
**As erosion of cohesive sediments occurs at this point, silt/clay deposits will not be sustained and this type of sediment will not exist here. The negative deposition rate therefore shows the change in erosion potential at this point.

Pt 4 Tees Channel

Case	Description	V_{max} (m/s)	C_{max} (mg/l)	C_{avg} (mg/l)	Δ depos. rate*
0	Baseline	0.552	4.93 sand 23.4 clay	1.96 sand 12.9 clay	100% sand 100%**clay
1	Dredging of dock and holding basin	0.552	4.93 sand 21.2 clay	1.96 sand 12.4 clay	100% sand 63%** clay
2	Dredg dock and Seaton Channel	0.552	4.93 sand 21.2 clay	1.96 sand 12.3 clay	98% sand 63%** clay
3	Dredg doc, and Q10/Q11	0.552	4.93 sand 21.2 clay	1.96 sand 12.4 clay	100% sand 63%** clay
4	Dredg dock, SC and Q10/Q11	0.552	4.92 sand 21.2 clay	1.96 sand 12.3 clay	100% sand 63%** clay
5	Dock closed	0.545	4.89 sand 21.0 clay	1.95 sand 12.3 clay	99% sand 60%** clay
6	Dock cl, dredged Seaton Channel	0.545	4.89 sand 20.9 clay	1.96 sand 12.2 clay	98% sand 60%** clay
7	Dock cl, dredged Q10/Q11	0.545	4.89 sand 21.0 clay	1.95 sand 12.4 clay	99% sand 60%** clay

Case	Description	V_{max} (m/s)	C_{max} (mg/l)	C_{avg} (mg/l)	Δ depos. rate*
8	Dock cl, dredged SC and Q10/Q11	0.545	4.88 sand 21.0 clay	1.95 sand 12.3 clay	99% sand 60%** clay
9	Dock cl, dredged SC and Q10/Q11 extended	0.545	4.88 sand 21.0 clay	1.95 sand 12.3 clay	99% sand 60%** clay

* in % of deposition rate for Scenario 0
**As erosion of cohesive sediments occurs at this point, silt/clay deposits will not be sustained and this type of sediment will not exist here. The negative deposition rate therefore shows the change in erosion potential at this point.

Pt 5 North Gare Sands

Case	Description	V_{max} (m/s)	C_{max} (mg/l)	C_{avg} (mg/l)	Δ depos. rate*
0	Baseline	0.074	6.48 sand 23.4 clay	3.28 sand 12.9 clay	100% sand 100% clay
1	Dredging of dock and holding basin	0.074	6.48 sand 21.2 clay	3.28 sand 12.3 clay	100% sand 98% clay
2	Dredg dock and Seaton Channel	0.074	6.48 sand 21.2 clay	3.28 sand 12.3 clay	100% sand 98% clay
3	Dredg doc, and Q10/Q11	0.074	6.48 sand 21.2 clay	3.28 sand 12.4 clay	100% sand 98% clay
4	Dredg dock, SC and Q10/Q11	0.074	6.48 sand 21.2 clay	3.28 sand 12.3 clay	100% sand 98% clay
5	Dock closed	0.073	6.45 sand 21.0 clay	3.28 sand 12.2 clay	100% sand 98% clay
6	Dock cl, dredged Seaton Channel	0.073	6.48 sand 21.0 clay	3.28 sand 12.3 clay	100% sand 97% clay
7	Dock cl, dredged Q10/Q11	0.073	6.45 sand 20.9 clay	3.28 sand 12.2 clay	100% sand 98% clay
8	Dock cl, dredged SC and Q10/Q11	0.073	6.45 sand 21.0 clay	3.27 sand 12.3 clay	100% sand 97% clay
9	Dock cl, dredged SC and Q10/Q11 extended	0.545	6.45 sand 21.0 clay	3.27 sand 12.3 clay	100% sand 97% clay

* in % of deposition rate for Scenario 0

Pt 6 Coatham Sands

Case	Description	V_{max} (m/s)	C_{max} (mg/l)	C_{avg} (mg/l)	Δ depos. rate*
0	Baseline	0.028	9.80 sand 22.4 clay	7.70 sand 19.3 clay	100% sand 100% clay
1	Dredging of dock and holding basin	0.028	9.80 sand 23.9 clay	7.70 sand 20.5 clay	100% sand 107% clay
2	Dredg dock and Seaton Channel	0.028	9.80 sand 23.9 clay	7.70 sand 20.5 clay	100% sand 107% clay
3	Dredg doc, and Q10/Q11	0.028	9.80 sand 23.9 clay	7.70 sand 20.5 clay	100% sand 107% clay
4	Dredg dock, SC and Q10/Q11	0.028	9.80 sand 23.9 clay	7.70 sand 20.5 clay	100% sand 107% clay

Case	Description	V_{max} (m/s)	C_{max} (mg/l)	C_{avg} (mg/l)	Δ depos. rate*
5	Dock closed	0.028	9.79 sand 23.9 clay	7.70 sand 20.5 clay	100% sand 107% clay
6	Dock cl, dredged Seaton Channel	0.028	9.79 sand 23.9 clay	7.70 sand 20.5 clay	100% sand 107% clay
7	Dock cl, dredged Q10/Q11	0.028	9.79 sand 23.9 clay	7.70 sand 20.5 clay	100% sand 107% clay
8	Dock cl, dredged SC and Q10/Q11	0.028	9.79 sand 23.9 clay	7.70 sand 20.5 clay	100% sand 107% clay
9	Dock cl, dredged SC and Q10/Q11 extended	0.545	9.79 sand 23.9 clay	7.70 sand 20.5 clay	100% sand 107% clay

* in % of deposition rate for Scenario 0

Pt 7 Teesport

Case	Description	V_{max} (m/s)	C_{max} (mg/l)	C_{avg} (mg/l)	Δ depos. rate*
0	Baseline	0.206	0.40 sand 10.4 clay	0.17 sand 3.95 clay	100% sand 7.82 clay
1	Dredging of dock and holding basin	0.206	0.40 sand 5.02 clay	0.17 sand 2.45 clay	100% sand 48% clay
2	Dredg dock and Seaton Channel	0.206	0.40 sand 4.85 clay	0.17 sand 2.40 clay	100% sand 46% clay
3	Dredg doc, and Q10/Q11	0.206	0.40 sand 5.02 clay	0.17 sand 2.45 clay	99% sand 48% clay
4	Dredg dock, SC and Q10/Q11	0.206	0.40 sand 4.85 clay	0.17 sand 2.40 clay	99% sand 46& clay
5	Dock closed	0.206	0.39 sand 4.86 clay	0.17 sand 2.40 clay	99% sand 46% clay
6	Dock cl, dredged Seaton Channel	0.206	0.40 sand 4.61 clay	0.17 sand 2.34 clay	99% sand 43% clay
7	Dock cl, dredged Q10/Q11	0.206	0.39 sand 4.87 clay	0.17 sand 2.40 clay	98% sand 46% clay
8	Dock cl, dredged SC and Q10/Q11	0.206	0.39 sand 4.73 clay	0.17 sand 2.80 clay	98% sand 45% clay
9	Dock cl, dredged SC and Q10/Q11 extended	0.206	0.40 sand 4.61 clay	0.17 sand 2.34 clay	99% sand 43% clay

* in % of deposition rate for Scenario 0

- o0o -

Appendix 16.2

Conservation Direction for Littoral Rock UK Biodiversity Habitat Plan

MarLIN, 2004

Conservation direction for Littoral Rock UK Biodiversity Habitat Plan

Maintain the extent and quality of littoral rocky habitats in the UK, including the full diversity of communities.
Measures to be considered further include:

- protecting sites of conservation importance from damage through contamination, physical disturbance or excessive use (e.g. maritime accidents, trampling and collection);
- minimising the risk of the introduction of non-native species;
- ensuring that EIAs for coastal developments, including developments above high water mark, examine potential effects on intertidal and nearshore areas;
- ensuring a co-ordinated framework for management of protected areas which span the coastal zone;
- developing and implementing strategies for the conservation and management of the wider marine environment at local, regional and national levels. For example, integrated coastal management plans, water quality objectives, pollution control and avoidance measures. Species recovery and habitat restoration programmes should be included.

MarLIN, 2004

Appendix 16.3

Drawing JER2917-AV-008

Indicative Distribution of the Main Biotopes in the Area

ENVIRONMENTAL PLANNERS AND SCIENTISTS
LANDSCAPE ARCHITECTS
ARCHITECTS

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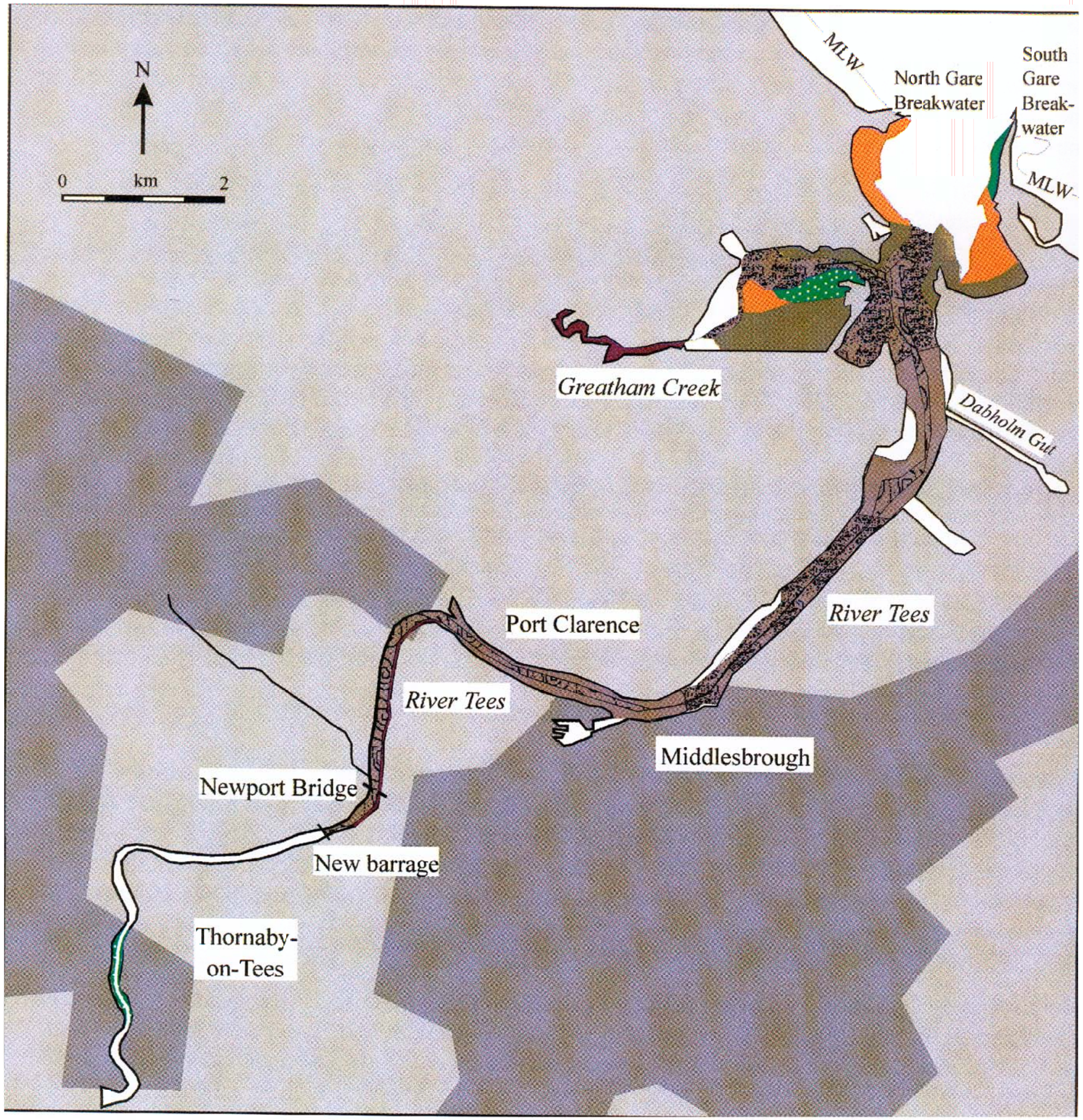


- Littoral rock with fucoid algae (Fves)
- Cobbles and pebbles with fucoid algae (FvesX)
- Mobile sand shores with amphipods and polychaetes (AP.P)
- Muddy sand shores with polychaetes and *Corophium volutator* (HedMac.Pyg)
- Estuarine mud shores with polychaetes and oligochaetes (HedOl)
- Sublittoral estuarine mud with sparse infauna (MobMud)
- Sublittoral estuarine mud with oligochaetes (CapTub, Tub)
- Sublittoral estuarine mud with polychaetes and bivalves (NhomTub)

PROJECT
TERRC Dock Environmental Impact Statement

TITLE
Indicative Distribution of the Main Biotopes in the Area

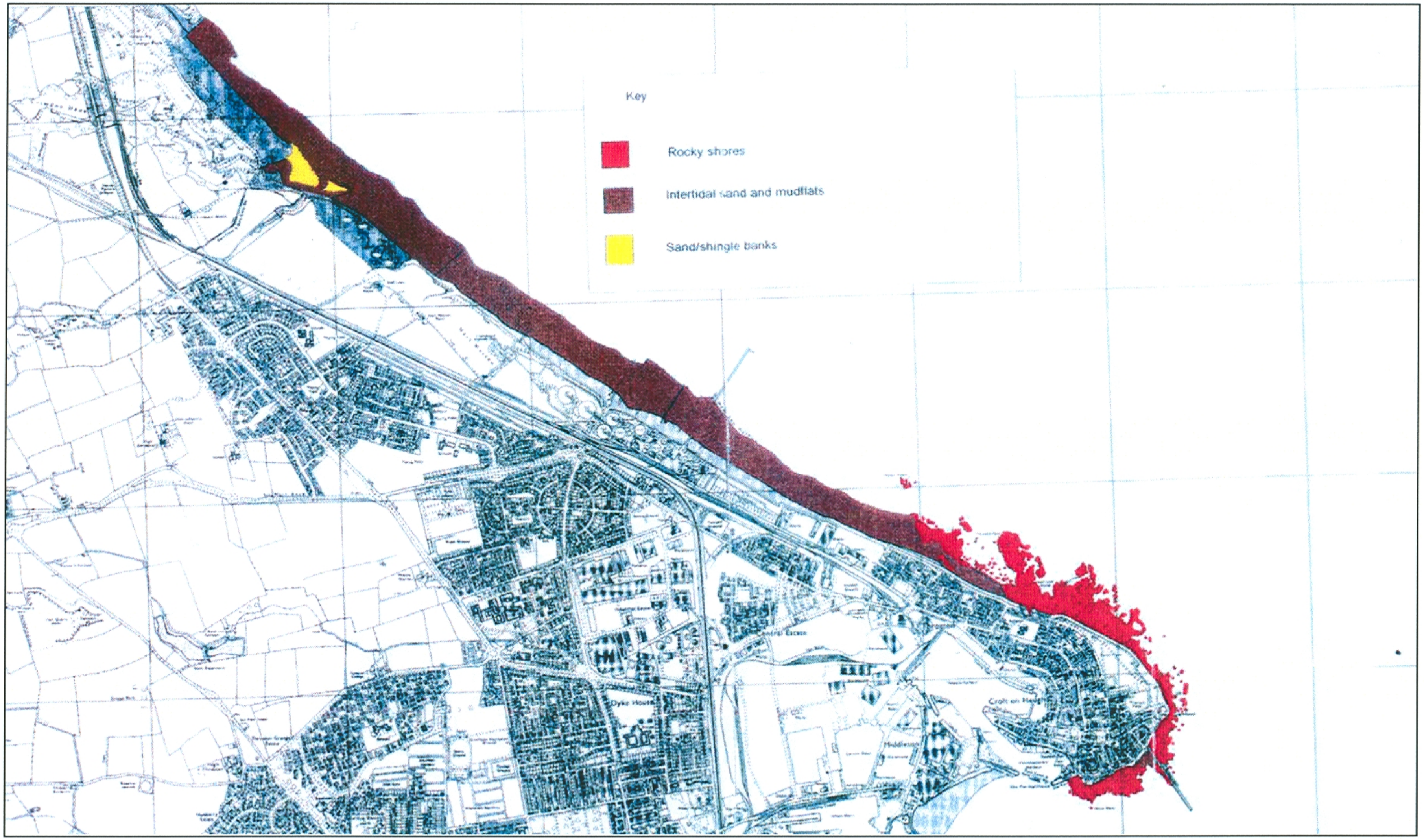
SCALE NTS	DRAWN BY R Northam
DATE 26/03/04	CHECKED
PROJECT NUMBER DE0295	DRAWING NUMBER JER2917-AV-008 REV 0

Appendix 16.4

The Distribution of the sub-features of the Teesmouth and Cleveland Coast European Marine Site

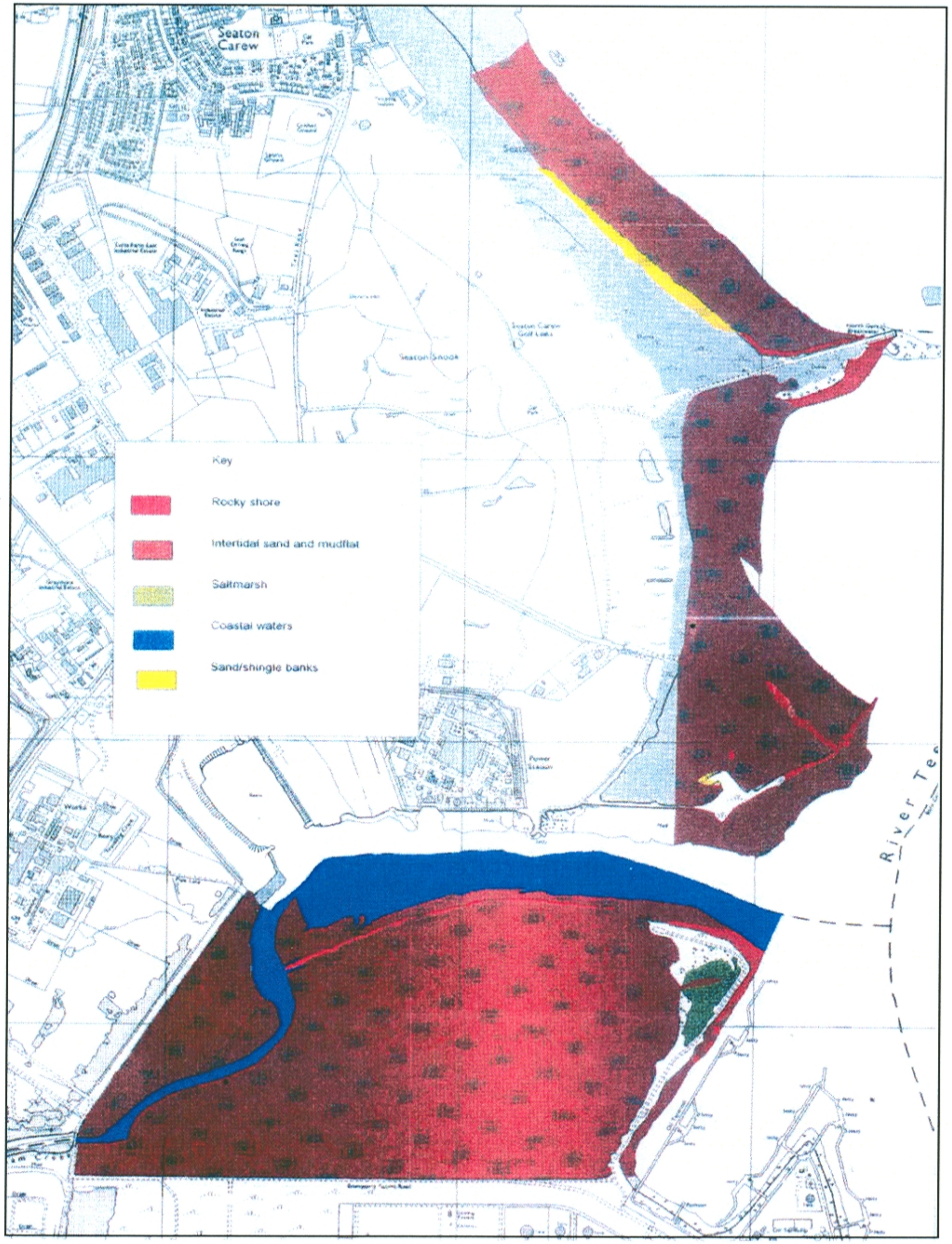
The Distribution of the sub-features of the Teesmouth and Cleveland Coast European Marine Site

(a)



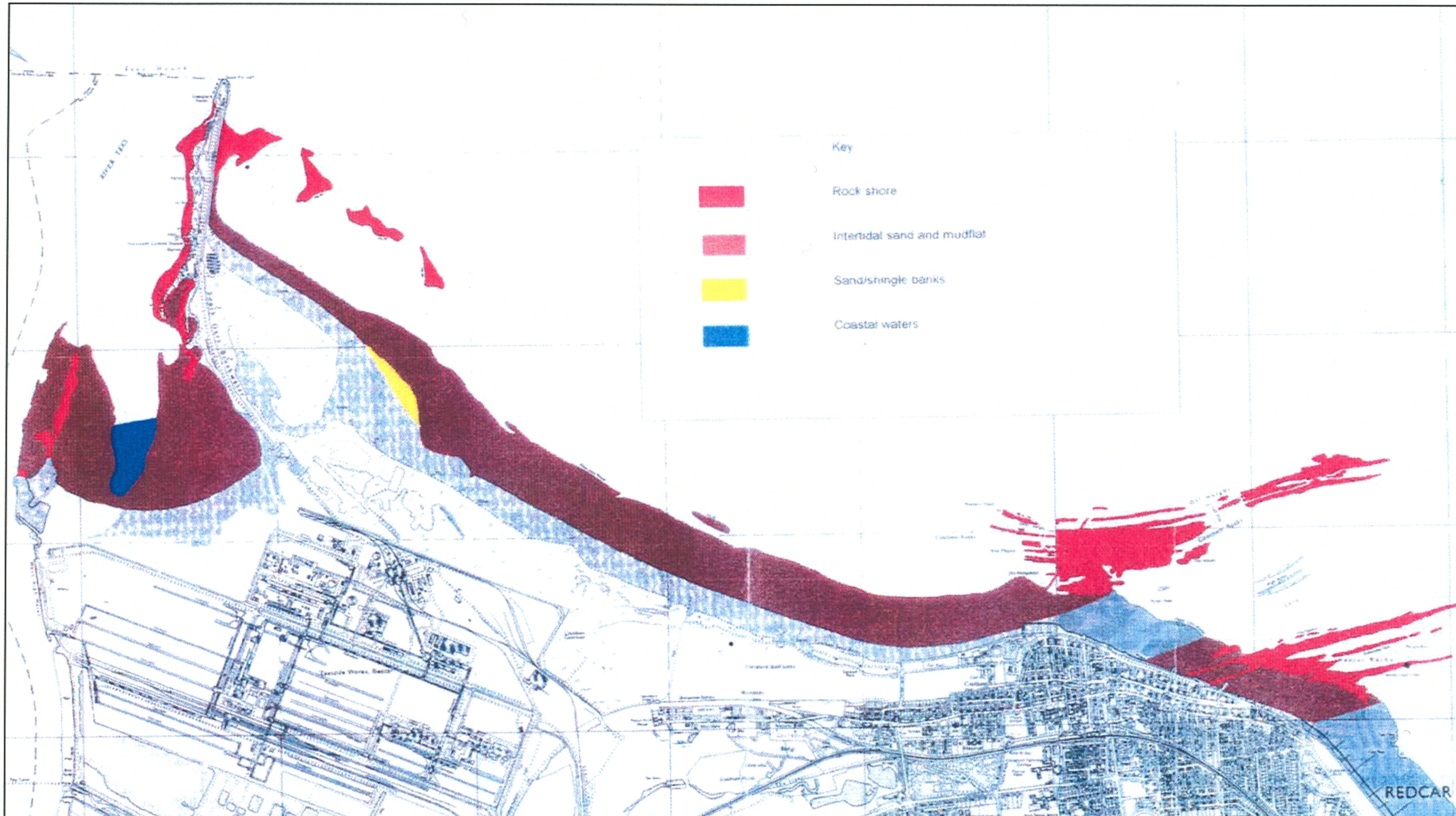
The Distribution of the sub-features of the Teesmouth and Cleveland Coast European Marine Site

(b)



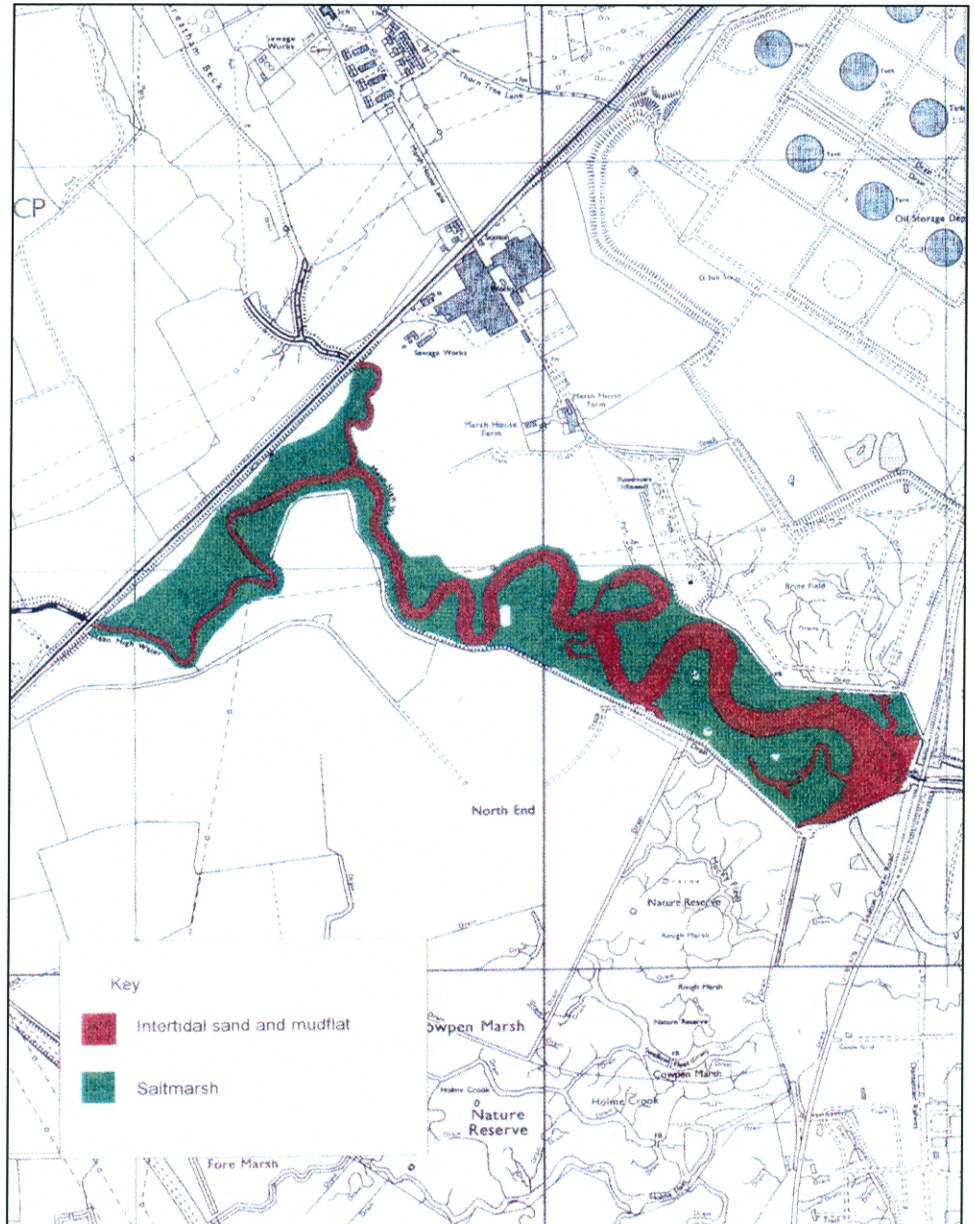
The Distribution of the sub-features of the Teesmouth and Cleveland Coast European Marine Site

(c)

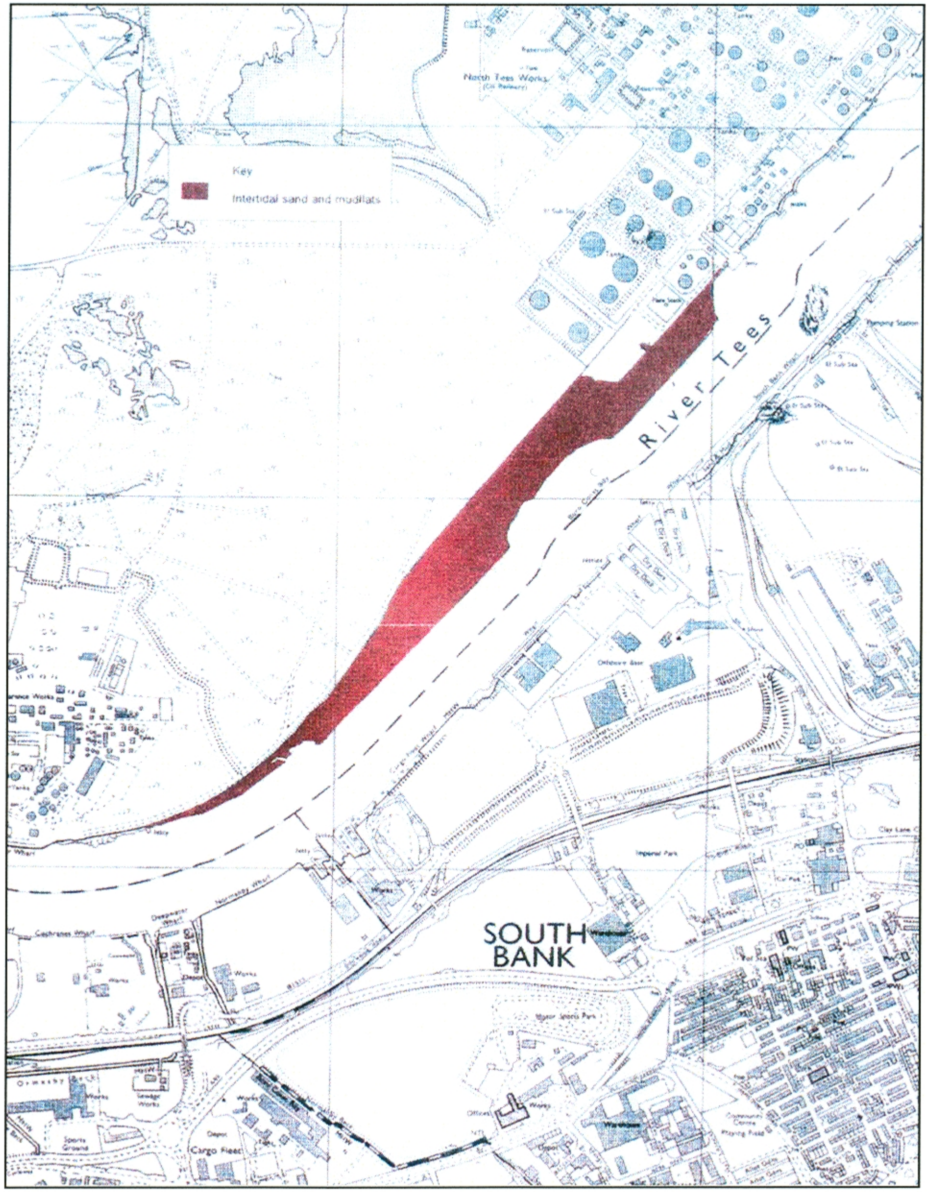


The Distribution of the sub-features of the Teesmouth and Cleveland Coast European Marine Site

(d)



The Distribution of the sub-features of the Teesmouth and Cleveland Coast European Marine Site



Appendix 16.5

Definitions of physical factors

Sensitivity assessment rationale

Aphelochaeta marioni and *Tubificoides* spp. in variable salinity infralittoral mud

IMU.AphTub

Biotope sensitivity matrix

Explanation of sensitivity and recoverability.	
Physical Factors	
Substratum Loss (View Benchmark)	Removal of the substratum would remove the entire benthic population. Significant recolonization by many species in the biotope might occur within a few months but the biotope would be unlikely to be recognised until after six months. Recoverability is therefore recorded as high (see additional information below).
Smothering (View Benchmark)	The characterizing species are all mobile and capable of burrowing through 5 cm of smothering sediment. Some mortality of the population may, however occur. Tube building polychaetes, including *Polydora ciliata*, would be covered and the population would have to build new tubes at the new sediment surface, with some energetic cost. *Hydrobia ulvae* may not be able to reach the sediment surface. The infaunal burrowing polychaetes would probably be able to relocate to their preferred depth and hence are unlikely to be sensitive. Based on the likelihood that some individuals of some species would perish, the biotope intolerance is assessed as intermediate but there is unlikely to be a decline in species richness. Recoverability is recorded as very high (see additional information below).
Increase in suspended sediment (View Benchmark)	The biotope occurs in estuarine waters that are subject to occasional very high suspended sediment loads. Most of the species in this biotope are deposit feeders and may benefit from increased settlement of detritus from increased siltation. Tube building polychaetes are likely to tolerate high suspended sediment as they normally inhabit waters with high levels of suspended sediment which they actively fix in the process of tube making. For example, in the Firth of Forth, *Polydora ciliata* formed extensive mats in areas that had an average of 68 mg/l suspended solids and a maximum of approximately 680 mg/l indicating the species is able to tolerate different levels of suspended solids (Read *et al.*, 1982; Read *et al.*, 1983). The biotope may benefit from an increase in suspended sediment.
Decrease in suspended sediment (View Benchmark)	Deposit feeders and tube builders rely on siltation of suspended sediment. A decrease in suspended sediment will reduce this supply and therefore may compromise growth and reproduction. The benchmark change only lasts for a month and so mortality is unlikely. Intolerance is therefore assessed as low. Growth would quickly return to normal when suspended sediment returns to original levels so recoverability is recorded as very high.
Desiccation (View Benchmark)	The biotope occurs from the lowest shore downwards and may be subject to desiccation. However, all of the characterizing species are burrowing and other frequently occurring species that are surface dwellers may be able to migrate (for instance: *Crangon crangon*, *Hydrobia ulvae*, *Carcinus maenas*). Therefore, desiccation, where the biotope occurs on the lower shore upward extent of its range, is considered not relevant.
Increase in emergence regime (View Benchmark)	The biotope occurs from the lowest shore downwards and may be subject to significant desiccation if emergence increased. Also, during heavy rain, low salinity is a consideration. However, all of the characterizing species are burrowing and other frequently occurring species that are

	surface dwellers may be able to migrate (for instance: Crangon crangon, Hydrobia ulvae, Carcinus maenas). The biotope occurs in situations subject to variable salinity and species are protected within the sediment and fairly stable interstitial water salinity and not expected to be intolerant of occasional downpours. Therefore, a minority of the community would be expected to be affected by increased emergence and no great alteration to the abundance of dominant or characterizing species so that an intolerance of low is suggested but with low confidence. Overall, the biotope would not be changed and so a recoverability of very high is suggested (see additional information below).
Decrease in emergence regime (View Benchmark)	The biotope is predominantly subtidal and a decrease in emergence would be unlikely to have any adverse effect and would increase the habitat available for development of the biotope.
Increase in water flow rate (View Benchmark)	The biotope occurs in areas of 'weak' to 'moderately strong' tidal streams (Connor *et al.*, 1997b) and is therefore likely to be intolerant of increases in water flow to some degree. An increase in water flow of 2 categories could place the biotope in areas of 'very strong' flow. Although muddy sediments are cohesive and may resist winnowing by strong currents, the turbulence involved in tidal flows of 3 knots and more will most likely alter the substratum. The increase would change the sediment characteristics in which the biotope occurs, primarily by re-suspending and preventing deposition of finer particles (Hiscock, 1983). There would be a decrease in tube building material and the lack of deposition of particulate matter at the sediment surface would reduce food availability for the deposit feeders in the biotope. The resultant energetic cost over one year would be likely to result in some mortality of tube builders and infauna. Overall, the biotope is likely to change to one that is characteristic of coarser sediments. A biotope intolerance of high is therefore recorded and species richness is expected to decline. Recoverability is assessed as high (see additional information below) especially as silt, from typically high turbidity estuarine conditions, is likely to redeposit rapidly.
Decrease in water flow rate (View Benchmark)	The biotope occurs in areas of 'weak' tidal streams (Connor *et al.*, 1997b), the characterizing species are adapted to low flow conditions and hence the biotope is unlikely to be intolerant of a further reduction in water flow. (The possibility of water becoming stagnant and, because wave action is typically very low in this biotope, de-oxygenated is considered later in 'Changes in oxygenation'.)
Increase in temperature (View Benchmark)	Bamber & Spencer (1984) observed that *Tubificoides* and *Caulleriella* species, common species in the biotope, were dominant in the area affected by thermal discharge in the River Medway estuary. Murina (1997) categorised *Polydora ciliata* as a eurythermal species because of its ability to spawn in temperatures ranging from 10.6-19.9° C. Increased temperature may have indirect effects. For instance, higher temperatures have been implicated in the proliferation of trematode parasites which have caused mass mortalities in the snail *Hydrobia ulvae* (Jensen & Mouritsen, 1992). No other information has been found on tolerance of component species to increased temperature although it would be expected that the infauna in the biotope will be insulated from extreme changes of temperature. Nevertheless, an increase in temperature may indirectly affect some species as microbial activity within the sediments will be stimulated increasing oxygen consumption and promoting hypoxia (see 'Change in oxygenation' below). An intolerance of low is suggested but with a low confidence. Recoverability is likely to be rapid.
Decrease in temperature (View Benchmark)	Very little information has been found describing the tolerance of component species in the biotope to low temperatures. Beukema *et al.* (1988) observed that *Nephtys hombergi* showed a lower survival in the (colder) north-east part of the Wadden Sea compared to the south-west. *Polydora ciliata* survived a drop in temperature from 11.5 to 7.5°C over the course of 15 hours (Gulliksen, 1977) and so it appears the species is tolerant of acute temperature decreases. During the extremely cold winter of 1962/63 when temperatures dropped below freezing point for several weeks, *Polydora ciliata* was apparently unaffected

	(Crisp, 1964). Observations in Crisp (1964) described mortality of *Lanice conchilega* between the tidemarks but not at lower levels. However, species dwelling in the sediments (at the upper intertidal limits of this biotope) are likely to be protected from the direct effects of temperature change at the surface. For instance, *Hediste diversicolor* burrows deeper in very cold and frosty weather (Linke, 1939). Overall, although mortality seems unlikely, especially as the biotope is mainly subtidal, some reduction in feeding and loss of condition may occur and an intolerance of low has been reported. Recovery would be likely to be immediate.
Increase in turbidity (View Benchmark)	The biotope occurs in relatively turbid waters and therefore the species in the biotope are likely to be well adapted to turbid conditions. An increase in turbidity may affect primary production in the water column and therefore reduce the availability of diatom food, both for suspension feeders and deposit feeders. In addition, primary production by the microphytobenthos on the sediment surface may be reduced, further decreasing food availability for deposit feeders. However, primary production is probably not a major source of nutrient input into the system and, furthermore, phytoplankton will also immigrate from distant areas so the effect may be decreased. As the benchmark turbidity increase only persists for a year, decreased food availability would probably only affect growth and fecundity of the intolerant species so a biotope intolerance of low is recorded. As soon as light levels return to normal, primary production will increase and hence recoverability is recorded as very high.
Decrease in turbidity (View Benchmark)	A decrease in turbidity will mean more light is available for photosynthesis by phytoplankton in the water column and microphytobenthos on the sediment surface. This would increase the primary production in the biotope and may mean greater food availability for deposit feeders and suspension feeders. However, primary production is probably not a major source of production in the biotope so the turbidity decrease is not likely to have a significant effect.
Increase in wave exposure (View Benchmark)	The biotope occurs in 'sheltered' and 'very sheltered' areas (Connor *et al.*, 1997a). This suggests that the biotope would be intolerant of wave exposure to some degree. An increase in wave exposure by two categories for one year would be likely to affect the biotope in several ways. Fine sediments would be eroded (Hiscock, 1983) resulting in the likely reduction of the habitat of the infaunal species, a decreased supply of tube building material and a decrease in food availability for deposit feeders. Furthermore, strong wave action is likely to cause damage or withdrawal of delicate feeding and respiration structures of species within the biotope resulting in loss of feeding opportunities and compromised growth. It is likely that high mortality would result and therefore an intolerance of high is recorded and species richness is expected to decline. Recoverability is recorded as high (see additional information below).
Decrease in wave exposure (View Benchmark)	The biotope occurs in 'sheltered' and 'very sheltered' areas (Connor *et al.*, 1997b). For a subtidal biotope, there is therefore likely to be very little oscillatory water movement and the predominant water movement will be tidal flow. A decrease in wave exposure by 2 categories for a year would place a portion of the biotope in 'ultra sheltered' areas. The characterizing species are adapted to low flow conditions and are likely to tolerate this change.
Noise (View Benchmark)	There is no evidence to suggest that any of the species which characterize the biotope are sensitive to noise or vibration at the level of the benchmark.
Visual Presence (View Benchmark)	Some of the species in the biotope may be intolerant of shading but would not 'see' predators. Farke (1979) noted their intolerance of *Aphelochaeta marioni* to disturbance by light in a microsystem in the laboratory. *Polydora ciliata* responds to shading by withdrawing its palps into its burrow, believed to be a defence against predation (Kinne, 1970). Although not strictly "visual presence", the withdrawal of feeding structures means that growth may be compromised by the interruption of feeding and so intolerance is assessed as low. Growth should quickly return to normal when the disturbance is over so recoverability is recorded as very high.
Abrasion & physical	Many species in the biotope are vulnerable to physical

disturbance (View Benchmark)	abrasion. The tubes of the polychaetes are bound only with mucous and are therefore likely to damaged by a passing scallop dredge. The infaunal annelids are predominantly soft bodied, live within a few centimetres of the sediment surface and may expose feeding or respiration structures where they could easily be damaged by a physical disturbance. Biotope intolerance is therefore recorded as intermediate. Recoverability is recorded as very high as damage at the benchmark level will be restricted in extent (see additional information below). For large scale physical disturbance, sensitivity will be more similar to 'substratum removal' above.
Displacement (View Benchmark)	The species in the biotope are either mobile and capable of re-burrowing or, mainly, capable of re-building tubes. However, following displacement of key or characterizing species, the biotope would have to be structurally re-established - there may be a succession of species before IMU.AphTub is recognised. Intolerance is identified as high and recoverability moderate but with low confidence.
Chemical Factors	
Synthetic compound contamination (View Benchmark)	Some species in the biotope are known to be adversely affected by synthetic chemicals. For instance, *Scoloplos armiger* (frequently found in the biotope) exhibited 'moderate' intolerance to tri-butyl tin antifoulants (Bryan & Gibbs, 1991). Collier & Pinn (1998) investigated the effect on the benthos of Ivermectin, a feed additive treatment for infestations of sea-lice on farmed salmonids. The polychaete *Hediste diversicolor* (frequently found in the biotope) was particularly susceptible, exhibiting 100% mortality within 14 days when exposed to 8 mg/m^2 of Ivermectin in a microcosm. On the other hand, Beaumont *et al.* (1989) investigating the effects of tri-butyl tin (TBT) on benthic organisms found that at concentrations of 1-3 µg/l there was no significant effect on the abundance of *Hediste diversicolor* or *Cirratulus cirratus* (an infrequent component of the biotope) after 9 weeks in a microcosm. However, no juvenile polychaetes were retrieved from the substratum and hence there is some evidence that TBT had an effect on the larval and/or juvenile stages of these polychaetes. *Polydora ciliata* was abundant at polluted sites close to acidified, halogenated effluent discharge from a bromide-extraction plant in Amlwch, Anglesey (Hoare & Hiscock, 1974). Spionid polychaetes, oligochaetes (principally *Tubificoides benedeni*) and *Hydrobia ulvae* were found by McLusky (1982) to be amongst the most tolerant species in the vicinity of a of a petrochemical industrial waste in the Firth of Forth, Scotland. The biotope occurs in polluted conditions and overall, an intolerance of intermediate is suggested reflecting the likelihood that some chemicals might adversely affect some species reducing abundance and viability but the biotope would persist. For recoverability, see additional information. Recovery would require synthetic chemicals to have depurated from the sediment.
Heavy metal contamination (View Benchmark)	The majority of species in this biotope are polychaetes and evidence suggests that they are "fairy resistant" to the effects of heavy metals (Bryan, 1984). However, Hall & Frid (1995) found that the four dominant taxa in their study (species typically found in this biotope including *Tubificoides* spp. and *Capitella capitata*) were reduced in abundance in copper-contaminated sediments and that recovery took up to one year after the source of contamination ceased. Some other species (for instance *Carcinus maenas*) , may adapt to high metal concentrations (Bryan, 1984). *Polydora ciliata*, one of the species that occurs frequently in the biotope, occurs in an area of the southern North Sea polluted by heavy metals but was absent from sediments with very high heavy metal levels (Diaz-Castaneda *et al.*, 1989). However, *Hediste diversicolor* has been found successfully living in estuarine sediments contaminated with copper ranging from 20 µm Cu/g in low copper areas to >4000 µm Cu/g where mining pollution is encountered e.g. Restronguet Creek in the Fal Estuary, Cornwall (Bryan & Hummerstone, 1971). Taking account of the low salinity conditions that affect this biotope (in general, for estuarine animals, heavy metal toxicity increases as salinity decreases and temperature increases: McLusky *et al.*, 1986), it seems possible that some species at least in the biotope might be adversely affected by high contamination by heavy metals. The assessment of intermediate intolerance is

	'precautionary' and the specific levels at a location would need to be matched to experimental or field studies to assign a more accurate rank. For recoverability, see additional information below. Recovery of species in the biotope would be influenced by the length of time it would take for the habitat to return to a suitable state (e.g. factors such as the decline of bioavailable metals within the marine environment), recolonization by adult and juvenile specimens from adjacent habitats, and the establishment of a breeding population.
Hydrocarbon contamination (View Benchmark)	The biotope is predominantly subtidal and component species are protected from the direct effects of oil spills by their depth but are likely to be exposed to the water soluble fraction of oils and hydrocarbons, or hydrocarbons adsorbed onto particulates. Some of the polychaetes in this biotope proliferate after oil spills: for instance *Capitella capitata* (Suchanek, 1993) and *Aphelochaeta marioni* (Dauvin, 1982, 2000). Cirratulids seem mostly immune probably because their feeding tentacles are protected by mucus (Suchanek, 1993). Nevertheless it might be expected that some of the species in the biotope may be affected and the increase in abundance of some species suggests reduced competition with others. However, because some species in the biotope may increase in abundance following a spill, and because of the subtidal character of the biotope, it is expected that adverse effects from hydrocarbons may reduce abundance and viability of some species but the biotope would persist. An intolerance of intermediate is therefore suggested but with a high recoverability (see additional information below).
Radionuclide contamination (View Benchmark)	No information has been found.
Changes in nutrient levels (View Benchmark)	It would be expected that some increase in nutrients would favour the expansion of food resources for deposit feeders. Increased nutrients often derive from sewage inputs and presence of species such as *Aphelochaeta marioni* in such situations (for instance Broom *et al.*, 1991) may reflect tolerance to high nutrients or to deoxygenated conditions or both. Overall, the benefits (higher food resources) and disbenefits (possible hypoxia) make it difficult to determine intolerance but, considering the often eutrophic situations the biotope occurs in, an intolerance of low is suggested but with very low confidence.
Increase in salinity (View Benchmark)	The biotope occurs in reduced to full salinity and so increase in salinity is considered not relevant.
Decrease in salinity (View Benchmark)	The biotope occurs in reduced salinity. One of the characterizing species, *Aphelochaeta marioni* , has been recorded from brackish inland waters in the Southern Netherlands with a salinity of 16 psu, but not in areas permanently exposed to lower salinities (Wolff, 1973). However, it also penetrates into areas exposed to salinities as low as 4 psu for short periods at low tide when fresh water discharge from rivers is high (Farke, 1979). The distribution of *Aphelochaeta marioni*, therefore, suggests that it is very tolerant of low salinity conditions and would be tolerant of reduced salinity especially for short periods. However, a long term reduction from reduced to low salinity may affect some of the species in the biotope with possible losses and reduced viability. The biotope would probably change to one more tolerant of very low salinity conditions. An intolerance of high is therefore suggested but recovery would be rapid on return to previous conditions (see additional information below).
Changes in oxygenation (View Benchmark)	Some of the species frequently found in the biotope (*Malacoceros fuliginosus*, *Nephtys hombergi*, *Heteromastus filiformis*) are noted by Diaz & Rosenberg (1995) as resistant to severe hypoxia or (*Capitella capitata*, *Hediste diversicolor*) to moderate hypoxia. *Tubificoides benedii* has a high capacity to tolerate anoxic conditions (see Giere *et al.*, 1999). Broom *et al.* (1991) found communities with species characteristic of this biotope in the Severn Estuary where the oxygenated layer was very thin probably as a result of sewage input and suggested that *Aphelochaeta marioni* was characteristic of faunal assemblages in the Severn Estuary with very poorly

	oxygenated mud. The successful survival of *Hediste diversicolor* under prolonged hypoxia was confirmed by the resistance experiments of Vismann (1990), which resulted in a mortality of only 15% during a 22 day exposure of *Hediste diversicolor* at 10% oxygen (ca. 2.8 mg O2 per litre). Whilst the biotope might thrive in conditions of hypoxia, some species might suffer, reducing species richness. Following a hypoxia event in summer 1994 in the southern Baltic, species (some of which occur in the biotope) took at least two years to recolonize but by summer 1996 had returned to pre-event community structure (Powilleit & Kube, 1999). Since species richness may be reduced by reduction in oxygen, an intolerance of intermediate is suggested reflecting the likelihood that the biotope will not be lost.
Biological Factors	
Introduction of microbial pathogens/parasites (View Benchmark)	No information was found concerning the infection of most of the characterizing species by microbial pathogens. However, there are records of mass mortalities of *Hydrobia ulvae* caused by high temperatures triggering mass development of larval digenean trematodes within the snails (Jensen & Mouritsen, 1992). The effect on the biotope is likely to be low and recovery high.
Introduction of non-native species (View Benchmark)	Invasion by the slipper limpet *Crepidula fornicata* may switch the biotope to IMU.CreAph suggesting high intolerance as the original biotope would be lost. Species richness might decline as *Crepidula* may dominate the seabed. On the other hand, low densities of *Crepidula* might have no effect on species richness and add one species (*Crepidula*) to the community.
Extraction of key or important characterizing species (View Benchmark)	There is no evidence of species in the biotope being targeted for extraction (for instance, for bait) and so no expected impact.
Extraction of important species (View Benchmark)	There is no evidence of species in the biotope being targeted for extraction (for instance, for bait) and so no expected impact.

Additional information

Recoverability

The biotope typically consists of fast growing opportunistic species so that recoverability is expected to be very high or high. However, recovery to full species richness may take longer than one year. The following information has informed the recoverability assessment. Ferns *et al.* (2000) found that, following significant depletion of *Nephtys hombergi* by cockle dredging recovery took more than 50 days (but not more than 100 days). Hall & Frid (1998) found that colonization by many of the polychaetes associated with this biotope did not vary significantly with season although recruitment of *Tubificoides benedii* and *Ophyrotrocha hartmanni* did vary significantly with season. Also, there may be spawning failure in some years, for instance in *Nephtys hombergi* (Olive *et al.* 1997). Following a hypoxia event in summer 1994 in the southern Baltic, species (some of which occur in the biotope) took at least two years to recolonize but by summer 1996 had returned to pre-event community structure (Powilleit & Kube, 1999).

Biotope sensitivity and recoverability matrix

Click here for Biotope Sensitivity references

Back to biotope selection

Terms & Conditions

Any comments? Click here

Glossary of scientific terms

Information last updated: 29/05/2002

The Biology and Sensitivity Key Information Sub-programme is funded by:

ENGLISH NATURE

SCOTTISH NATURAL HERITAGE

defra Department for Environment Food and Rural Affairs

THE CROWN ESTATE

Cyngor Cefn Gwlad Cymru Countryside Council for Wales

SEPA Scottish Environment Protection Agency

MarLIN The Marine Life Information Network for Britain & Ireland

Information to support marine environmental management, protection and education.

www.marlin.ac.uk

Biotope Intolerance

The susceptibility of a habitat, community or species (i.e. the components of a biotope) to damage, or death, from an external factor. Intolerance must be assessed relative to change in a specific factor.

Rank	Definition
High	Species important for the structure and/or function of the biotope, or its identification ('important characterizing' species), are likely to be killed and/or the habitat is likely to be destroyed by the factor under consideration.
Intermediate	The population(s) of species important for the structure and/or function of the biotope, or its identification ('important characterizing' species), may be reduced or degraded by the factor under consideration, the habitat may be partially destroyed, or the viability of a species population, diversity and function of a community may be reduced.
Low	Species important for the structure and/or function of the biotope, or its identification ('important characterizing' species), will not be killed or destroyed by the factor under consideration and the habitat is unlikely to be damaged. However, the viability of a species population or the diversity / functionality in a community will be reduced.
Tolerant	The factor does not have a detectable effect on the structure and/or function of a biotope or the survival or viability of species important for the structure and/or function of the biotope or its identification.
Tolerant*	The extent or species richness of a biotope may be increased or enhanced by the factor.
Not relevant	Intolerance may be assessed as not relevant where communities and species are protected or physically removed from the factor (for, instance circalittoral communities are unlikely to be affected by increased emergence regime).

Recoverability

The ability of a habitat, community or individual (or individual colony) of species to redress damage sustained as a result of an external factor.

Recoverability is only applicable if and when the impacting factor has been removed or has stopped. Ranks also only refer to the recoverability potential of a species, based on their reproductive biology etc.

Rank	**Definition** (from Hiscock *et al.*, 1999)
None	Recovery is not possible
Very low / none	Partial recovery is only likely to occur after about 10 years and full recovery may take over 25 years or never occur.
Low	Only partial recovery is likely within 10 years and full recovery is likely to take up to 25 years.
Moderate	Only partial recovery is likely within 5 years and full recovery is likely to take up to 10 years.
High	Full recovery will occur but will take many months (or more likely years) but should be complete within about five years.
Very high	Full recovery is likely within a few weeks or at most 6 months.
Immediate	Recovery immediate or within a few days.
Not relevant	For when intolerance is not relevant or cannot be assessed. Recoverability cannot have a value if there is no 'intolerance' and is thus 'Not relevant'.

References:

Hiscock, K, Jackson, A. & Lear, D., 1999. Assessing seabed species and ecosystem sensitivities: existing approaches and development, October 1999 edition. *Report to the Department of Environment, Transport and the Regions form the Marine Life Information Network (MarLIN), Marine Biological Association of the United Kingdom, Plymouth.*

Sensitivity

Sensitivity is defined according to the following scenarios. These scenarios give rise to rationale used to combine intolerance and recoverability in order to determine sensitivity (see below). For further information refer to the summary rationale.

Sensitivity scale	Sensitivity definition or scenario
Very High	'Very high' sensitivity is indicated by the following scenario: • The habitat or species is very adversely affected by an external factor arising from human activities or natural events (either killed/destroyed, 'high' intolerance) and is expected to recover only over a prolonged period of time, i.e. >25 years or not at all (recoverability is 'very low' or 'none'). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, 'intermediate' intolerance) but is not expected to recover at all (recoverability is 'none').
High	'High' sensitivity is indicated by the following scenarios. • The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, 'high' intolerance) and is expected to recover over a very long period of time, i.e. >10 or up to 25 years ('low' recoverability). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, 'intermediate' intolerance) and is expected to recover over a very long period of time, i.e. >10 years (recoverability is 'low', or 'very low'). • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, 'low' intolerance) but is not expected to recover at all (recoverability is 'none'), so that the habitat or species may be vulnerable to subsequent damage.
Moderate	'Moderate' sensitivity is indicated by the following scenarios: • The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, 'high' intolerance) but is expected to take more than 1 year or up to 10 years to recover ('moderate' or 'high' recoverability). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, 'intermediate' intolerance) and is expected to recover over a long period of time, i.e. >5 or up to 10 years ('moderate' recoverability). • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, 'low' intolerance) but is expected to recover over a very long period of time, i.e. >10 years (recoverability is 'low', 'very low'), during which time the habitat or species may be vulnerable to subsequent damage.
Low	'Low' sensitivity is indicated by the following scenarios: • The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, 'high' intolerance) but is expected to recover rapidly, i.e. within 1 year ('very high' recoverability). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, 'intermediate' intolerance) but is expected to recover in a short period of time, i.e. within 1 year or up to 5 years ('very high' or 'high' recoverability). • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, 'low' intolerance) but is expected to take more than 1 year or up to 10 years to recover ('moderate' or 'high' recoverability).
Very low	'Very low' is indicated by the following scenarios: • The habitat or species is very adversely affected by an external factor arising from human activities or natural events (killed/destroyed, 'high' intolerance) but is expected to recover rapidly i.e. within a week ('immediate' recoverability). • The habitat or species is adversely affected by an external factor arising from human activities or natural events (damaged, 'intermediate' intolerance) but is expected to recover rapidly, i.e. within a week ('immediate' recoverability). • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, 'low' intolerance) but is expected to recover within a year ('very high' recoverability).

Not sensitive	'Not sensitive' is indicated by the following scenarios: • The habitat or species is affected by an external factor arising from human activities or natural events (reduced viability **, 'low' intolerance) but is expected to recover rapidly, i.e. within a week ('immediate' recoverability). • The habitat or species is tolerant of changes in the external factor.
Not sensitive*	The habitat or species may benefit from the change in an external factor (intolerance has been assessed as 'tolerant*')
Not relevant	The habitat or species is protected from changes in an external factor (i.e. through a burrowing habit or depth), or is able to avoid the external factor.
(**) 'Reduced viability' includes physiological stress, reduced fecundity, reduced growth, and partial death of a colonial animal or plant	

Combining 'intolerance' and 'recoverability' assessments to determine 'sensitivity'.
NS = not sensitive, NR = not relevant

		Recoverability						
		None	Very low (>25 yr.)	Low (>10–25 yr.)	Moderate (>5 -10 yr.)	High (1 -5 yr.)	Very high (<1 yr.)	Immediate (< 1 week)
Intolerance	High	*Very high*	*Very high*	*High*	*Moderate*	*Moderate*	*Low*	*Very low*
	Intermediate	*Very high*	*High*	*High*	*Moderate*	*Low*	*Low*	*Very Low*
	Low	*High*	*Moderate*	*Moderate*	*Low*	*Low*	*Very Low*	*NS*
	Tolerant	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*	*NS*
	Tolerant*	*NS**	*NS**	*NS**	*NS**	*NS**	*NS**	*NS**
	Not relevant	NR	NR	NR	NR	NR	NR	NR

Species richness

The number of species in a given habitat, biotope, community or assemblage. The following scale is used to judge the likely response of species richness to an external factor.

Rank	Definition
Major decline	The number of species in the community is likely to decrease significantly (>75% of species) in response to the factor, probably because of mortality and loss of habitat. For example, a change from very rich to very poor on the NHAP scale (Hiscock 1996).
Decline	The community is likely to loose some of its species in response to the factor by either direct mortality or emigration.
Minor decline	The community is likely to loose few species (<25% of species) in response to the factor. For example, a decrease of one level on the NHAP scale (Hiscock 1996).
No change	The factor is unlikely to change the species richness of the community
Rise	The number of species in the community may increase in response to the factor. (Note the invasion of the community by aggressive or non-native species may degrade the community).
Not relevant	It is extremely unlikely for a factor to occur (e.g. emergence of a deep water community) or the community is protected from the factor.

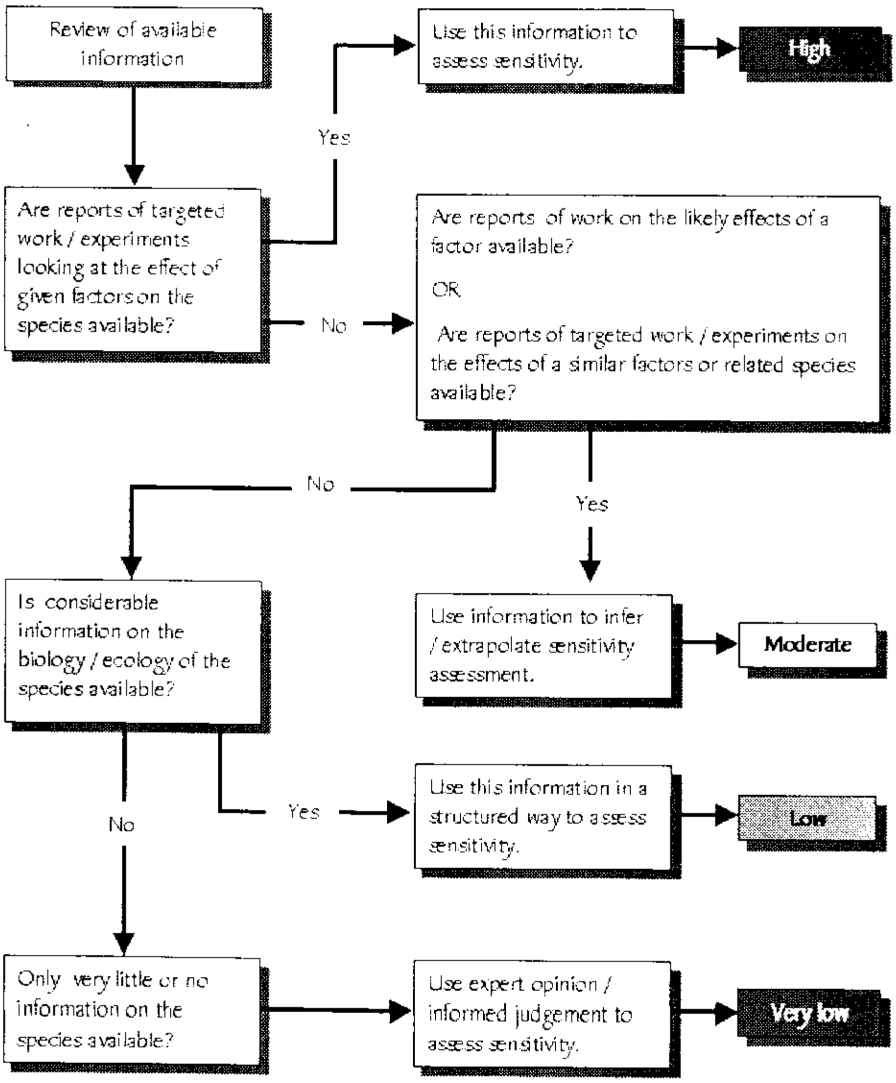
References:

Hiscock, K., 1996. Interpretation of data. In *Marine Nature Conservation Review: Rationale and methods*, ed. K. Hiscock, p.73-84. Peterborough, Joint Nature Conservation Committee.

Evidence/ Confidence

The scale indicates an appraisal of the specificity of the information (data) available to support the assessment of sensitivity and recoverability.

Evidence / Confidence	Definition
High	Assessment has been derived from sources that specifically deal with sensitivity and recoverability of a species or biotope to a particular factor. Experimental work has been done investigating the effects of such a factor.
Moderate	Assessment has been derived from sources that consider the likely effects of a particular factor on a species or biotope.
Low	Assessment has been derived from sources that only cover aspects of the biology of the species (or biotope) or from a general understanding of the species or biotope. No information is present regarding the effects of factors.
Very low	Assessment derived by 'informed judgement' where very little or no information is present at all on the species.
Not relevant	No assessment of sensitivity or recoverability was made.
NB:	In some cases it is possible for limited evidence to be considered 'high' for the assessment of sensitivity to a specific factor. For example, if a species is known to lack eyes (or equivalent photoreceptors) then it could confidently be considered 'not sensitive' to visual disturbance and the level of evidence would be recorded as 'high'.



Appendix 17.1

Mean Low Water Counts for Each Sector of Seal Sands by Month and Species, May 1990 - December 2003 (Source:WWT)

Appendix 17.1

Mean Low Water Counts for Each Sector of Seal Sands by Month and Species, May 1990 - December 2003 (Source: WWT) **Continued/...**

Species	Period/ Season	Sectors of Seal Sands												Conservation status
		1	2	3	4	5	6	7	8	9	10	11	12	
Shelduck	Jan	0.86	110.64	4.21	43.64	10.50	80.00	0.79	274.50	0.29	20.36	0.00	51.00	SPA citation species
	Feb	0.00	59.08	14.46	36.15	1.54	52.31	0.31	225.23	0.23	17.23	1.15	48.15	
	Mar	0.07	49.57	16.71	26.50	2.21	22.79	0.07	133.71	0.43	9.29	0.43	43.36	
	Apr	0.86	23.93	15.93	25.14	0.36	5.93	0.00	54.71	1.43	16.36	0.57	35.07	
	May	0.93	7.07	9.62	35.67	0.33	7.64	0.00	7.21	2.48	5.10	0.19	19.81	
	June	2.72	4.83	16.22	42.06	4.50	7.44	0.00	1.22	2.11	3.78	0.11	23.83	
	July	3.60	8.96	21.62	25.44	1.12	4.12	0.00	4.44	0.12	6.14	0.02	9.62	
	Aug	0.49	1.47	3.96	6.07	0.04	1.18	0.00	0.73	0.00	0.11	0.00	1.22	
	Sept	0.38	3.20	5.60	11.29	3.40	6.31	0.00	10.09	0.00	3.73	0.00	15.16	
	Oct	0.50	47.00	24.75	37.75	1.38	29.00	2.31	80.00	0.00	18.25	0.00	45.06	
	Nov	0.36	123.29	27.79	44.36	2.64	52.36	0.43	137.14	0.00	41.07	0.00	55.00	
	Dec	0.21	121.00	33.50	56.00	2.36	69.29	2.71	237.29	0.43	29.86	0.00	60.00	
Mallard	Jan	0.00	0.75	0.00	0.00	0.00	0.00	0.00	2.75	0.17	0.00	0.00	0.00	SSSI citation species
	Feb	0.00	0.18	0.00	0.00	0.00	0.00	0.00	1.91	0.36	0.00	0.00	0.00	
	Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.17	0.00	0.00	0.00	
	Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.67	0.00	0.00	
	May	0.15	0.00	0.00	0.00	0.00	0.00	0.00	0.06	0.00	0.29	0.00	0.00	
	June	0.00	0.67	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.80	0.00	0.00	
	July	0.78	0.18	0.28	0.00	0.00	0.00	0.00	3.00	0.00	0.08	0.00	0.00	
	Aug	0.06	1.86	0.00	0.00	0.00	0.00	0.00	4.42	0.00	0.06	0.00	0.00	
	Sept	0.00	11.62	0.03	0.00	0.00	0.00	0.00	16.95	0.24	3.89	0.00	0.54	
	Oct	0.00	12.31	0.00	0.00	0.00	0.00	0.00	12.38	5.08	0.00	0.00	0.00	
	Nov	0.00	0.50	0.00	0.00	0.00	0.00	0.00	8.08	0.00	0.00	0.00	0.00	
	Dec	0.00	0.42	0.00	0.00	0.00	0.08	0.00	0.50	6.25	0.00	0.00	0.00	
Wigeon	Jan	0.00	0.42	0.00	0.17	1.00	0.00	0.00	15.25	0.00	0.00	3.92	0.00	SSSI citation species
	Feb	0.00	3.82	0.00	0.00	0.00	0.55	0.00	41.45	0.00	0.00	1.18	0.00	
	Mar	0.00	0.50	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	0.00	0.00	
	Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.42	
	May	0.00	0.06	0.00	0.00	0.00	0.12	0.00	0.00	0.00	0.00	0.00	0.00	
	June	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	July	0.05	0.03	0.00	0.00	0.00	0.00	0.00	0.28	0.00	0.05	0.00	0.00	
	Aug	0.00	0.72	0.00	0.83	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.75	
	Sept	0.00	9.03	0.24	0.00	0.00	1.14	0.00	19.00	0.16	3.57	0.00	0.00	
	Oct	0.00	35.31	0.00	0.00	0.00	0.00	0.00	90.54	43.46	0.00	0.00	5.38	
	Nov	0.00	31.58	0.00	0.00	0.00	0.00	0.00	96.42	2.25	0.00	0.00	0.00	
	Dec	0.00	7.08	0.00	0.00	0.00	0.00	0.00	30.58	0.00	0.00	4.58	0.00	

Mean Low Water Counts for Each Sector of Seal Sands by Month and Species, May 1990 - December 2003 (Source: WWT) **Continued/...**

Species	Period/ Season	Sectors of Seal Sands												Conservation status
		1	2	3	4	5	6	7	8	9	10	11	12	
Grey Plover	Jan	2.50	19.07	12.07	31.50	0.14	32.93	0.00	16.00	0.29	12.93	0.57	10.64	SSSI citation species
	Feb	1.38	18.46	12.92	13.00	0.00	39.31	0.31	20.15	0.08	21.77	0.23	26.00	
	Mar	0.43	6.36	12.36	1.71	0.00	17.21	0.00	12.50	2.71	13.43	0.00	5.36	
	Apr	1.00	1.50	1.57	0.71	0.00	2.43	0.00	1.57	0.00	0.64	0.00	0.64	
	May	0.00	0.21	1.00	1.10	0.00	1.33	0.00	0.74	0.00	0.74	0.00	1.10	
	June	0.06	0.39	0.28	0.00	0.00	0.11	0.00	0.83	0.00	0.22	0.00	0.72	
	July	0.00	0.14	0.34	0.10	0.00	0.54	0.00	0.58	0.00	0.00	0.00	0.30	
	Aug	0.29	0.56	4.69	1.93	0.00	1.20	0.00	2.96	0.04	2.78	0.02	2.02	
	Sept	0.58	4.22	4.58	2.36	0.09	4.11	0.00	4.69	0.18	7.84	0.13	2.44	
	Oct	1.50	7.75	7.13	4.00	0.06	17.38	0.13	11.38	0.44	10.00	0.06	6.63	
	Nov	0.07	7.79	5.43	6.57	0.00	25.71	0.29	8.36	0.36	11.43	0.14	13.71	
	Dec	0.43	8.64	4.50	12.29	0.07	36.50	0.00	16.57	0.21	10.50	0.14	17.29	
Golden Plover	Jan	2.71	0.00	0.00	0.00	0.00	10.36	0.00	2.79	0.00	0.00	0.00	0.00	Annex 1 species SSSI citation species SPEC category 4
	Feb	0.00	0.15	0.00	0.85	0.00	4.92	23.85	10.00	0.00	0.00	0.00	4.00	
	Mar	0.00	26.00	0.00	0.00	0.00	0.00	0.00	2.50	0.00	0.71	0.00	0.00	
	Apr	0.00	0.14	13.43	0.00	0.00	0.00	0.00	2.43	0.00	0.00	0.00	0.00	
	May	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.19	0.00	1.26	0.00	0.00	
	June	0.00	0.00	0.06	0.00	0.00	0.00	0.00	0.39	0.00	0.00	0.00	0.00	
	July	2.56	11.48	8.46	1.96	0.00	0.02	0.00	31.34	0.00	5.62	0.00	0.00	
	Aug	0.47	17.69	9.58	11.49	0.00	0.09	0.00	48.22	0.00	2.13	0.00	0.16	
	Sept	0.87	3.62	0.84	1.62	0.00	0.02	0.00	19.27	0.00	0.16	0.00	0.00	
	Oct	0.00	0.00	0.00	6.88	0.00	2.88	0.00	9.50	0.00	0.00	0.00	0.00	
	Nov	1.43	0.14	0.00	2.79	0.00	12.36	0.00	2.79	0.00	0.00	0.00	0.00	
	Dec	0.00	0.00	0.00	0.93	0.00	23.79	0.00	0.36	0.00	0.00	0.00	0.00	
Knot	Jan	0.00	219.93	6.36	83.93	0.00	3.00	0.00	367.00	0.07	247.21	0.36	107.71	SPA citation species
	Feb	0.00	22.54	25.00	12.15	0.00	47.08	0.00	220.00	0.00	43.31	0.00	19.85	
	Mar	0.00	13.71	28.64	25.79	0.00	15.71	0.00	85.71	0.00	52.86	0.00	26.21	
	Apr	0.00	0.29	0.57	30.07	0.00	3.93	0.00	11.00	0.00	3.57	0.00	9.64	
	May	0.00	0.17	0.76	4.90	0.00	2.83	0.00	1.26	0.00	0.33	0.00	1.43	
	June	0.00	1.89	0.00	0.00	0.00	4.67	0.00	0.11	0.00	0.33	0.00	1.67	
	July	0.64	7.64	4.06	3.84	0.00	2.16	0.00	2.06	0.00	3.42	0.00	2.28	
	Aug	0.56	6.29	4.13	9.31	0.00	0.22	0.00	7.38	0.00	5.00	0.02	5.49	
	Sept	0.00	4.64	0.67	2.38	0.00	0.58	0.00	8.04	0.00	0.78	0.04	1.02	
	Oct	0.00	0.38	2.75	2.88	0.00	0.00	0.00	4.69	0.00	7.69	0.00	10.13	
	Nov	0.00	0.79	2.64	0.36	0.00	5.43	0.00	1.43	0.00	7.29	0.00	3.21	
	Dec	0.00	3.21	4.14	7.57	0.00	7.86	0.00	69.07	0.00	4.43	0.00	35.71	

Mean Low Water Counts for Each Sector of Seal Sands by Month and Species, May 1990 - December 2003 (Source: WWT) Continued/...

Species	Period/ Season	Sectors of Seal Sands												Conservation status
		1	2	3	4	5	6	7	8	9	10	11	12	
Teal	Jan	0.00	0.00	0.00	19.14	1.21	12.71	0.00	0.00	0.00	0.00	0.00	0.00	SSSI citation species
	Feb	0.00	0.00	0.00	26.62	0.00	31.92	0.00	0.00	0.00	0.00	0.00	0.00	
	Mar	0.00	0.00	0.00	11.21	0.29	4.79	0.00	0.00	0.14	0.00	0.00	0.00	
	Apr	0.00	0.00	0.00	1.93	0.00	0.57	0.00	0.00	0.00	0.00	0.00	0.00	
	May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	June	0.00	0.39	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	July	0.02	0.08	0.06	0.00	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	
	Aug	0.00	1.60	0.00	2.76	0.00	0.38	0.00	2.56	0.07	0.20	0.00	0.76	
	Sept	0.00	1.76	0.00	0.24	0.07	0.00	0.00	1.16	0.11	0.00	0.07	0.80	
	Oct	0.00	1.71	0.00	0.59	0.00	0.35	0.00	8.12	17.47	0.00	0.00	0.00	
	Nov	0.00	0.00	0.00	4.64	0.00	2.14	0.00	2.43	0.00	0.00	0.00	0.00	
	Dec	0.00	0.00	0.00	19.00	0.00	12.21	0.00	2.36	3.71	0.00	0.00	0.00	
Oystercatcher	Jan	4.86	28.07	13.71	16.07	0.00	10.79	2.50	42.21	0.36	10.79	9.71	5.93	SSSI citation species
	Feb	14.31	16.31	28.77	21.62	0.00	12.46	0.85	27.15	2.15	17.23	13.92	1.62	
	Mar	9.64	14.79	17.43	25.71	0.00	25.36	1.86	21.43	1.43	15.79	12.14	1.50	
	Apr	0.14	3.93	6.57	8.79	1.14	21.21	2.57	6.29	0.36	2.29	13.07	3.50	
	May	0.14	5.38	2.14	22.52	0.98	34.60	1.45	7.07	0.45	3.48	6.52	6.45	
	June	1.33	6.83	5.33	11.94	0.39	22.61	1.39	15.89	0.61	3.61	3.56	2.89	
	July	2.80	14.76	21.30	10.36	0.04	2.84	0.56	13.96	1.28	8.56	7.08	1.44	
	Aug	1.18	35.84	29.11	17.24	0.18	3.40	1.04	58.04	0.33	19.71	11.49	4.13	
	Sept	0.67	33.47	28.58	11.98	0.00	9.53	1.18	85.64	0.00	14.47	10.62	8.07	
	Oct	1.13	28.25	27.25	9.81	0.00	2.44	0.50	64.63	0.00	14.94	11.13	3.56	
	Nov	0.86	37.57	20.21	15.07	0.07	9.36	1.07	79.50	2.14	27.64	10.50	6.00	
	Dec	1.50	30.79	25.57	6.14	0.00	5.14	0.36	52.79	0.07	36.71	10.07	6.57	
Ringed Plover	Jan	0.00	6.86	11.07	12.36	0.00	0.00	0.00	2.93	0.00	0.43	0.00	0.14	SPA citation species
	Feb	1.54	1.69	15.38	16.54	0.00	6.38	0.00	2.85	0.00	1.00	0.00	1.85	
	Mar	0.00	2.79	7.93	15.57	0.00	5.36	0.00	5.71	0.00	6.14	0.00	0.00	
	Apr	0.07	1.21	14.86	23.93	0.00	9.64	0.00	4.71	0.00	2.79	0.00	0.50	
	May	0.00	8.19	49.74	115.86	0.00	119.76	1.31	37.98	0.00	21.76	0.02	23.67	
	June	1.33	2.83	10.72	18.11	0.00	3.61	0.00	10.33	0.00	5.00	0.06	0.06	
	July	0.92	5.60	2.78	1.72	0.00	0.40	0.00	2.62	0.36	1.80	0.18	0.14	
	Aug	0.24	35.62	43.16	74.51	0.00	12.27	1.47	21.11	0.24	17.58	0.00	4.09	
	Sept	0.00	26.36	9.13	5.40	0.02	4.58	0.00	23.16	0.00	13.56	0.00	2.82	
	Oct	0.44	4.56	3.94	10.19	0.00	13.25	2.88	11.81	0.00	1.94	0.00	0.31	
	Nov	0.00	5.29	0.00	20.21	0.00	13.64	0.00	5.21	0.00	4.93	0.00	0.00	
	Dec	0.00	7.14	2.57	17.07	0.00	8.43	0.00	1.79	0.00	0.50	0.00	0.00	

Mean Low Water Counts for Each Sector of Seal Sands by Month and Species, May 1990 - December 2003 (Source: WWT)

Continued/…

Species	Period/ Season	Sectors of Seal Sands												Conservation status
		1	2	3	4	5	6	7	8	9	10	11	12	
Sanderling	Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	SPA citation species
	Feb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Mar	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Apr	0.00	0.00	0.00	0.36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	May	0.00	0.90	17.55	14.48	0.00	9.76	0.00	5.00	0.00	18.31	0.12	3.24	
	June	0.00	0.17	2.28	8.78	0.00	0.00	0.00	0.33	0.00	10.72	0.00	0.00	
	July	0.00	0.46	0.00	0.16	0.00	0.00	0.00	0.08	0.00	0.84	0.00	0.00	
	Aug	0.00	2.30	0.75	0.09	0.00	0.00	0.00	0.50	0.00	2.00	0.23	0.09	
	Sept	0.00	0.02	0.00	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.09	
	Oct	0.00	0.00	0.00	1.25	0.00	0.75	0.00	0.00	0.00	0.00	0.00	0.00	
	Nov	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Dec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Turnstone	Jan	0.00	0.29	0.07	0.07	0.00	0.00	0.00	1.50	0.00	0.36	0.00	0.00	SSSI citation species
	Feb	0.00	0.08	0.15	0.00	0.00	0.00	0.00	0.69	0.00	0.08	0.00	0.00	
	Mar	0.00	0.07	0.07	0.07	0.00	0.29	0.00	0.36	0.00	0.14	0.14	0.00	
	Apr	0.00	0.21	0.36	0.07	0.00	0.29	0.00	5.00	0.00	0.00	0.14	0.00	
	May	0.00	2.14	1.95	3.24	0.00	0.38	0.07	3.21	0.00	1.12	0.17	0.29	
	June	0.00	0.17	0.61	0.17	0.00	0.72	0.00	0.89	0.00	0.39	0.00	0.00	
	July	0.00	3.20	0.40	0.98	0.00	1.70	0.16	2.60	0.00	0.58	0.14	0.40	
	Aug	0.00	5.91	2.42	1.56	0.00	0.11	0.00	3.58	0.04	1.27	0.49	0.20	
	Sept	0.00	1.00	0.02	0.07	0.24	0.00	0.00	0.38	0.00	0.11	0.07	0.00	
	Oct	0.00	0.25	0.06	0.13	0.00	0.00	0.00	0.44	0.00	0.31	0.00	0.38	
	Nov	0.00	0.36	0.43	0.14	0.00	0.00	0.00	0.57	0.00	1.21	0.00	0.00	
	Dec	0.00	0.07	0.36	0.14	0.00	0.00	0.00	0.64	0.00	0.21	0.00	0.00	
Dunlin	Jan	0.29	51.86	17.14	223.93	12.14	166.64	0.00	277.93	0.00	89.57	0.00	164.14	SSSI citation species SPEC category 3W
	Feb	0.38	47.46	33.54	161.46	2.31	87.08	0.00	66.08	8.69	27.38	0.00	146.77	
	Mar	0.00	9.14	12.86	76.21	0.29	40.71	0.00	12.00	10.29	25.57	0.00	41.71	
	Apr	0.00	1.07	13.07	74.43	0.00	30.07	0.00	27.07	0.00	17.79	0.00	10.14	
	May	0.00	4.05	17.62	93.31	0.00	136.33	0.07	13.48	0.00	13.33	0.02	37.17	
	June	0.06	0.61	2.39	7.89	0.00	2.00	0.00	2.17	0.00	1.00	0.00	0.94	
	July	0.16	32.06	9.06	31.52	0.00	102.24	0.16	67.90	0.06	50.88	0.00	57.50	
	Aug	0.02	90.58	56.16	212.80	0.31	109.96	0.13	105.13	0.09	133.51	0.00	67.31	
	Sept	0.02	71.49	26.96	172.51	7.58	254.76	0.00	59.60	0.02	75.60	0.44	72.07	
	Oct	0.00	57.94	18.50	119.94	1.13	155.25	0.00	34.50	0.00	38.19	0.00	59.44	
	Nov	0.00	9.50	6.14	143.07	0.14	167.57	0.00	31.14	0.00	46.93	0.00	96.43	
	Dec	0.00	40.50	2.71	120.00	0.00	156.71	0.00	41.21	0.00	51.79	0.00	105.71	

Mean Low Water Counts for Each Sector of Seal Sands by Month and Species, May 1990 - December 2003 (Source: WWT) Continued/...

Species	Period/ Season	Sectors of Seal Sands												Conservation status
		1	2	3	4	5	6	7	8	9	10	11	12	
Redshank	Jan	0.86	36.36	5.07	55.79	11.79	20.36	1.21	25.29	5.36	5.57	0.29	34.86	SPA citation species
	Feb	0.77	25.54	4.15	84.15	10.46	72.46	3.46	24.00	2.77	5.38	1.15	58.85	Ramsar citation species
	Mar	0.50	21.93	7.71	165.79	25.14	126.36	8.57	22.00	1.64	18.57	0.57	48.93	SPEC category 2
	Apr	0.14	30.93	34.07	220.71	5.64	185.86	7.14	62.93	2.86	23.71	0.36	90.36	
	May	0.00	0.88	0.07	6.12	0.24	8.45	0.00	2.38	0.00	0.24	0.02	2.86	
	June	0.00	0.00	0.00	0.00	1.28	8.61	0.00	0.28	0.00	0.11	0.00	0.22	
	July	0.18	29.62	18.56	130.20	6.68	137.84	1.58	31.86	0.84	24.24	2.08	60.30	
	Aug	0.09	72.60	40.20	241.20	16.38	241.80	5.40	62.20	7.78	51.02	0.42	99.69	
	Sept	0.18	92.49	19.89	256.13	26.76	174.09	0.51	122.38	0.69	65.87	0.84	108.71	
	Oct	3.31	81.31	29.88	191.25	15.81	114.25	11.88	84.00	10.63	46.88	1.13	83.13	
	Nov	1.14	68.14	8.50	123.29	13.93	74.29	0.50	74.64	0.71	28.50	0.64	56.21	
	Dec	0.43	71.93	13.79	94.71	9.21	56.29	0.00	87.07	2.64	22.21	0.64	45.79	
Bar-tailed Godwit	Jan	0.07	3.79	5.14	25.43	0.07	29.14	0.00	8.00	0.00	3.00	0.43	14.57	Annex 1 species
	Feb	0.62	2.08	7.38	17.38	0.00	16.23	0.54	12.08	0.00	2.31	3.15	8.00	SSSI citation species
	Mar	0.00	0.29	2.79	2.57	0.00	10.71	0.43	0.79	0.00	0.14	0.43	13.21	SPEC category 3W
	Apr	0.00	0.21	0.21	1.29	0.00	10.21	0.71	0.29	0.00	0.00	0.07	5.00	
	May	0.00	0.48	0.21	1.76	0.14	7.48	0.55	1.00	0.00	0.36	0.00	2.00	
	June	0.00	0.72	0.06	0.11	0.00	2.72	0.00	1.61	0.00	0.28	0.00	0.44	
	July	0.04	1.20	0.98	0.36	0.00	1.50	0.16	2.32	0.00	0.88	0.10	0.74	
	Aug	0.22	2.07	0.67	0.73	0.13	1.11	0.18	1.80	0.00	0.62	0.13	0.11	
	Sept	0.07	2.36	0.56	3.60	0.49	2.87	0.27	2.38	0.02	0.73	0.62	1.31	
	Oct	0.44	0.94	0.06	4.88	0.13	9.13	0.69	1.63	0.00	0.56	0.94	1.25	
	Nov	0.36	0.21	0.07	0.86	0.00	16.00	0.57	2.21	0.00	0.50	0.64	2.29	
	Dec	0.07	0.57	1.43	8.50	0.00	22.50	0.29	0.43	0.00	0.50	0.14	1.93	
Black-tailed Godwit	Jan	0.00	0.00	0.00	0.21	0.07	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Feb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Mar	0.00	0.00	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.00	0.00	0.00	
	Apr	0.00	0.00	0.00	0.36	0.00	0.21	0.00	0.00	0.00	0.00	0.00	0.00	
	May	0.00	0.00	0.00	0.48	0.00	0.31	0.00	0.00	0.00	0.00	0.00	0.00	
	June	0.00	0.00	0.00	0.50	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.06	
	July	0.00	0.02	0.98	1.70	0.02	0.22	0.00	0.58	0.00	0.20	0.00	0.32	
	Aug	0.00	0.51	0.33	1.13	0.89	0.96	0.00	1.24	0.02	0.11	0.00	0.82	
	Sept	0.00	0.89	0.02	2.16	0.04	0.69	0.00	0.58	0.00	0.22	0.02	0.13	
	Oct	0.00	0.06	0.19	1.19	0.00	0.00	0.00	2.13	0.00	0.44	0.00	0.06	
	Nov	0.00	0.00	0.29	3.79	0.21	2.00	0.00	1.29	0.00	0.00	0.00	0.00	
	Dec	0.00	0.00	0.00	0.50	0.07	0.29	0.36	0.93	0.00	0.00	0.00	0.00	

Mean Low Water Counts for Each Sector of Seal Sands by Month and Species, May 1990 - December 2003 (Source: WWT)

Species	Period/ Season	Sectors of Seal Sands												Conservation status
		1	2	3	4	5	6	7	8	9	10	11	12	
Curlew	Jan	1.50	12.00	11.64	26.86	1.21	47.21	0.21	21.14	0.50	14.64	1.71	40.29	SSSI citation species
	Feb	3.00	26.62	15.69	31.38	0.08	86.15	1.31	40.38	0.77	22.92	2.23	50.69	SPEC category 3W
	Mar	2.43	21.93	19.29	36.43	0.93	57.64	2.07	47.86	0.93	8.00	2.21	36.71	
	Apr	0.57	7.21	8.93	20.07	0.14	40.93	7.00	29.86	0.36	6.79	1.57	27.86	
	May	0.07	4.43	2.29	4.02	0.12	6.79	1.17	15.52	0.31	3.67	0.52	7.45	
	June	0.22	11.00	7.78	7.72	0.11	4.83	0.50	33.72	0.11	11.89	0.11	9.17	
	July	1.88	38.24	47.50	61.64	0.40	90.20	0.48	115.62	1.80	35.02	3.46	52.48	
	Aug	3.36	37.44	44.22	74.58	0.49	120.78	0.56	81.38	0.58	36.07	1.62	46.76	
	Sept	3.18	34.69	21.33	77.18	1.89	97.73	0.64	57.62	0.64	38.56	2.13	47.47	
	Oct	2.44	18.88	15.25	51.44	2.44	55.88	0.75	27.25	3.75	20.00	2.50	48.56	
	Nov	2.21	16.07	8.21	25.43	0.93	53.00	1.29	16.71	0.29	15.43	2.14	37.93	
	Dec	1.07	19.64	8.64	41.50	0.07	55.57	0.50	17.00	0.29	15.21	1.71	44.71	
Sandwich Tern	Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Annex 1 species
	Feb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	SPA citation species
	Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Ramsar citation species
	Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	SPEC category 2
	May	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	
	June	0.00	0.44	0.00	0.11	0.00	0.61	0.00	3.89	0.00	0.00	0.00	0.00	
	July	114.42	83.10	0.18	3.04	0.00	0.44	0.00	26.30	4.74	1.54	17.16	0.00	
	Aug	178.36	145.20	3.78	0.33	0.00	0.00	4.09	34.22	7.49	0.33	13.02	0.00	
	Sept	4.44	3.53	0.00	0.00	0.00	0.00	0.04	0.00	0.00	0.00	4.53	0.00	
	Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Nov	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Dec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Common Tern	Jan	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Annex 1 species
	Feb	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	SSSI citation species
	Mar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Apr	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	May	0.00	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.00	0.00	0.00	
	June	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.25	0.00	0.00	0.00	0.00	
	July	5.89	1.50	8.28	7.94	0.00	0.56	0.00	4.06	0.00	0.00	0.06	0.00	
	Aug	4.00	14.81	0.00	1.94	0.00	0.38	1.00	1.25	0.00	0.31	5.31	0.00	
	Sept	0.00	1.06	0.00	0.00	0.00	0.12	2.24	0.00	0.00	0.00	0.59	0.00	
	Oct	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Nov	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
	Dec	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

Shaded columns = sectors of Seal Sands closest to TERRC Docks
Time period covered by these data:
May 1990 - December 2003: Bar-tailed Godwit, Black-tailed Godwit, Curlew, Dunlin, Golden Plover, Grey Plover, Knot, Oystercatcher, Redshank, Ringed Plover, Sanderling, Sandwich Tern, Shelduck, Teal, Turnstone.
May 1990 - June 1996 & July 1997 - December 2003: Mallard, Wigeon
July 1997 - December 2003: Common Tern

Appendix 17.2

Light Monitoring Report

LIGHT MONITORING REPORT
TERRC DOCK

RPS Planning, Transport and Environment

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Mountjoy Research Centre
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Durham
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November 2004

CONTENTS

FIGURES

1.0 BACKGROUND

1.1 The following report sets out information on the levels of illumination (Lux) in the vicinity of the TERRC site located at the Seaton on Tees Channel, Hartlepool.

1.2 The report is intended to assess the level of artificial lighting measurable on the nearby SPA (Special Protected Area).

2.0 PROJECT SUMMARY

2.1 The monitoring was carried out on the 3/11/04 between the hours of 19.00 and 21.00 at high tide. Weather conditions were fair to good with good all round visibility.

2.2 Equipment used to carry out the survey was a 'Solex SL100 Lux Meter'. The meter was in good working order and was suitable for the purpose of the survey. Means of reaching monitoring points was by use of a small boat with outboard engine.

3.0 RESULTS

3.1 Measurements of light were taken from a number of points within the Seaton on Tees Channel. These are shown as Figure A17.2.1 to A17.2.3.

3.2 The first set of data (trip 1) shows the level of illumination on the SPA with the lighting towers and quayside lights on the TERRC site in total darkness. Data were taken from 7 points along the SPA facing the TERRC site seen on Fig A17.2.1. The results were as follows:

Monitoring Point	Bearing (Degrees)	Source of Illumination (1)	Level of Illumination (Lux)
1	285	Tioxide Plant – Paint manufacturing	1
2	350	Basin – Ship Storage	1
3	10	TERRC – site operations	1
4	340	Power Station	1
5	340	Power Station	1
6	360	Power Station	1
7	330	Power Station	1

3.3 The second set of results (trip 2) measured the levels of light at the SPA with the lighting towers and foreshore lights in darkness. Data is taken along the same points as trip 1 (1-7) but facing towards the SPA. See Fig A17.2.2. The results were as follows:

Monitoring Point	Bearing (Degrees)	Source of Illumination (1)	Level of Illumination (Lux)
1b	150	Philips Oil Refinery	0
2b	140	Philips Oil Refinery	0
3b	140	Philips Oil Refinery	0
4b	140	Philips Oil Refinery	0
5b	140	Philips Oil Refinery	0
6b	0	Philips Oil Refinery	1
7b	25	Philips Oil Refinery	0

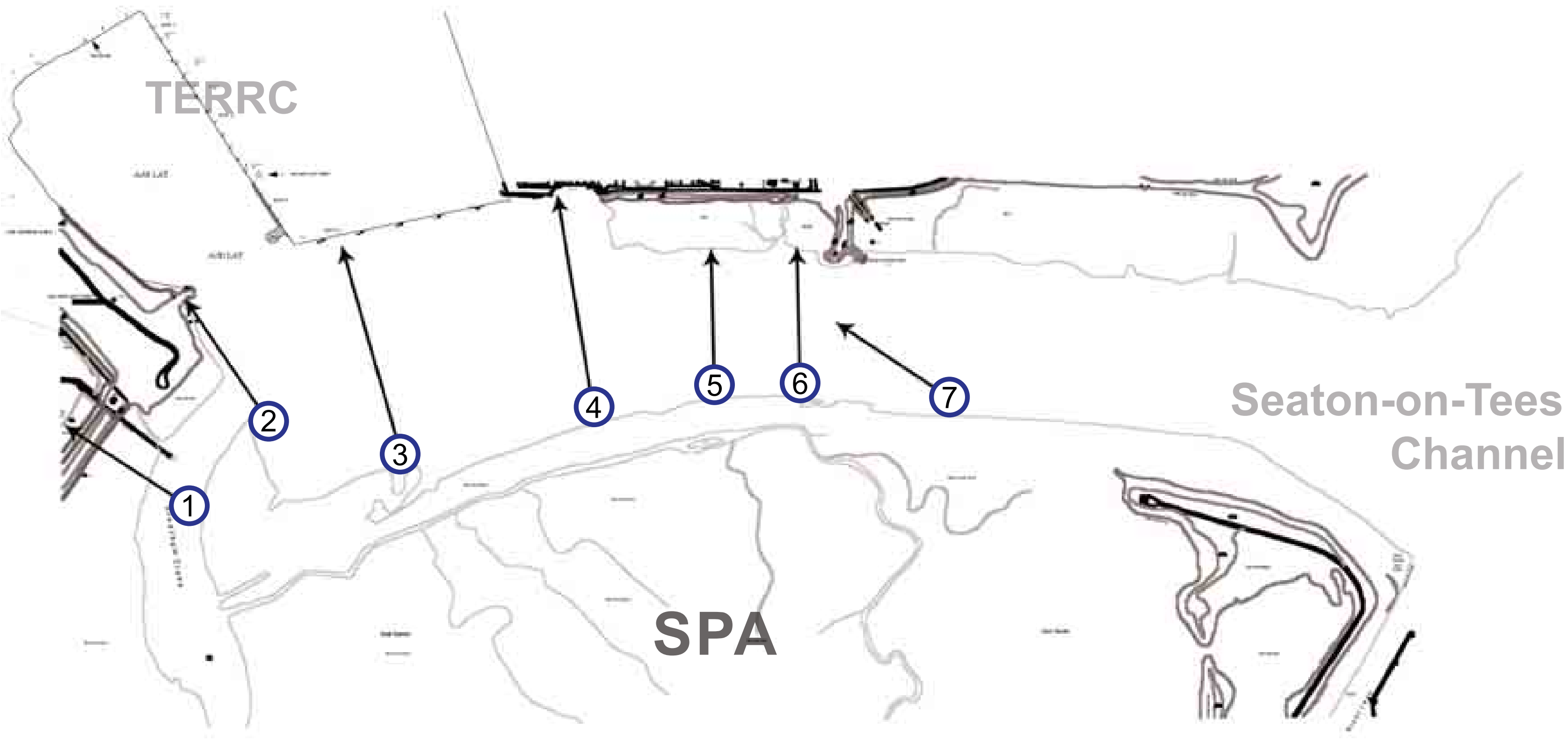
NOTE: A reading of 0 Lux denotes light levels were below the level of measurement, ie less than 1 Lux.

3.4 The third set of results (trip 3) show the effects of light from the TERRC site on the SPA with the lighting towers and quayside lights switched fully on. Data were measured along points 1 – 11 facing the TERRC site from the centre of the channel. The table also includes an additional column of visible sources of light from each location point. See Fig A17.2.3. The results for the area as follows:

Monitoring Point	Bearing (Degrees)	Source of Illumination (Lux)	Additional Visible Sources of Light (Following Bearing)	Results (Lux)
1	285	Tioxide Plat – Paint manufacturing	Lighting tower 1 – TERRC, and Tioxide Plant	1
2	350	Basin – Ship Storage	Lighting tower 1 and 2, and foreshore lights from TERRC	1
3	140	TERRC – site operations	Sewage works lights in distance, TERRC lighting tower 2, foreshore lights and street lighting within TERRC site	1
4	140	Power Station	Edge TERRC site, few foreshore lights and power station viable	1
5	140	Power Station	Power station only	1
6	360	Power Station	Power station only	1
7	25	Power Station	Power station and edge of TERRC plant	1
8	350	Power Station	Edge of power station	1
9	350	Power Station	Power station only	1
10	350	Power Station	No lights visible	1
11	350	TERRC – site operations	Lighting tower 2	3

3.5 About 30% of the individual lights in the lighting towers on the TERRC site were not working. If all faulty units were replaced levels of illumination attributable to the towers would increase by approximately 30%.

FIGURE A17.2.1



Key / Notes

1 Light Monitoring Point and direction of measurement

RPS Planning, Transport and Environment

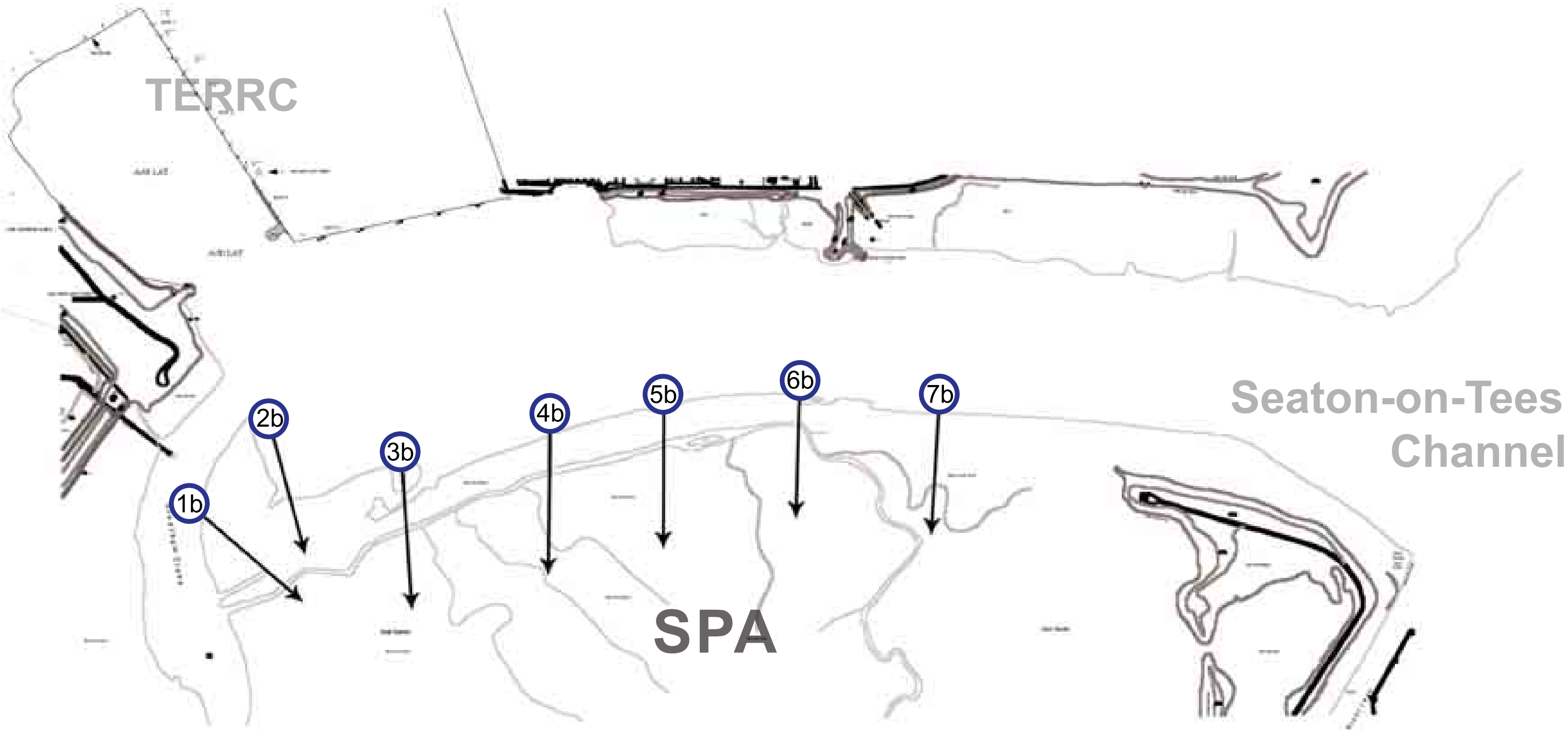
THIS DRAWING IS NOT TO BE SCALED ALL DIMENSIONS TO BE CHECKED ON SITE DISCREPANCIES, AMBIGUITIES AND/OR OMISSIONS BETWEEN THIS DRAWING AND INFORMATION GIVEN ELSEWHERE MUST BE REPORTED IMMEDIATELY TO THIS OFFICE FOR CLARIFICATION BEFORE PROCEEDING.

PROJECT
Seaton Port TERRC Facility
Environmental Impact Statement

TITLE
Light Monitoring points

SCALE	DRAWN BY
NTS	NA
DATE	CHECKED
02.12.04	SL/GD
PROJECT NUMBER	DRAWING NUMBER
DE0295	Figure A17.2.1

FIGURE A17.2.2



Key / Notes

1b — Light Monitoring Point and direction of measurement

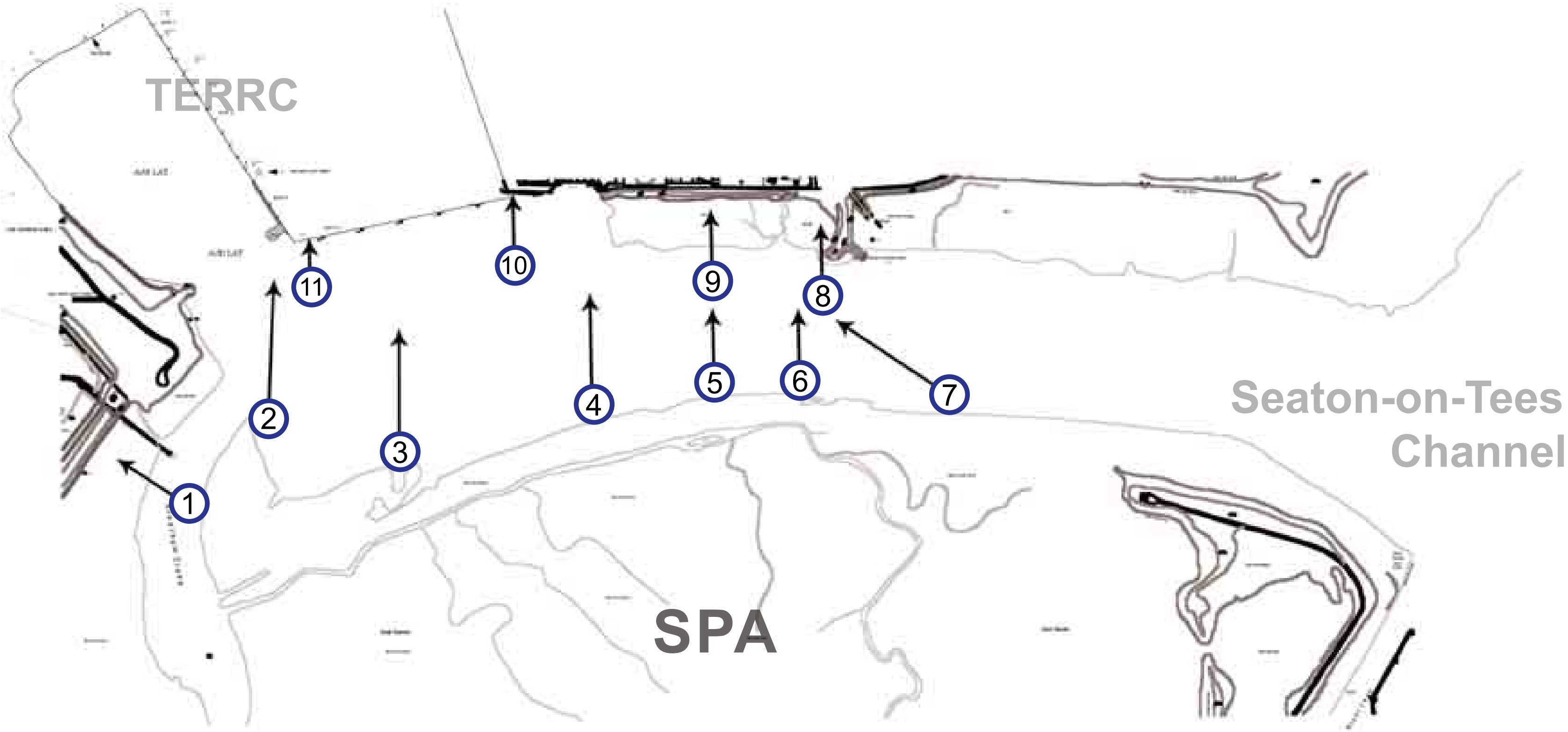
RPS Planning, Transport and Environment

PROJECT
Seaton Port TERRC Facility
Environmental Impact Statement

TITLE
Light Monitoring points

SCALE	DRAWN BY
NTS	NA
DATE	CHECKED
02.12.04	SL/GD
PROJECT NUMBER	DRAWING NUMBER
DE0295	Figure A17.2.2

FIGURE A17.2.3



Key / Notes

1 — Light Monitoring Point and direction of measurement

RPS Planning, Transport and Environment

Able

PROJECT
Seaton Port TERRC Facility
Environmental Impact Statement

TITLE
Light Monitoring points

SCALE NTS	DRAWN BY NA
DATE 02.12.04	CHECKED SL/GD
PROJECT NUMBER DE0295	DRAWING NUMBER Figure A17.2.3

Appendix 18.1

Seal Monitoring Report No. 16 (1989 – 2004), INCA

Monitoring Report no. 16 (1989 - 2004)

Programme Funding
Corus

Further Acknowledgements
Huntsman Tioxide
Conoco Phillips
Tees Pilots
PD Teesport

Field Observations
David Barrett
Linda Watson
Emma Young
Jane Sinclair
Tony Marron
Brian Lewis
Ian Reynolds

Contents

1. The Tees Seals Research Programme

The Tees Seals Research Programme was initiated by the Teesside Development Corporation to monitor the effects of the 1988 phocine distemper virus. The programme was then continued by INCA in order to observe the status of the seal colony at Seal Sands and the ability of this colony to live alongside industry. Each year INCA co-ordinates a team of volunteers to monitor the Tees seals colony from the sea-wall on Huntsman Tioxide's land. This monitoring takes place between early June and late August. The results of the research programme could possibly give indications of improvements in water quality and reduction of pollutants in the estuary. This is the 16th report of the research programme. The results of this summer's monitoring will be shown in this report, and compared with the results since 1989. Past reports should be consulted for detailed information regarding prior monitoring.

Map 1 shows the area of Teesmouth where the seals haul-out at low tide.

2.1 The Seal Sands Seal Colony

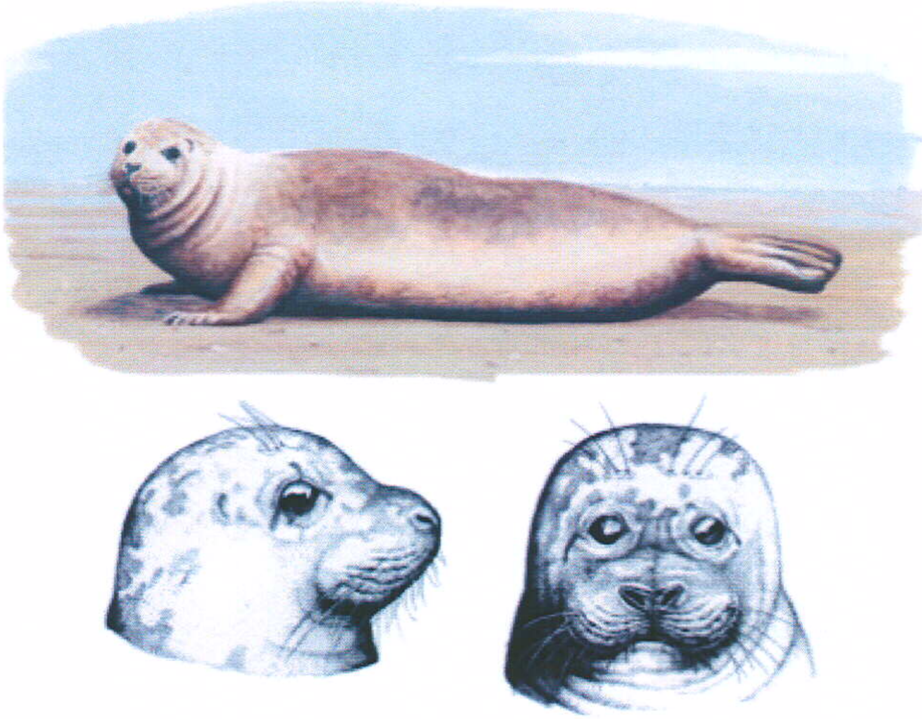
At Seal Sands there are two species of seals, common (harbour) seals, Phoca vitulina, and grey seals, Halichoerus grypus. The harbour seals breed here between mid/late June to early July. The grey seals do not breed here, as the conditions are unsuitable for them. Grey seal pups are fur-covered and cannot swim straight away, therefore they like to 'haul-out' far from the water above the high tide for long periods of time during and after giving birth. This isn't possible at Seal Sands, as they would be inundated by the tide. The grey seals here are probably from the Farne Islands or the Humber. Most of the grey seals leave during the winter to breed, however, a few non-breeding grey seals, particularly juveniles, remain at Seal Sands.

Grey seals are much larger than harbour seals. Male grey seals (bulls) are especially large and can be very aggressive towards other grey seals and harbour seals. Grey seals have a dog-like nose and nostrils, which are close together and vertical. Harbour seals have a smaller, more rounded head and smaller nostrils which are further apart and more horizontal. At Seal Sands the two species of seals generally haul-out in separate groups. Harbour seals tend to leave a lot of space between individuals in the group, whereas the grey seals haul-out in a tightly-bunched group, and do not mind being in close proximity to each other. Confrontations can occur when harbour seals attempt to haul-out close to a group of grey seals, with the grey seals barking, grunting and sometimes snapping at the harbour seals. The grey seals are also more vocal than the harbour seals, and can be heard early in the morning calling and barking.

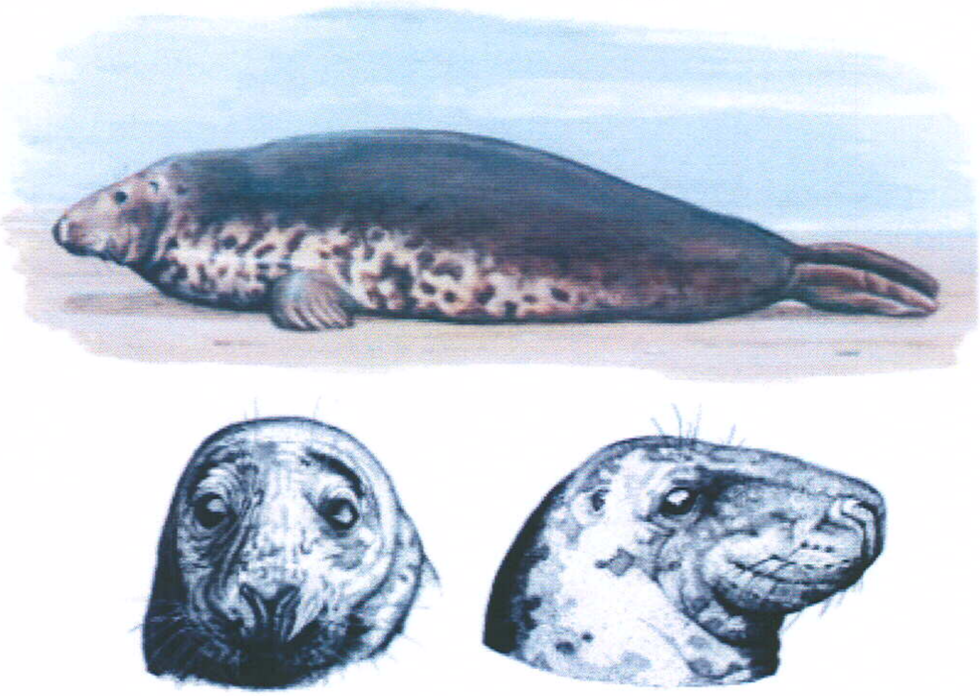
The harbour seals usually have their pups early/mid June at Seal Sands. The pups stay by their mother all the time, even in the water the mother stays very close, maintaining contact and even giving the pup 'piggyback' rides to support it at the surface. The pups are very small when born and look very dark, almost black from a distance. The pups are taken into the water only hours after birth. It is important to watch the mother/pup relationship to ensure the pup is being cared for and is not malnourished or abandoned. There is a three to four week lactation period during which the pups more than double their birth weight of around 10 kilograms.

Illustrations of harbour and grey seals are shown overleaf to highlight the differences between the two species.

Harbour Seal, *Phoca vitulina*



Grey Seal, *Halichoerus grypus*



2.2 History of the Tees Seals Colony

Seals have lived at the mouth of the River Tees for hundreds of years. Seal Sands was named after the large numbers of harbour seals that once bred there every year. Two hundred years ago harbour seals were still numerous in the estuary, with an estimated population of around 1000 animals. However, numbers then rapidly declined and by the mid 1800's only 20-30 animals remained and breeding had ceased. By 1862 only three harbour seals remained. By the 1930's an extensive survey of the Tees showed that there were no seals present at all.

The reasons for the demise of the Tees seals colony are not fully understood and a number of factors were probably responsible. From the mid 1800's there was a large increase in the amount of shipping through the estuary. It created disturbance to the seals but also meant that extra dredging was needed to keep the channels clear. Dredging led to the loss of essential haul-out and pupping sites. Intensive industrialisation along the banks of the river also created disturbance and greatly polluted the estuary. This pollution decimated the once-thriving Tees salmon populations. Salmon fisherman mistakenly blamed the seals for this decrease and persecuted the already low numbers of seals.

The clean up of the River Tees began in the mid 20th century as old-style steel and coke plants were replaced by newer, less polluting works. Reclamation of the lower estuary restricted river access and probably reduced disturbance to the seals. In the late 1960's and early 1970's there began a concerted effort by local authorities and industry to reduce the pollution load. Eventually harbour seals began to re-appear more regularly and by the mid 1980's there was a resident population of 17 seals, the highest number recorded for over a century. In response to these encouraging developments, the Teesside Development Corporation embarked on a seal research programme in 1989 which was soon taken on by INCA. Between 1989 and 1993 a single harbour seal pup was born in alternate years. All three pups died within one to five days of birth. However, in 1994, two pups were born and survived. The colony is now breeding successfully again with the highest number of pups born in one year and surviving to weaning being six.

Teesmouth is the only known estuary in Europe where harbour seals have re-colonised as a direct result of environmental improvements.

3. Monitoring Methods

The seal colony at Seal Sands is monitored most intensively during the harbour seal pupping season between early June and late August. At each daylight low tide period monitoring is undertaken from the Huntsman Tioxide hide, approximately 250m from the most regularly used haul-out site. The monitoring takes place two hours before, and one hour after low tide. A 60X magnification telescope is used to record:

- Total population numbers for each species
- Variability in numbers of seals hauling out each low tide
- Areas used as haul out sites and the changes in site usage
- Number and health of pups. The behaviour of the mother-pup unit is closely observed.
- Disturbance to the colony and other potential problems e.g. injuries, pup desertion.
- Recognisable individuals e.g. colouration, markings, scars, tags etc.
- Behaviour e.g. interaction, feeding etc.

The different haul out sites used by the seals at Seal Sands are shown on Map 2. Sites C and D tend to be used mainly by the grey seals. Sites A, B and the 'spit' are mainly used by the harbour seals. Site usage is dependent on the level of the low tide. The 'spit' is sometimes covered by water on neap tides when the level of the tide is not low enough to expose the sand bank. When this happens, the majority of the harbour seals congregate at Site A. As site A is quite far from the hide, the monitors sometimes move up the sea-wall to get a better view of the seals, especially when trying to distinguish between juvenile seals and pups.

The Seals usually congregate on Seal Sands a few hours before low tide. In recent years a lot of the harbour seals have taken to swimming up Greatham Creek to haul-out there over high tide whilst Seal Sands remains immersed. As the tide goes out, the harbour seals move back through to Seal Sands and haul-out at site A. If the low tide level is low enough to expose the 'spit' sandbank, the harbour seals usually swim down and haul-out there closer to the time of low tide. There are also midway haul-out points between these areas such as site B where some harbour seals may haul-out for a while before moving on. The grey seals do not tend to have a pattern of following the tide as the harbour seals do, instead they settle at Site C or sometimes site D and stay there for a long period of time until their haul-out location is inundated by the tide.

Due to a slight decrease in peak numbers of harbour seals in 2003 compared to 2002, it was decided this year to undertake two co-ordinated seal counts on a wider scale. As INCA usually only monitors from Seal Sands at low tide, it was possible that harbour seals could be hauling-out or feeding elsewhere in the estuary at low tide, thus reducing the numbers at Seal Sands. With the help of PD Teesport it was proposed to monitor up the river on the Harbour Master's launch whilst other volunteers, other INCA staff and helpers from Corus, Tioxide, ConocoPhillips and Tees Pilots, monitored various locations around Teesmouth simultaneously. By this approach it was hoped to gain a more accurate estimate of the number of harbour seals around Teesmouth, not just at Seal Sands.

The first co-ordinated count took place on the 20th of July. The count lasted for an hour, half an hour each side of low tide. Monitors were stationed at Seal Sands, Greatham Creek, North & South Gare, Seaton Snook, ConocoPhillips' Jetties, the Tees Barrage and on the Harbour Master's launch. The second count took place on August 17th with the same locations monitored, again for an hour over low tide.

Maps 3 & 4 show the areas monitored during the 2 co-ordinated counts, both from the Harbour Master's launch and the fixed monitoring positions.

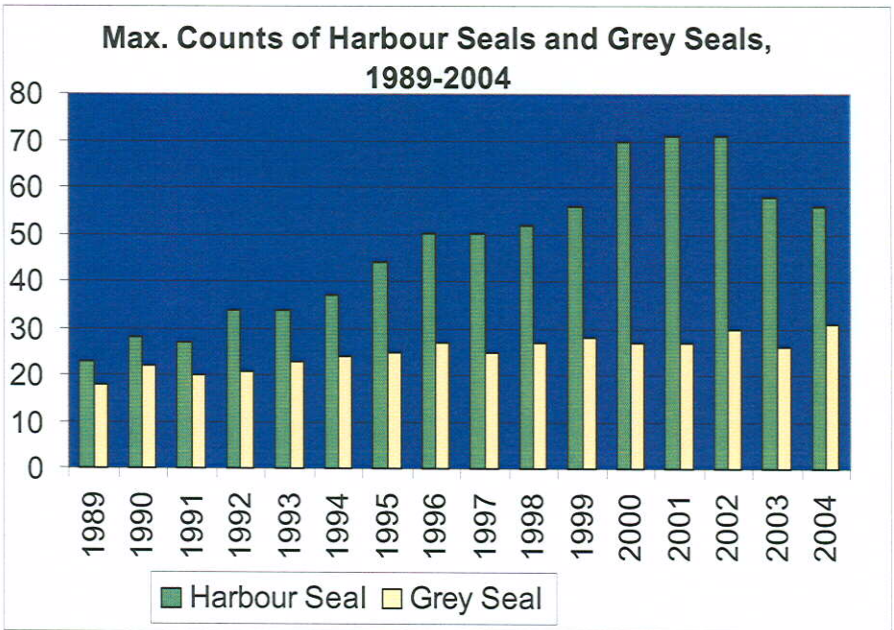
4. Results of the 2004 Seal Monitoring

4.1 Maximum Numbers of Harbour Seals and Grey Seals

The results mainly focus on the harbour seals at Seals Sands, as the grey seals are not resident or breeding here. Results are given for grey seals but not in as much detail.

The maximum number of harbour seals observed on any one day in 2004 was 56 on the 17th of August. This was the day of the 2nd co-ordinated seal count. This compares to 23 in 1989, 71 in 2002 and 58 in 2003. Figure 1 below shows the maximum counts of harbour seals at Seal Sands from 1989 to 2004.

Figure.1



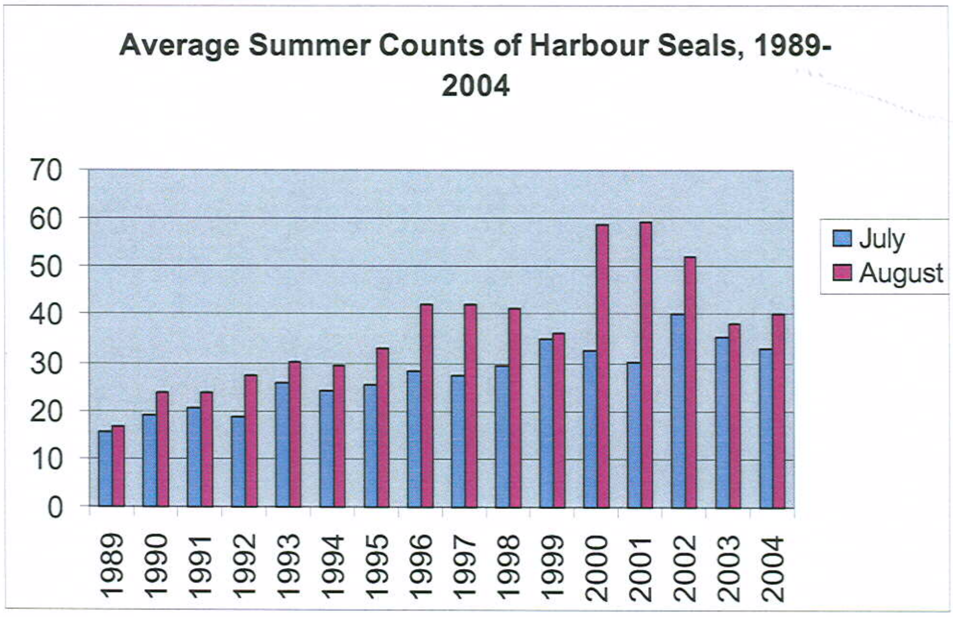
The maximum number of grey seals observed on any one day in 2004 was 31 on the 20th of July. This is the highest number of grey seals seen at Seal Sands since monitoring began in 1989. It compares to 18 grey seals in 1989 and 26 in 2003.

The number of grey seals recorded during June-August, 2004 ranges from 0 seals to 31 seals. The mean number of grey seals recorded for June, July and August, 2004 is 7, 10 and 12 respectively.
In June the number of grey seals ranged from 0 to 15. In July the range was between 0 and 31, and in August the range was between one and 26.

4.2 Mean Numbers of Harbour Seals

The mean number of harbour seals was calculated for each of the three months monitored, from the data collected in 2004. The mean number of harbour seals at Seal Sands in June was 31, in July the mean was 33 and in August the mean was 40. Figure 2 below shows the mean numbers of harbour seals for July and August from 1989 to 2004.

Figure 2



August is the peak month for numbers of harbour seals. Figure 2 shows that this year's August mean is marginally higher than last years, despite the maximum number of harbour seals seen on any one day falling this year. This years July mean is higher than the mean for July in 2001. This years July mean of 33 is lower than last years mean of 36, and is lower than the July mean for 2002, which at 41, is the highest recorded July mean since monitoring began in 1989. In 1989 the mean numbers of harbour seals for July and August were 16 and 17 respectively. The August mean numbers of harbour seals have been higher than the numbers for 2004 on six occasions previously. The July mean numbers of harbour seals have only been higher than those for 2004 on three previous occasions.

Figure 2 shows that on average, there were 19 less harbour seals in August of 2004 than there were in August of 2001. However, there were on average two more harbour seals in August of 2004 than there were in August of 2003.

4.3 Results of the two Co-ordinated Seal Counts

The co-ordinated counts took place on the 20th July and 17th August 2004 as described in section three of this report. On the 20th July and 17th August the low tide levels were 1.1 and 0.9 metres respectively. At these levels all haul-out sites at Seal Sands were exposed, maximising haul-out opportunities for the seals. Maps 3 and 4 at the end of the report show the monitoring positions and key observation points.

On the 20th July monitoring took place for half an hour before and after low tide. Monitoring from the Harbour Master's launch was done during this period. There were no sightings of seals at North or South Gare during the hour of monitoring, nor at Seaton Snook. There were no seals at Greatham Creek during the hours monitoring. One harbour seal was seen off the ConocoPhillips jetties at 13:06. On the launch, whilst travelling up the river to the Tees Barrage, five harbour seals were noted. Once at the barrage, one harbour seal was seen as well as one large male grey seal. At Seal Sands a maximum of 39 harbour seals were seen. The findings showed that while INCA was monitoring at Seal Sands at low tide, there could be up to six seals along the river as far as the barrage.

On the 17th August, the monitoring was carried out in the same way. Again, there were no seals at North Gare or Seaton Snook, however, one grey seal was sighted at South Gare for the duration of the monitoring. At the ConocoPhillips jetties, 2 harbour seals were seen at 11:26. On the launch, one harbour seal was seen just past Newport Bridge and one harbour seal was seen close to the Transporter Bridge. At the barrage, the same male grey seal as seen on the first co-ordinated count, was sighted again.

At Seal Sands the maximum number of harbour seals recorded was 45. Again, the results of the monitoring showed that whilst the majority of the Tees Seals colony hauls out at Seal Sands at low tide, some individuals are fishing along the river and around the river mouth. These results will be discussed further in section five of the report.

Figure 3 overleaf shows a summary of the results of the two co-ordinated seal counts.

Figure 3. Harbour seal and grey seal max. counts at locations and on dates shown, at low tide.

	20/7/04	17/8/04
Seal Sands	39 harbour seals 31 grey seals	45 harbour seals 25 grey seals
Greatham Creek	0 seals	0 seals
North Gare	0 seals	0 seals
South Gare	0 seals	1 grey seal
Seaton Snook	0 seals	0 seals
Conoco Phillips Jetties	1 harbour seal	2 harbour seals
Tees Barrage	1 harbour seal 1 grey seal	1 harbour seal 1 grey seal
Teesport Launch (along the river)	5 harbour seals	2 harbour seals

4.4 Disturbance

Disturbance to the seals on Seal Sands mudflats has tended to be sporadic. Disturbance is not a major problem at Seal Sands as there is very limited public access due to the surrounding industrial sites. The main cause of disturbance during 1989-1990 was industrial boats involved in temporary construction work. Disturbance decreased in subsequent years until 1995 when there were 14 disturbance incidents caused by 25 recreational boats. In recent years disturbance incidents have decreased.

There were disturbance incidents on nine of the monitoring days this year. On most of these days there was only one type of disturbance but on some there were combined factors forcing the seals to enter the water and leave their haul-out sites. The seals were disturbed seven times by bait diggers, once by kayakers (when all the seals at Seal Sands entered the water), once by a loud flare stack, and three times by people in boats. On all of these occasions the seals returned to their haul-out sites eventually, once the disturbance had passed.

4.5 Birth and Survival of Harbour Seal Pups

The number of pups born and surviving has increased since monitoring began in 1989. Between 1989 and 1993 a single harbour seal pup was born in alternate years. All three pups died within one to five days of birth.

In 1994 two pups were born and survived to weaning. In 1995 and 1996 two pups were born and in both years one of the pups was rescued and rehabilitated. Four pups were born in 1997 but one was stillborn. Two of the other three pups required rescue and rehabilitation. In 1998 four pups were born and three weaned successfully. Of the four pups rehabilitated three had been abandoned at a young age and were suffering from malnutrition. Observations of nursing seemed to indicate that the mothers were not able to supply an adequate quantity of milk. The fourth pup was rescued because it failed to wean.

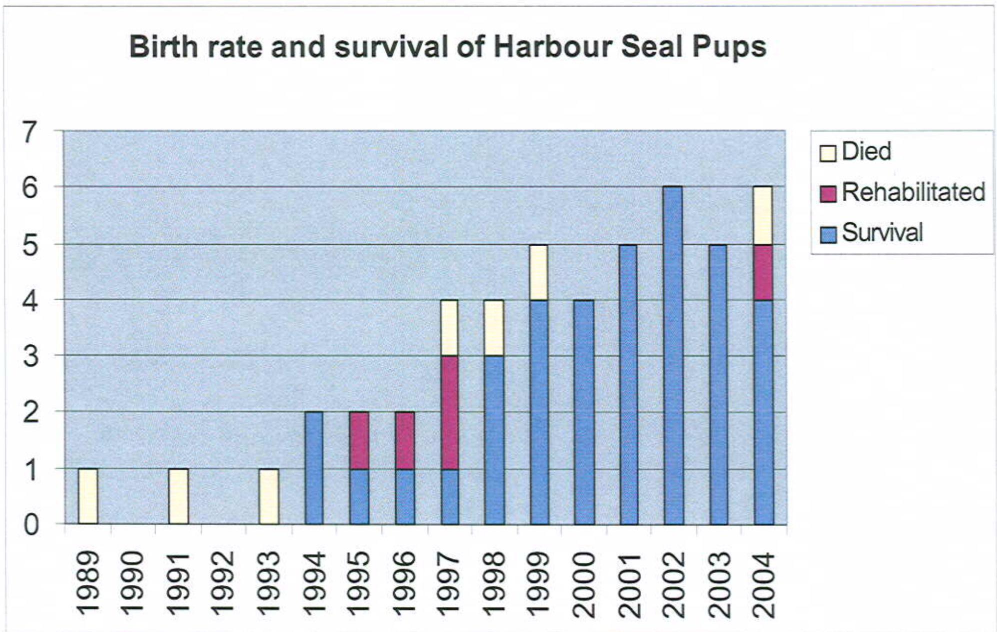
In 1999, five pups were born and four strong and healthy pups survived to weaning. The other pup was either stillborn or died soon after birth. The body could not be recovered for tissue analysis as the mother would not leave it and carried it around in her mouth for over a week. In 2000, 2001, 2002 and 2003 four, five, six and five healthy pups were born, respectively. All of these pups survived to weaning.

This year there were six pups born. The first pup was observed on the 15^{th} of June. This is around a week earlier than the first pup is usually sighted at Seal Sands. In Both 2002 and 2003 the first harbour seal pup was sighted on the 22^{nd} of June. This year, the second pup was observed on the 21^{st} of June, and the third on the 24^{th}. The fourth, fifth and sixth pups were observed on the 29^{th} of June. All six pups were strong and healthy and survived to weaning.

In late August, two harbour seal pups were rescued from Teesmouth by the RSPCA. It is not known if they were two of the Tees colony's pups, but it is probable. One of the pups had very severe head injuries, while the other had a flipper injury which had become infected. Both pups were taken away and treated. The pup with head injuries was rehabilitated and recovered from its injuries. This pup has since been released back into the wild. The other pup with the flipper injury had to be put down as the flipper infection was too severe and the flipper would have needed amputation. If these two pups were two of the six born at Seal Sands this year, then that would mean five of these pups survived and one died.

Figure 4 below shows the birth and survival rates of harbour seal pups at Seal Sands from 1989 to 2004.

Figure 4



5. Rarities

Occasionally, rarities visit the Teesmouth area. In 1999, a bearded seal (Erignathus barbatus) came to Teesmouth and stayed around Hartlepool Dock for two weeks. These kind of occurrences are very rare however as this seal had probably come from the high arctic.

This year a juvenile hooded seal, Cystophora cristata, was rescued by the RSPCA off the ConocoPhillips jetties. It died in transit on the way to the RSPCA centre in Norfolk. The autopsy showed rubber gloves, plastic and other debris in the seal's stomach. It was reported that this young hooded seal's mother remained around the ConocoPhillips jetties for a while after the young seal was taken away. However, INCA could not confirm any sightings.

Hooded seals are found in the north-west Atlantic from around Svalbard, past Greenland to the Canadian Arctic and Gulf of St Lawrence. Hooded seal pups are born from mid-March to early April. It is possible that these hooded seals followed a fishing vessel down to the east coast of England. The Sea Mammal Research Unit (SMRU) in St Andrews report that there are usually only one or two instances of hooded seals off the east coast of Britain each year.

Bearded Seal at Hartlepool Dock in 1999

Hooded Seal, Cystophora cristata

6. Discussion

Maximum numbers of seals

The maximum number of grey seals on any one day was the highest it has ever been this year at 31 individuals. The fact that visiting grey seal numbers are the highest they've ever been at Teesmouth, is probably an indication of the improving water quality and availability of food here.

This year the maximum number of harbour seals at Seal Sands on any one day had decreased from 58 in 2003 to 56. From 2002 to 2004 the maximum counts of harbour seals dropped from 71 in 2002 to 56 in 2004. However, this is not as significant when compared to the fact that the average count for the month of August (the peak month for harbour seal numbers) increased to 40 this year, compared to 38 last year. There are large variations in the number of seals at Seal Sands daily, so it comes as no surprise to see variations in the numbers from year to year. It is the average numbers of seals which are more important, as they give a better reflection of the overall size of the colony.

Average monthly numbers of harbour seals

This year the average count for July (32) was higher than the average July count in 2001 (30), but lower than the July averages for 2002 (40) and 2003 (36). From 2001 to 2003 the average August counts of harbour seals had dropped from 59 to 38. However, this year was the first time in 3 years that the average count was better than the previous year. This year's mean August count could also have been affected by the wet weather, as less seals haul-out when it is raining. In July the number of harbour seals counted ranged from five to 33. This is 28 below, and 20 above the mean, therefore the sample range was 28. This is a large sample range and shows the variation in numbers. In August the mean number of harbour seals was 40. The highest number counted was 53 and the lowest 24. This is 13 above, and 16 below the mean. The sample range was 29. Again this shows the large amount of variation in numbers of seals hauling-out from day to day. Given these large variations from the mean numbers of seals, it shouldn't necessarily cause too much concern when there are yearly changes in peak or mean numbers of seals.

Co-ordinated Counts

It was because of the slight decrease in peak and mean harbour seal numbers over the last two years, that this year's two co-ordinated counts were introduced into the monitoring programme. Both counts showed that while normal monitoring took place at Seal Sands, there could be up to six more harbour seals along the river and in the Teesmouth area. The Tees seals colony appears to be expanding its range and feeding further up the river. In the summer of 2004 a male grey seal could be seen feeding at the barrage regularly. Harbour seals can also often be seen as far up river as the barrage. This reflects well on the improving water quality of the Tees, as the seals follow migratory fish up the river. No seals were seen hauling-out along the banks of the river at low tide. However we did discover that some of the Tees seals are feeding in the river at low tide, not resting at Seal Sands. There is the possibility that the seals feeding at low tide may rest at other times of the day on areas that aren't inundated by the tide.

Harbour seal pups

The harbour seals are continuing to breed and give birth to healthy, strong pups which survive to weaning. One more pup was born this year than last year. It is hoped that as the Tees seals colony matures, pup production will increase. The success of the harbour seal pups at Seal Sands is encouraging when it is taken into account that the colony only started breeding successfully again in 1994.

Disturbances

There were few disturbance incidents this year. The only major one being when kayakers travelled right up Greatham Channel and scared all of the seals into the water. There were 9 disturbance incidents in total and in 8 of these cases the seals returned to their haul-out sites shortly after the disturbance. It does not seem that the current level of disturbance incidents are affecting the Tees seals colony.

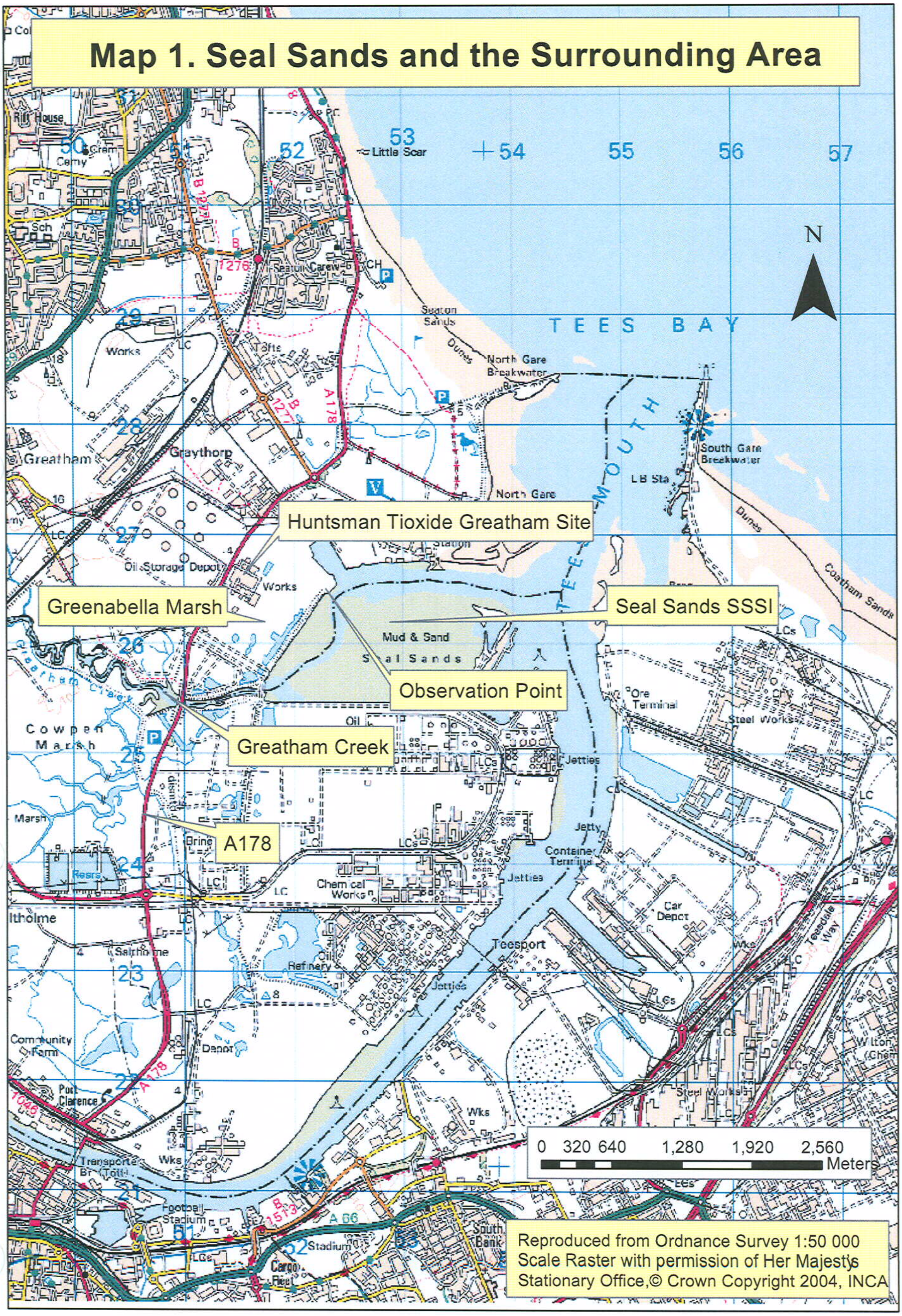
The Tees seals colony

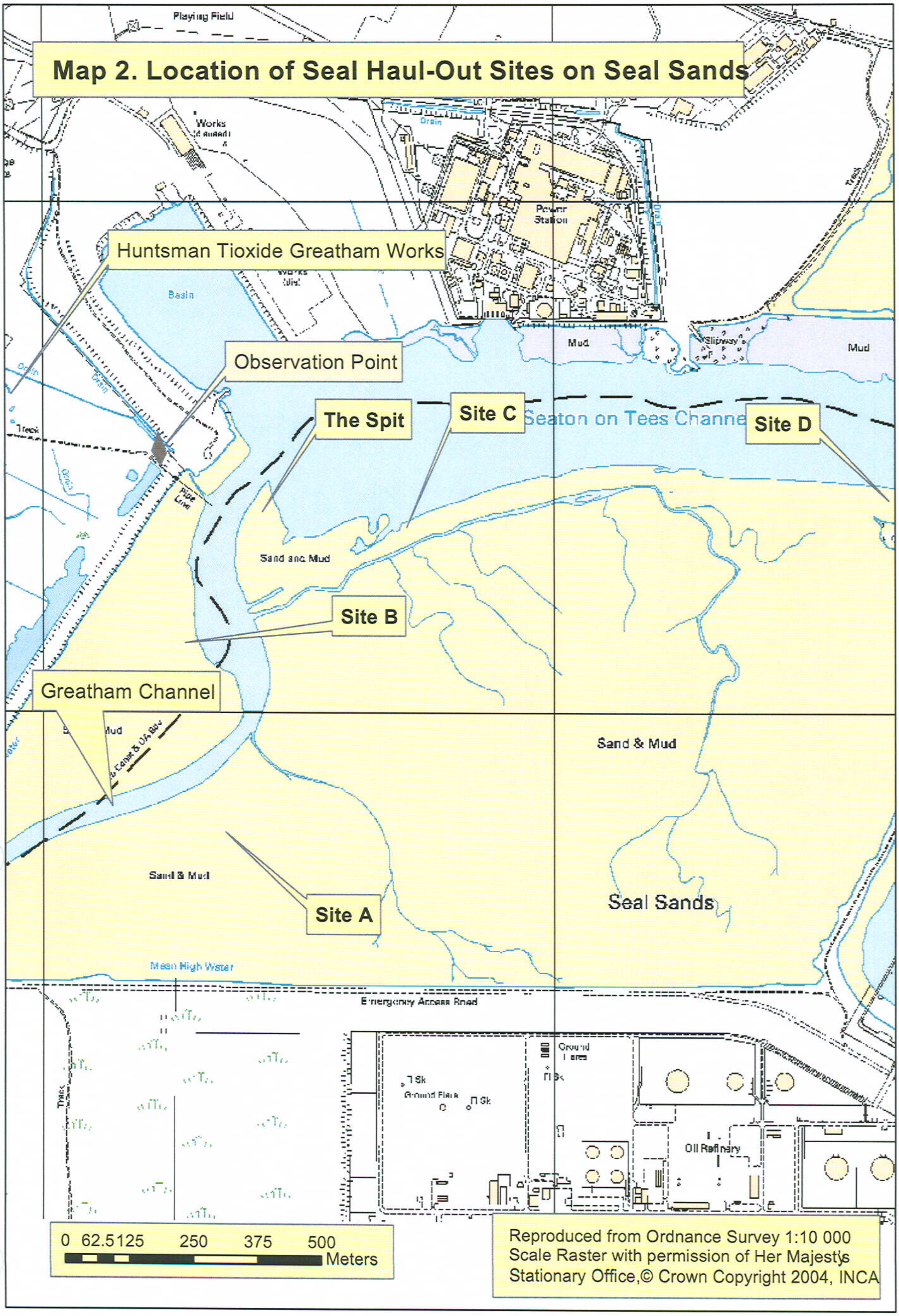
It appears from this summer's monitoring that the seals are expanding their range up the River Tees. It is probable that they are following migratory fish up river to the barrage. This reflects well on the river water quality. The seal colony can be indicative of environmental quality in a manner that the public understand.

Six harbour seal pups were born this year and survived to weaning. Although two pups were rescued from Teesmouth, and one later died, all of the pups born this year were healthy and strong. The two pups rescued had injuries and had not contracted any diseases. They were not malnourished, as were none of the other pups at Teesmouth. The mother-pup relationships had been good and all six pups had been taught how to fish for themselves. A new seal rehabilitation centre has been set up in Tynemouth, and this is where the two seals rescued from Teesmouth were rehabilitated. Having a seal rehabilitation centre not far from Teesmouth is very helpful as it means rescued seals can be released back at Seal Sands if they recover sufficiently enough at the centre.

Although average numbers of harbour seals were down on 2001 and 2002, they had increased from 2003 and hopefully this will continue next year.

Map 1. Seal Sands and the Surrounding Area





Map 2. Location of Seal Haul-Out Sites on Seal Sands
Playing Field
Works
Power Station
Huntsman Tioxide Greatham Works
Basin
Mud
Slipway
Observation Point
The Spit
Site C
Seaton on Tees Channel
Site D
Pipe Line
Track
Drain
Sand and Mud
Site B
Greatham Channel
Sand & Mud
Site A
Seal Sands
Mean High Water
Emergency Access Road
Ground Flare
Oil Refinery
0 62.5125 250 375 500
Meters
Reproduced from Ordnance Survey 1:10 000
Scale Raster with permission of Her Majestys
Stationary Office,© Crown Copyright 2004, INCA

Map 3. Co-ordinated Seal Watch - Monitoring Positions and Key Observation Points

Map 4. Co-ordinated seal Watch - Monitoring Positions & Key Observation Points
Fixed Monitoring Positions
Key Observation Points
BILLINGHAM
MIDDLESBROUGH
0 255510 1,020 1,530 2,040
Meters
Reproduced from Ordnance Survey 1:50 000 Scale Raster with permission of Her Majesty's Stationary Office,© Crown Copyright 2004, INCA

Appendix 18.2

Notes on Noise and Visual Stimuli

Noise

Underwater noise levels e.g., the regular passing of a 30 metre trawler at 100 metres or a working cutter-suction transfer dredge at 100 metres for 1 month during important feeding or breeding periods.

Atmospheric noise levels e.g., the regular passing of a Boeing 737 passenger jet 300 metres overhead for 1 month during important feeding or breeding periods.

Further Details on Noise

Generally defined as unwanted or disruptive sound**.** Noise can cause sensitivity in three ways:

- actual discomfort, damage or death;
- interference with the use of hearing for feeding or communication reducing viability;
- Disturbance of breeding or other behaviours reducing viability.

The units of the benchmark are received sound pressure in decibels (dB) shown as a ratio of received pressure to a fixed reference pressure (re) of 1 µPa at 1 metre. A typical ambient coastal noise level in calm weather would be around 40 – 60 dB (Morris, 1995). Various maritime activities produce noise of various frequencies at pressures from 120 to 250 dB (Richardson *et al.*, 1999). A distance of 1 metre is not very applicable to the exposure of marine organisms to noise in the environment. A typical decrease in pressure (transmission loss) over 100 metres would be 40 dB (Richardson *et al.,* 1999). In setting the benchmark for underwater noise, this loss has been applied to the typical noise pressures resulting from various activities. Different activities tend to produce noise of different pressures at different frequencies. For example:

- drilling noise tends to be up to 160 dB re 1 µPa-m at frequencies below 300 Hz with a peak below 2 Hz;
- dredging tends to be up to 180 dB re 1 µPa-m and below 1kHz;
- boats and small ships produce sound up to 170 dB re 1 µPa-m with frequencies up to 10 kHz (outboards motors have peaks at frequencies above 1kHz and larger vessels peak below 1 kHz);
- the regular passing of a 30 metre trawler at 100 metres or a working cutter-suction transfer dredge at 100 metres approximates to 130 dB re 1 µPa (for broad spectrum noise 45 – 7070 Hz);

- the regular passing of a Boeing 737 passenger jet 300 metres overhead approximates to 98 dB re 1 μPa (for broad spectrum noise 45 – 7070 Hz) @ 300 metres below the source;
- sonar sound can be up to 230 dB re 1 μPa-m and range from 500 Hz to several hundred kHz; and
- Seismic air guns at 250 dB re 1 μPa-m up to several kHz (strongest below 100Hz) (Richardson *et al.,* 1999).

In addition, atmospheric noise can affect marine animals at the water surface or for example, hauled out on sand banks. Conventionally aircraft noise is referred to at a distance of 300 metres from the source. In extreme cases, such as for military jets, noise produced can be up to 130 dB re 1 μPa at 300 m

Noise duration varies with activity, ranging from several weeks (dredging) to a fraction of a second repeated regularly for several hours (seismic survey) to a few minutes (a passing ship or plane). The benchmark was set using a duration that could typically result from a variety of activities e.g. continuous daytime boat activity, dredging, construction or proximity to an airport. This benchmark does not deal with the transmission of atmospheric noise to the water.

Visual Benchmark

The continuous presence for one month of moving objects not naturally found in the marine environment (e.g., boats, machinery, and humans) within the visual envelope of the species or community under consideration

Further Details on Visual presence

This benchmark applies only to species that have sufficient visual acuity to resolve moving objects or at least differentiate between rapid changes in light intensity (as in a moving shadow). Response is likely to be immediate with the species moving out of range of the stimulus. The duration of the factor has been set in line with potential maritime activities (such as disturbance to seals by tourists) and also at a level that could cause a measurable effect on the species.

http://www.marlin.ac.uk/glossaries/benchmarks.htm#_visual

Appendix 34.1

Archaeology – Email from Hartlepool Borough Council

dated 13 April 2004

Diane Clark

From: Roy.Merritt@hartlepool.gov.uk
Sent: 13 April 2004 11:59
To: Diane Clark
Subject: Re: TERRC DOCK EIA[Scanned]

Gary

am able to confirm that Tees Archaeology have now confirmed that no further action is required with respect to archaeology,

Regards

Roy Merrett