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# Implementation of WGS84 and GPS for Marine Navigation

**Dr Terry Moore**

**Institute of Engineering Surveying and Space Geodesy  
The University of Nottingham**



# The Project Consortium

- **IESSG, The University of Nottingham**
- **General Lighthouse Authorities**
  - Trinity House Lighthouse Service
  - Northern Lighthouse Board
  - Commissioners of Irish Lights
- **Port of London Authority**
- **United Kingdom Hydrographic Office**



# Project Overview

## Implementation of WGS 84



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– UK Hydrographic Office



– Port of London Authority



– General Lighthouse Authorities



– Port of London Authority

- **WGS 84 for Navigation Charts**

- **Coordination of Port Facilities**

- **Coordination of Aids to Navigation**

- **WGS 84 as a Vertical Datum**



# Project Overview

## Implementation of GPS



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- **Precision Navigation**
  - Port of London Authority
- **GNSS Systems Integration**
  - Port of London Authority (VTS)
  - General Lighthouse Authorities (Loran-C)
- **GNSS Integrity Assessment**
  - All Partners



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# Chart Datum Transformations

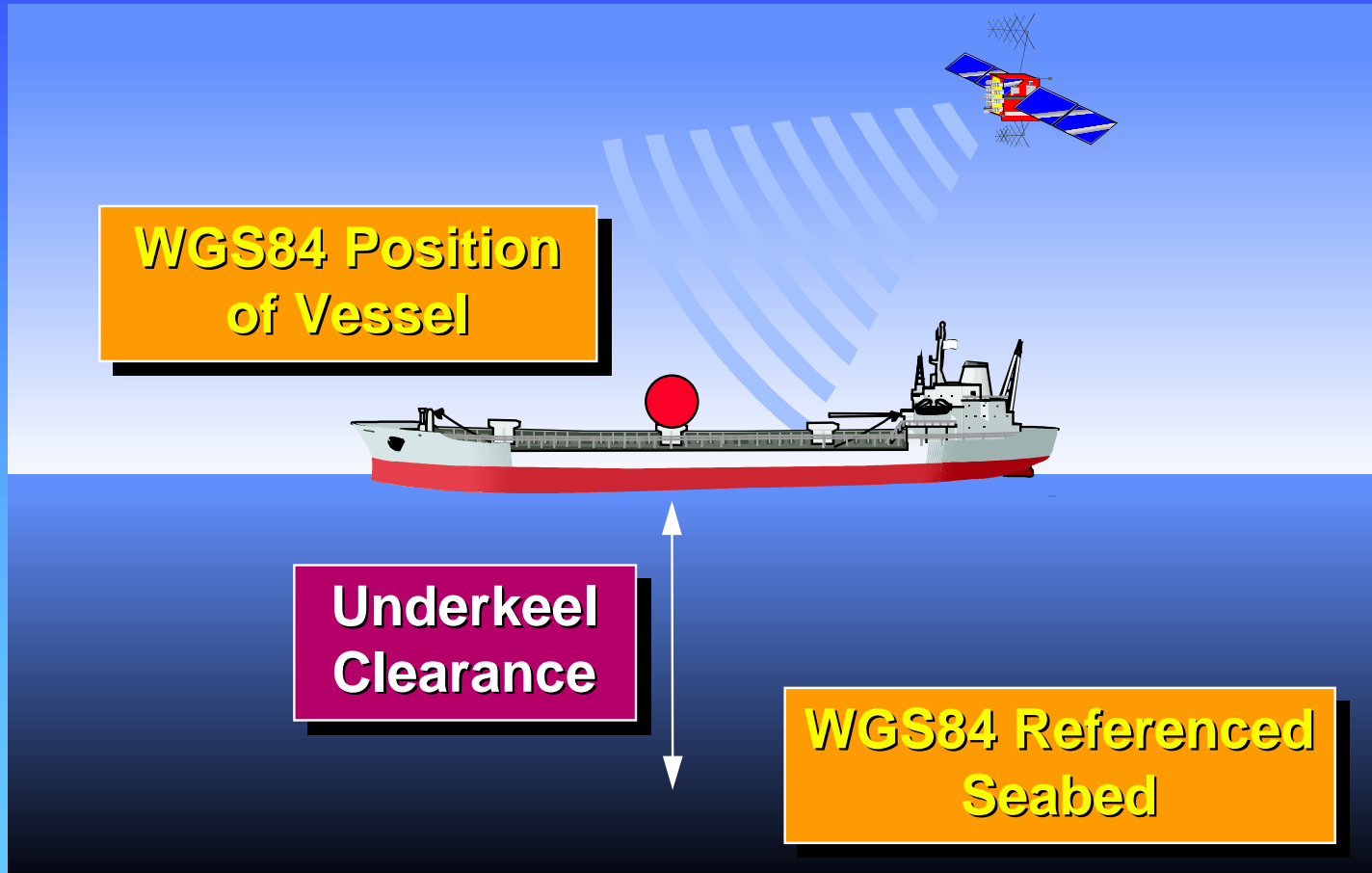
- Test areas in UK and Ireland
- Current chart shift parameters show good agreement on average with transformed coordinates
- Variations (up to 20m at long range)
- Agreement between OSTN97 and UKHO method better than 2m
- UK and Ireland OK - but what about other regions?
- What if no published datum, or known parameters?



# WGS 84 as Vertical Reference Datum



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Ignores Sea, Tides etc..



# Port of London Trials



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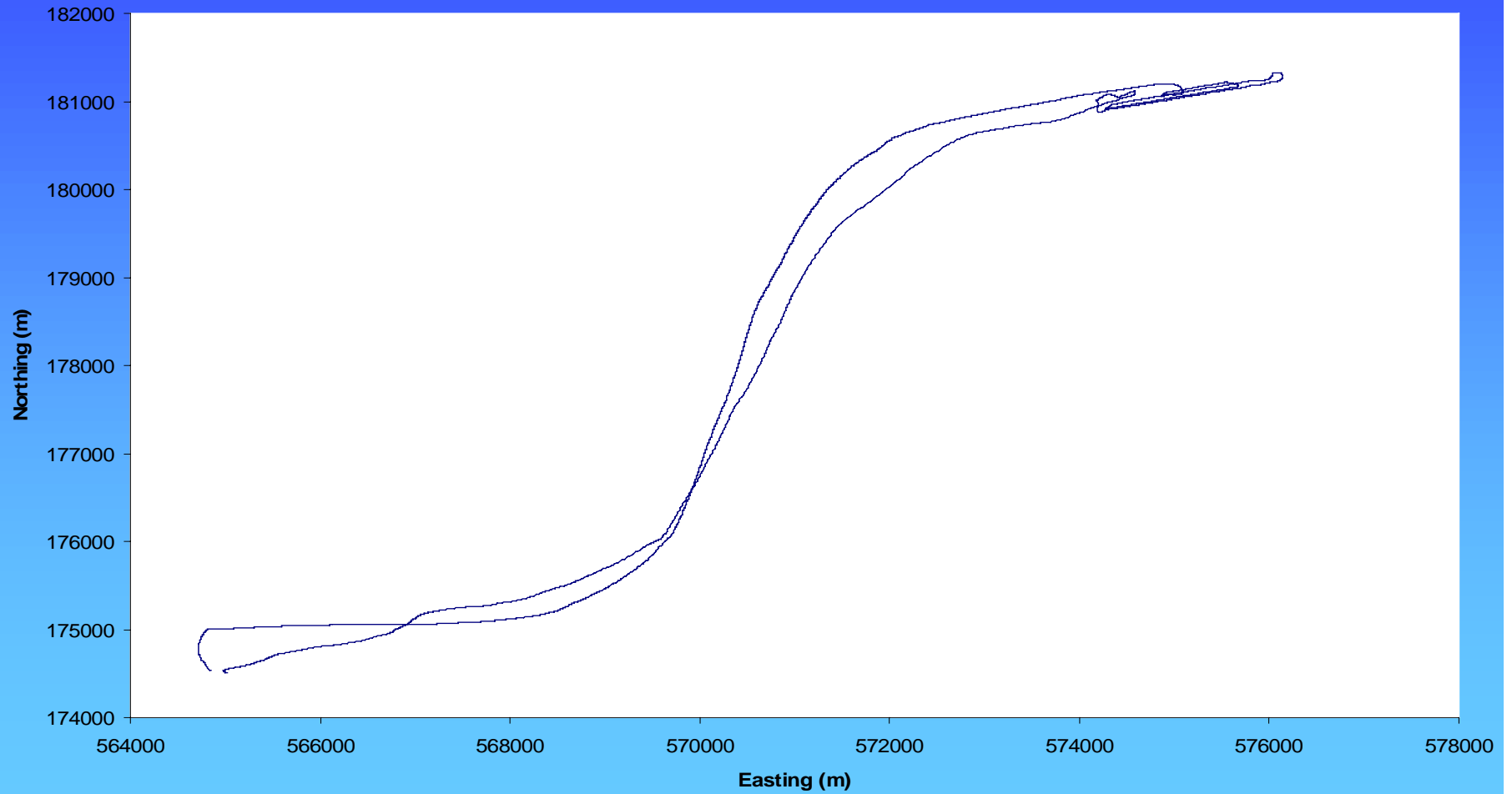
GPS Antennas



# River Thames Trial Trajectory



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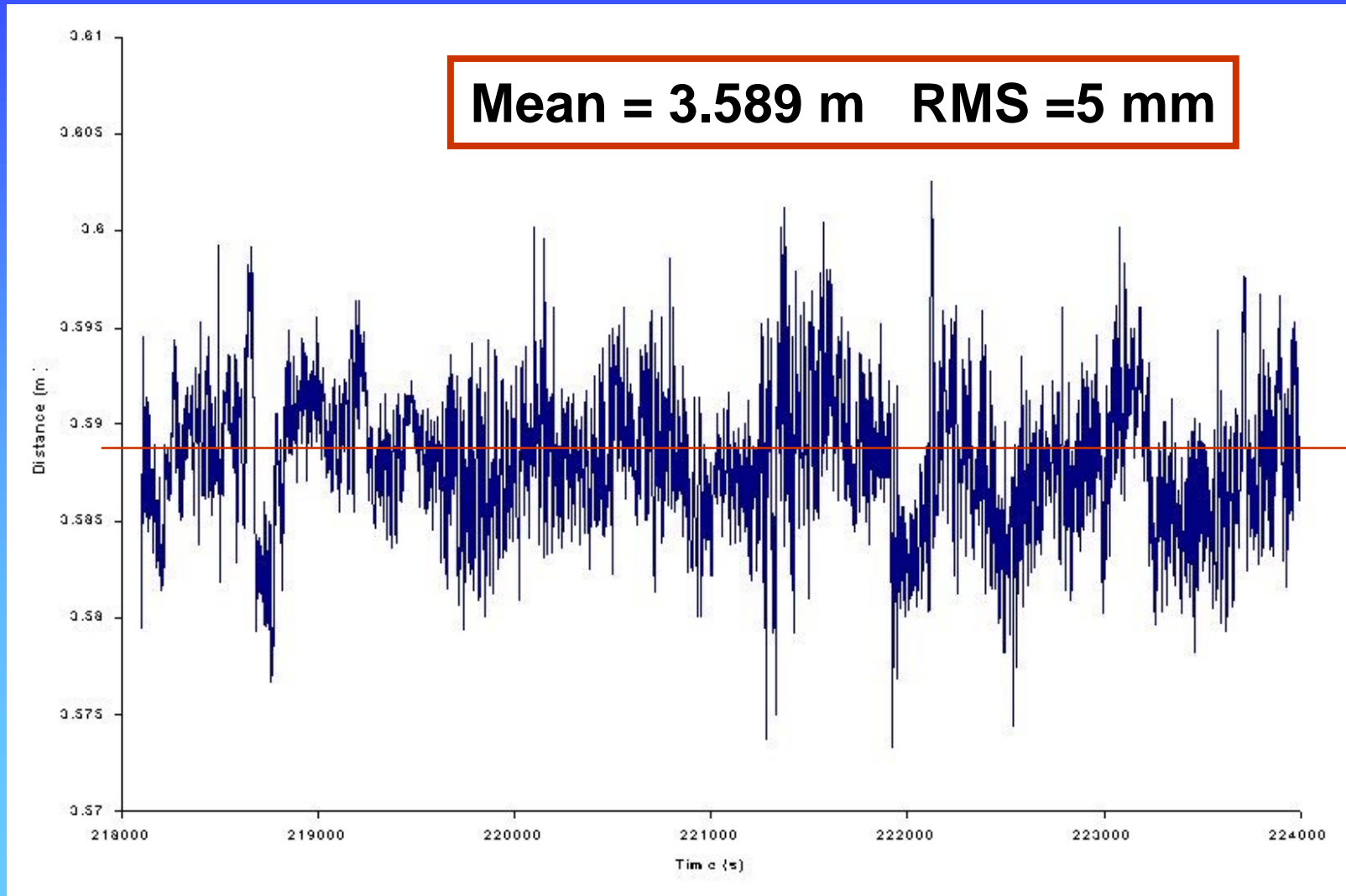




# GPS Accuracy Evaluation



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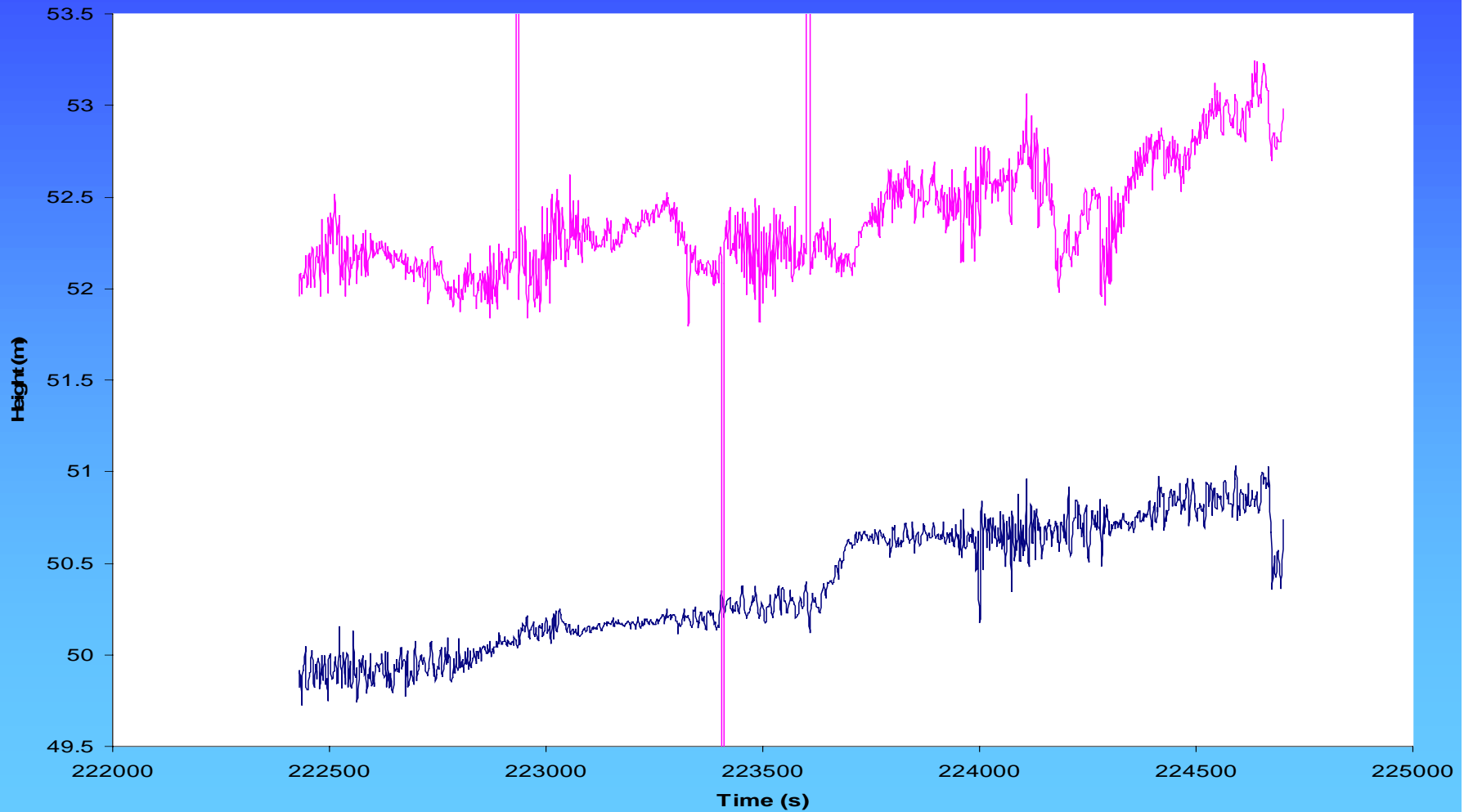




# Height of Vessel



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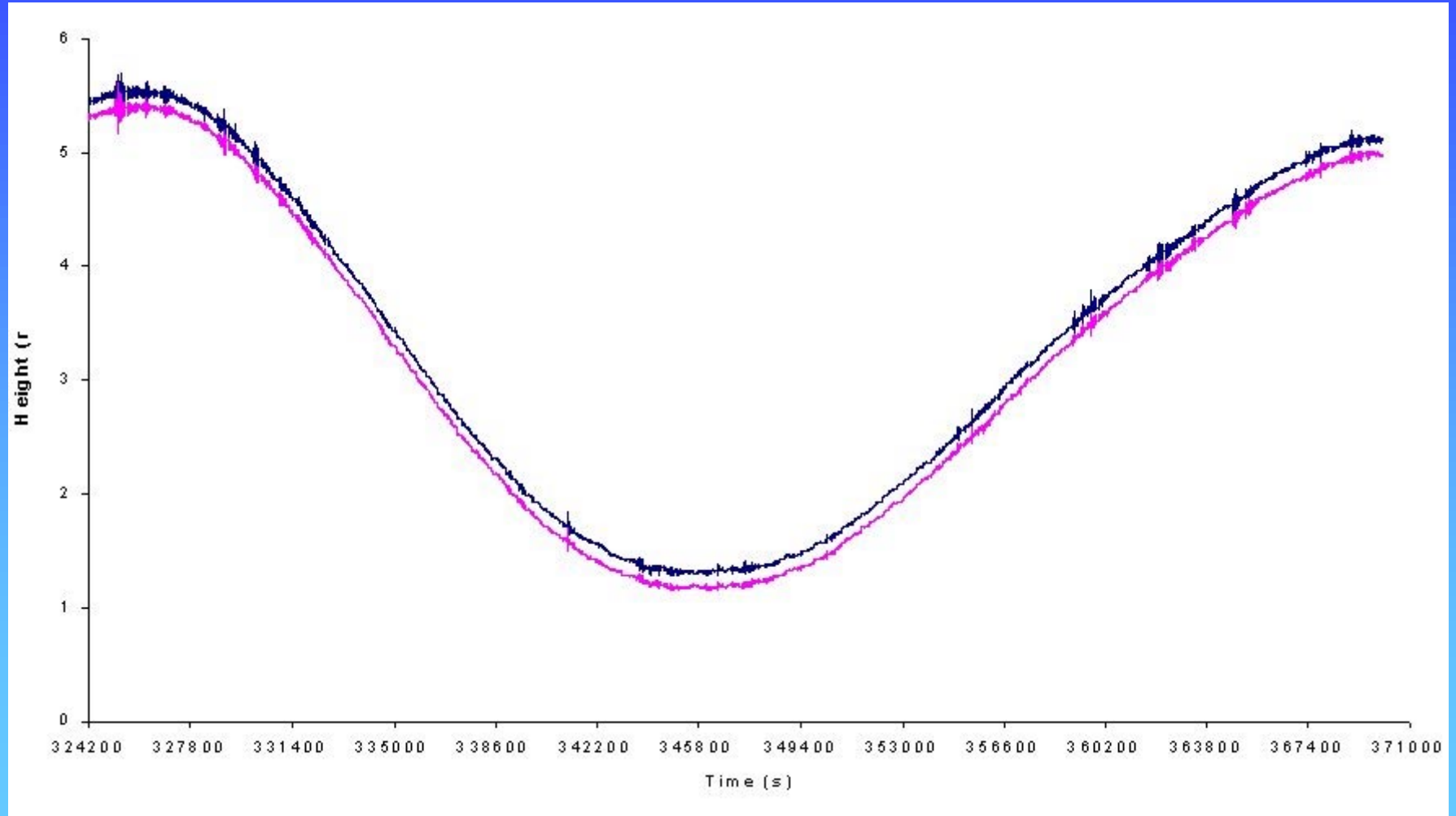




# GPS Heights of Survey Boat



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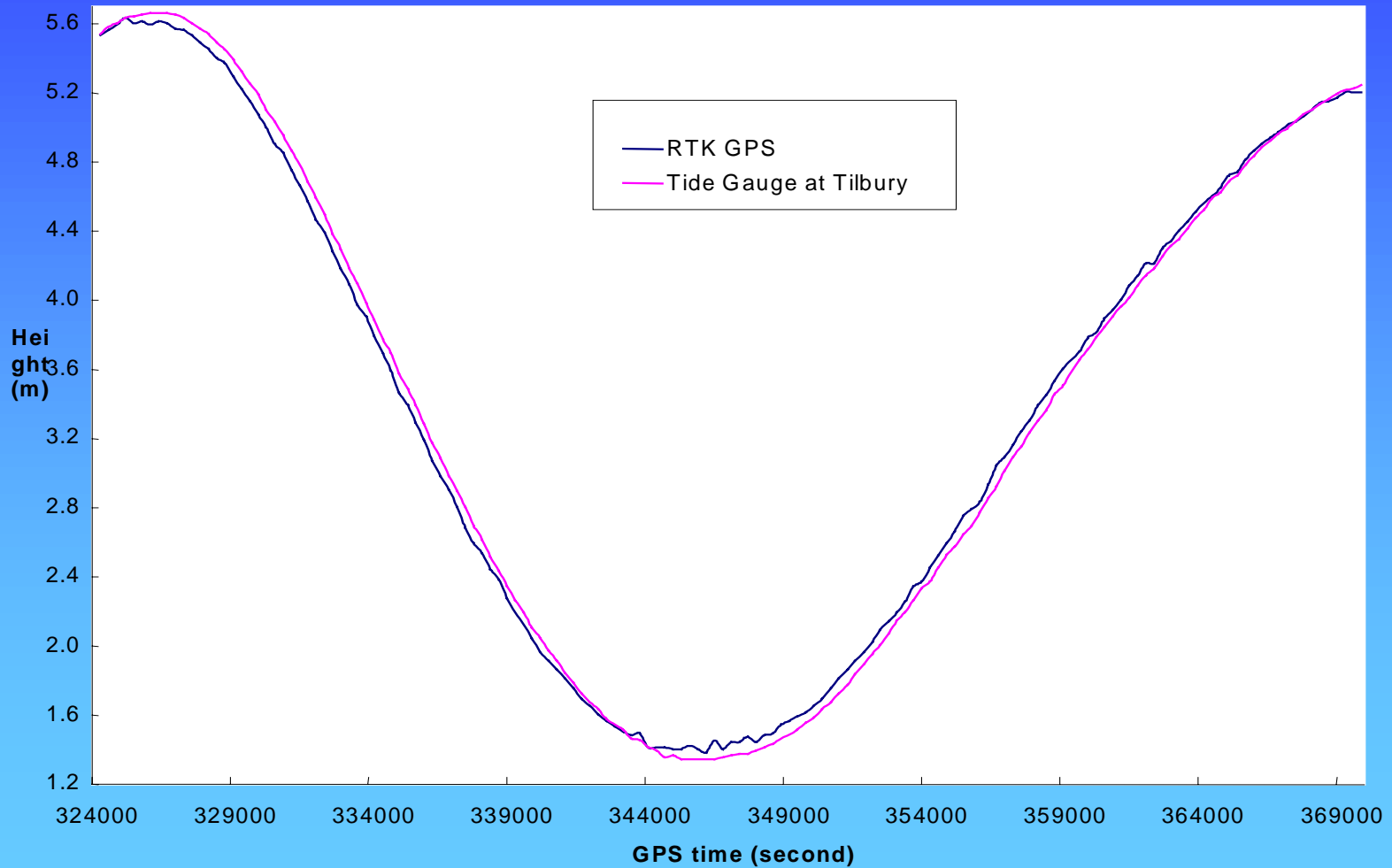




# GPS River Level



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# Pilot Survey of a Typical European Port

## Aims

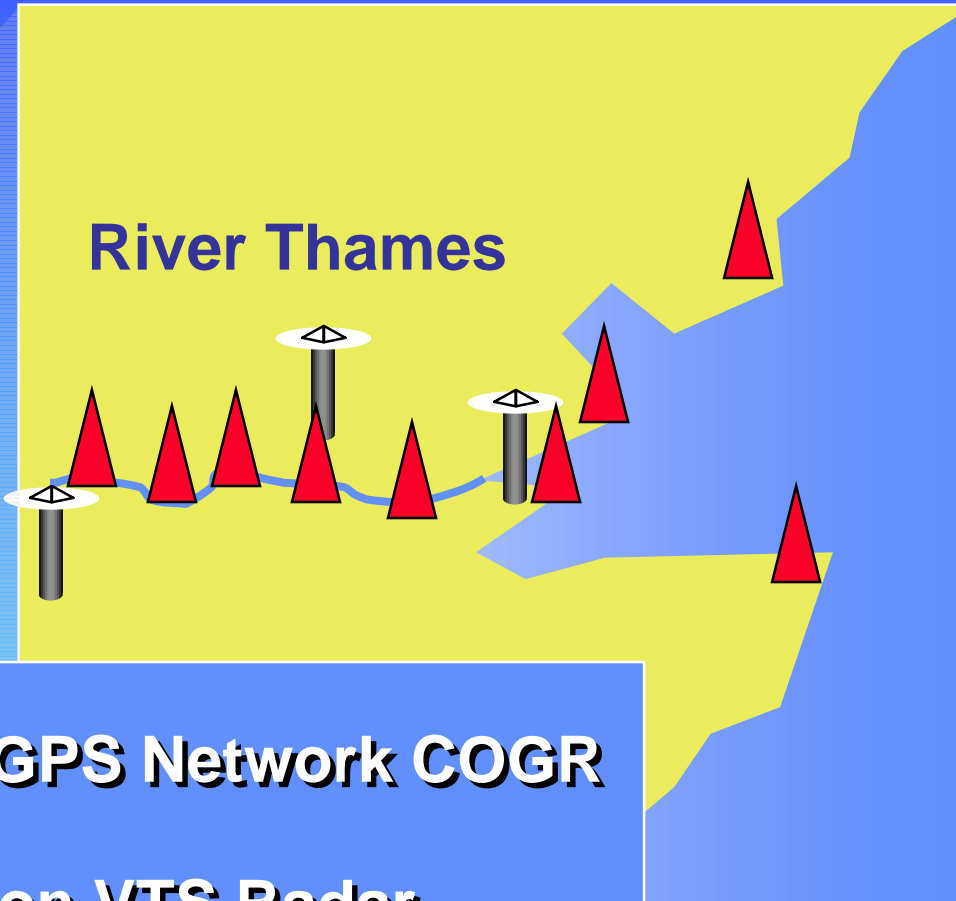
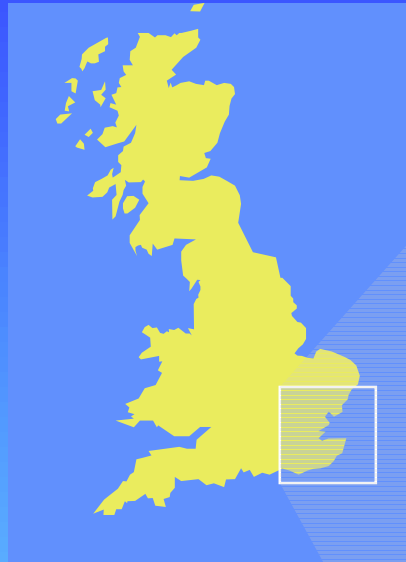
- Assess Quality of Existing Coordinates
- Identify Potential Problems
- Define Survey Procedure(s)
- Estimate Effort Required
- Estimate Scale and Cost of WGS84 Implementation

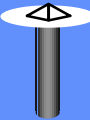



# Port of London Authority



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 **UK National GPS Network COGR**

 **Port of London VTS Radar**



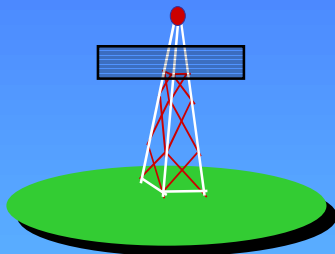
# Pilot Survey



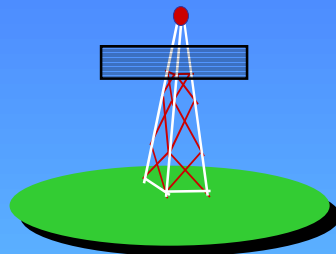
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**Surveyed  
WGS84  
Coordinates**

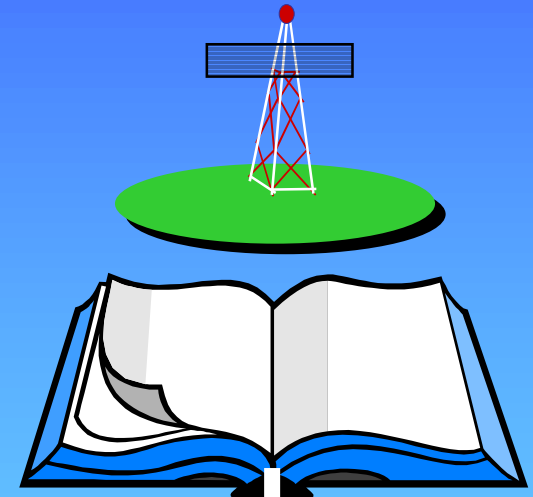


**Transformed  
New Coords**



**OSGB  
Transformation  
Parameters**

**Published  
VTS Radar  
Coordinates**



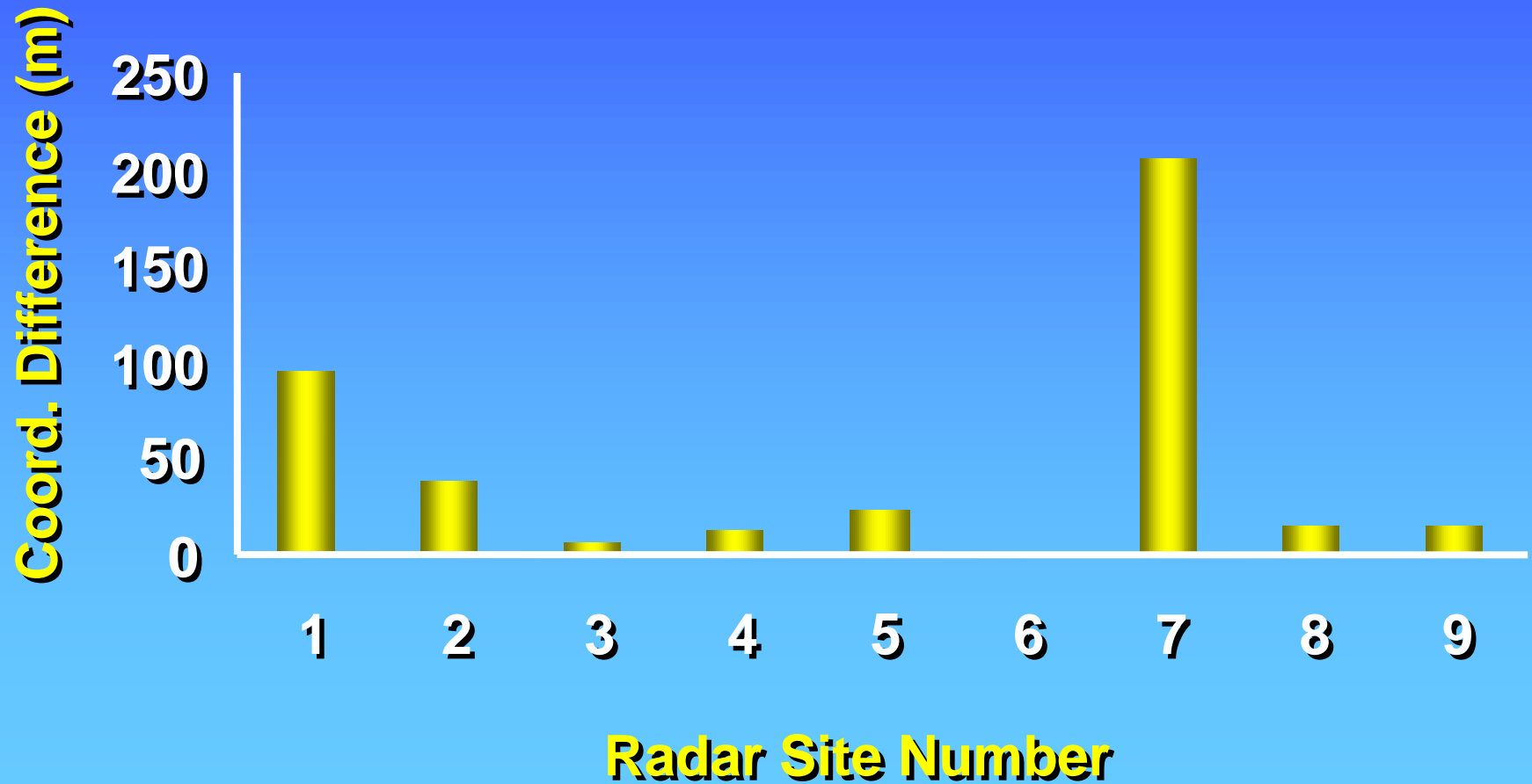
**Compare**



# Quality of Existing Coordinates



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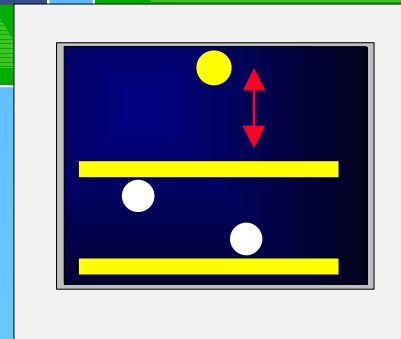
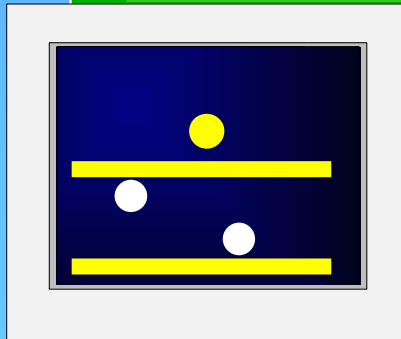
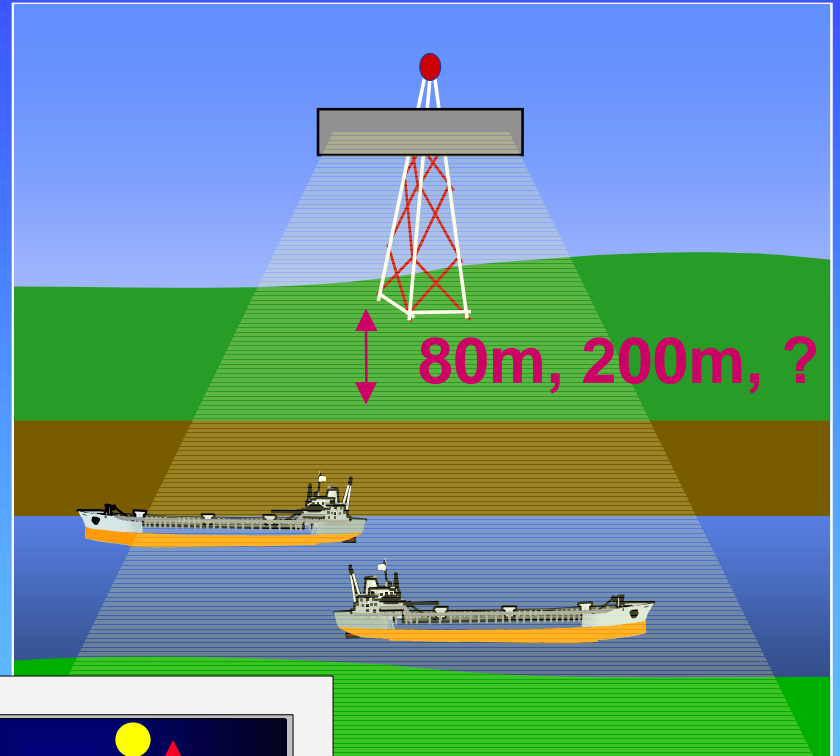
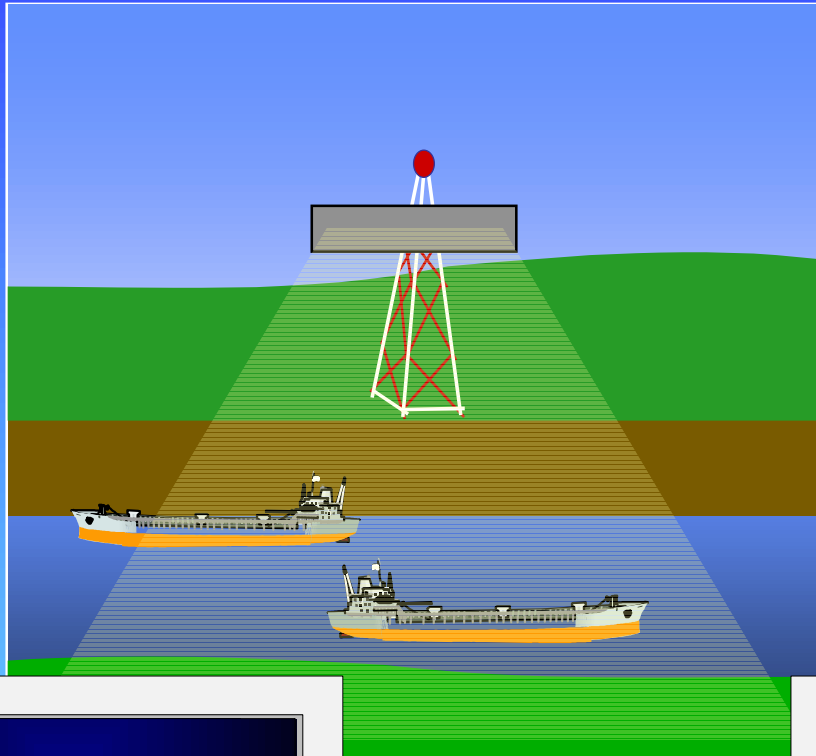




# Why then no Incidents ?



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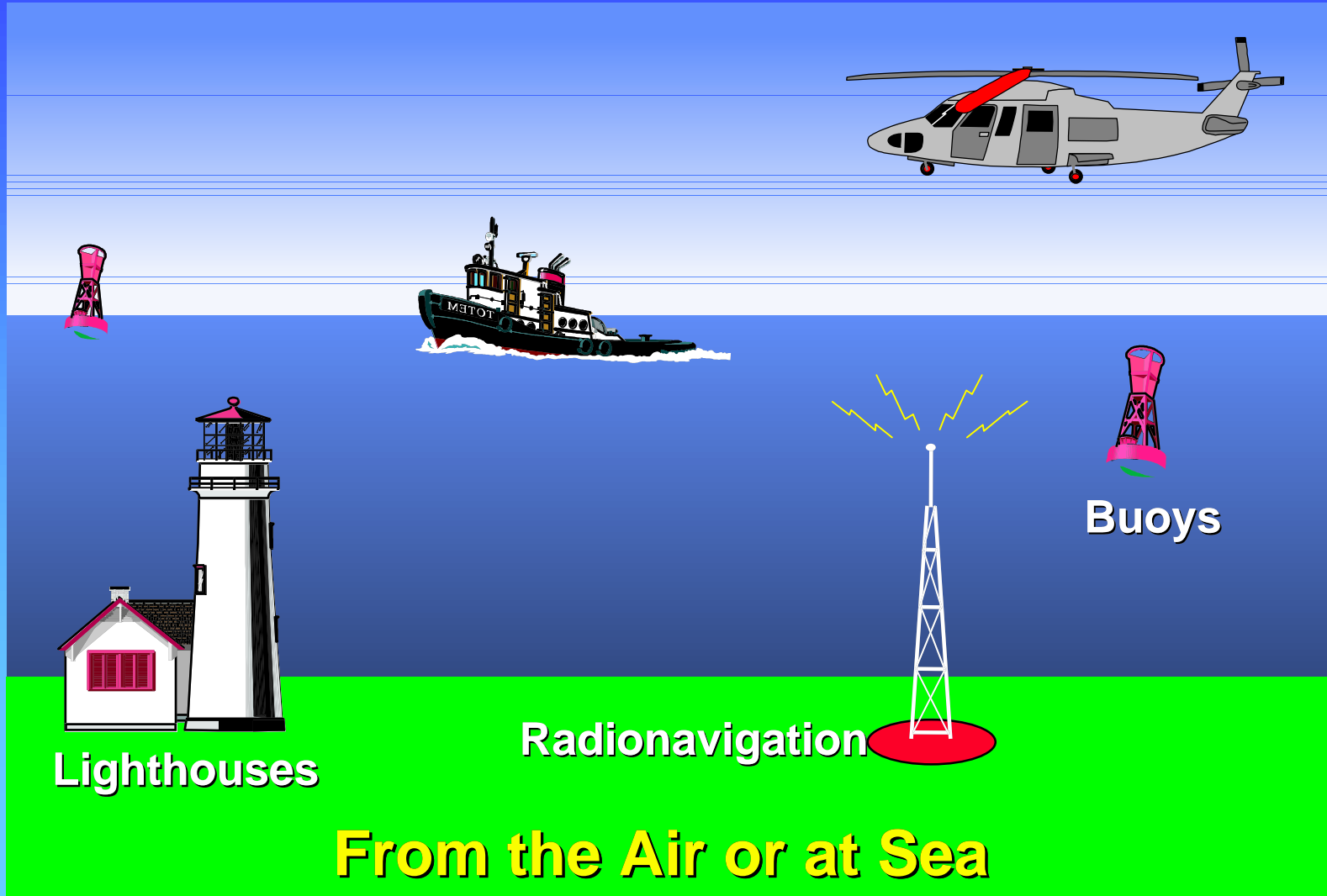




# Coordination of Navaids to WGS 84



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Lighthouses

Radionavigation

Buoys



# Implementation of WGS84

## Coastal Aids to Navigation



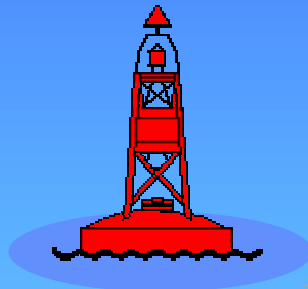
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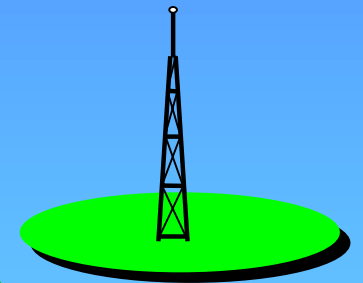
Sound of Mull



3



1



2

Shannon Estuary

Thames Estuary

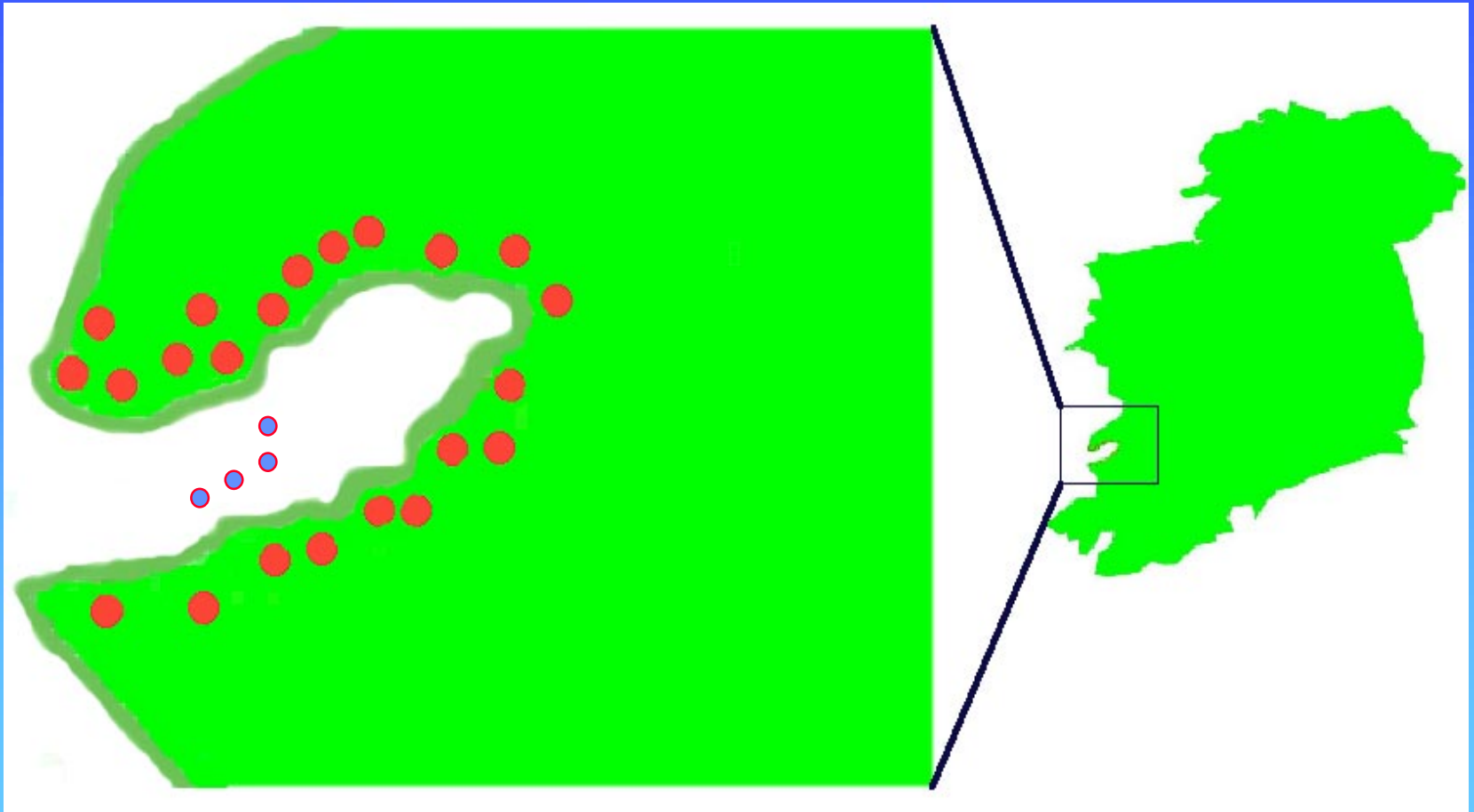


# Aids to Navigation

## Shannon Estuary



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# Shannon Estuary Survey Ship



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# Classification of Surveyed Points



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Type	Number
Lighthouse	6
Leading Light	4
Navigational Light	2
Radar Site	1
Tide Gauge	1
OSI Mark	7
Buoy	3
Others	4
<b>Total</b>	<b>28</b>



# Approach



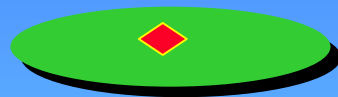
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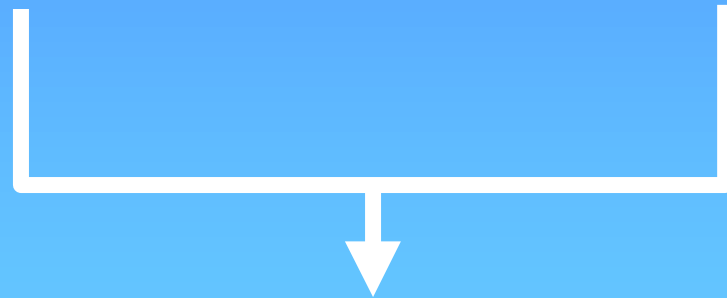
**Surveyed  
WGS84  
Coordinates**

**Transformed  
to Chart Coords**

**Chart  
Coordinates**



**7 parameter OSI  
Transformation  
(0.5m Accuracy)**



**Compare**

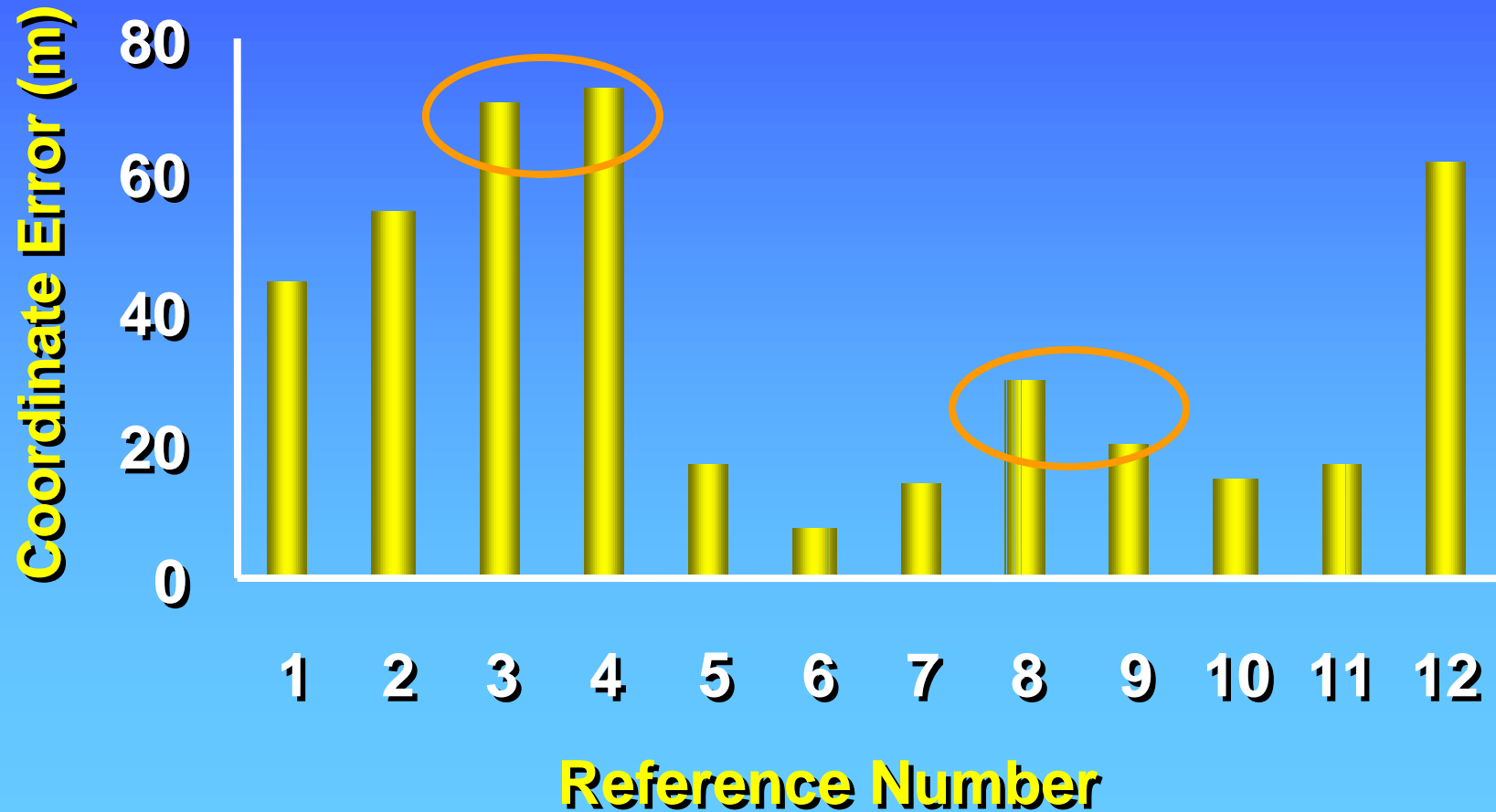




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# Lights and Lighthouses



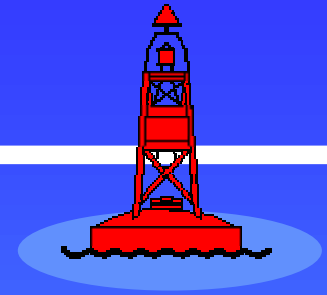




# Buoys



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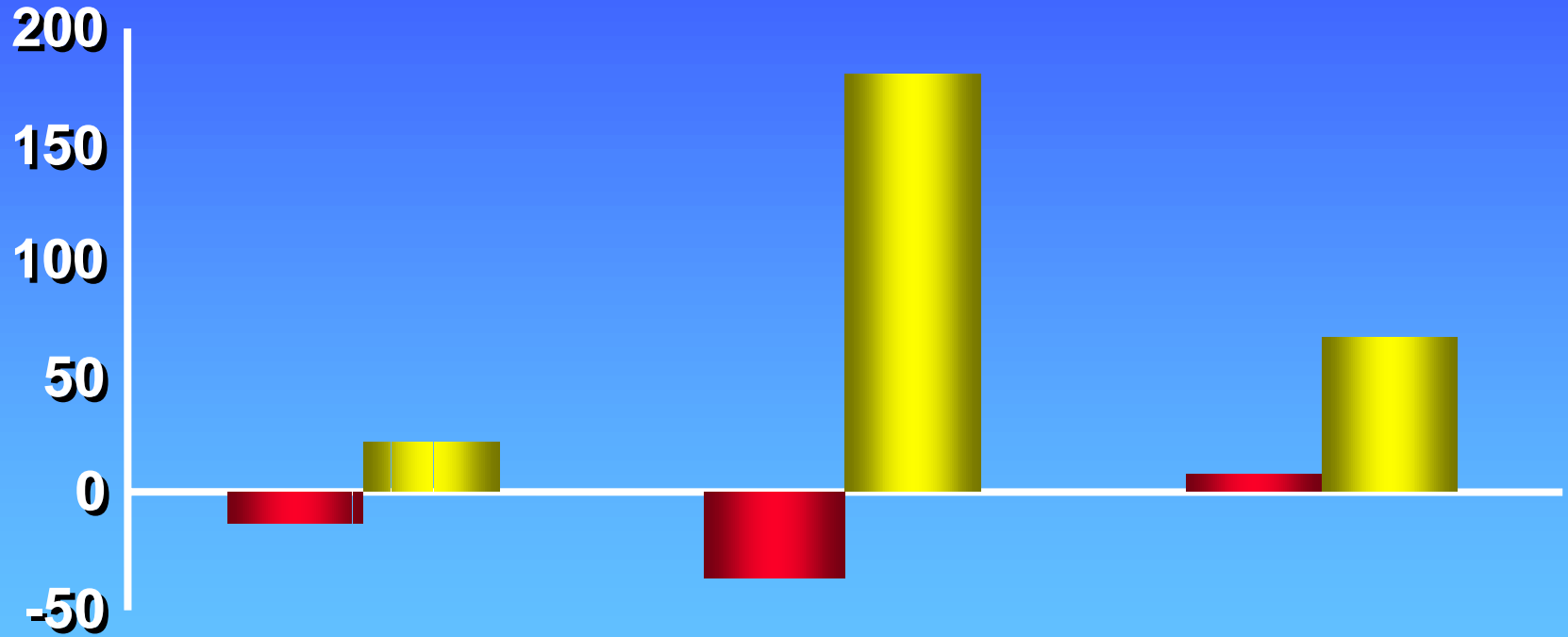
**Coordinate Error (m)**

200  
150  
100  
50  
0  
-50

Letter Point

Beal Bar

Doonaha





# VTS Radar



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945m !



# Brown's Castle B'Bunnion Landmark



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**6534m !**



# However,



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## Rubbish In

V1.03 [D A T U M] Options Quit

Input Transform Project Options Quit

Select Datum [WGS84] |  
Execute Transformat

Point : Nottingham  
Country Code : EG

Source Datum :	OSGB36	Transformation	WGS84
Latitude :	52°56' 0.00" North	Latitude :	52°56' 1.10" North
Longitude :	1°11' 0.00" West	Longitude :	1°11' 5.59" West
Height :	'No Height'	Height :	'No Height'
Option :		Option :	

Session being logged to:- DATUM.LOG

Input ?

Transformation

Output ?

## Rubbish Out



# Size of the Task



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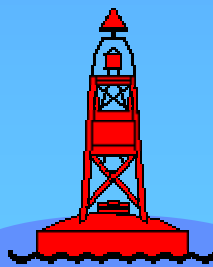
343

- **Lighthouses**

– THLS 67

– NLB 196

– CIL 80



743

- **Buoys**

– THLS 413

– NLB 185

– CIL 147



# The Broad Financial Implications



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## Fixed Aids to Navigation

Requirement

**10cm** Accuracy

Approach

Static GPS positioning

Production

**5 points** per day (average)

Resources

**2+1** staff, plus equip & **mobility**

## Floating Aids to Navigation

Requirement

**10m** Accuracy

Approach

DGPS positioning

Production

**10 points** per day (average)

Resources

**2+1** staff, plus equip & **mobility**



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# A Recommended Approach : Nav aids

- 1) Re-Position All Fixed Facilities
- 2) Re-Position all Critical Floating Aids to Navigation
- 3) Transform Coordinates of Non-Critical AtoN

Provided the transformation is extensible

- 4) Verify Coordinates of Non-Critical AtoN

Preferably during routine operations