A Body in the River: the application of environmental science in murder investigations

Carolyn Roberts

Specialist, UK Knowledge Transfer Network

and

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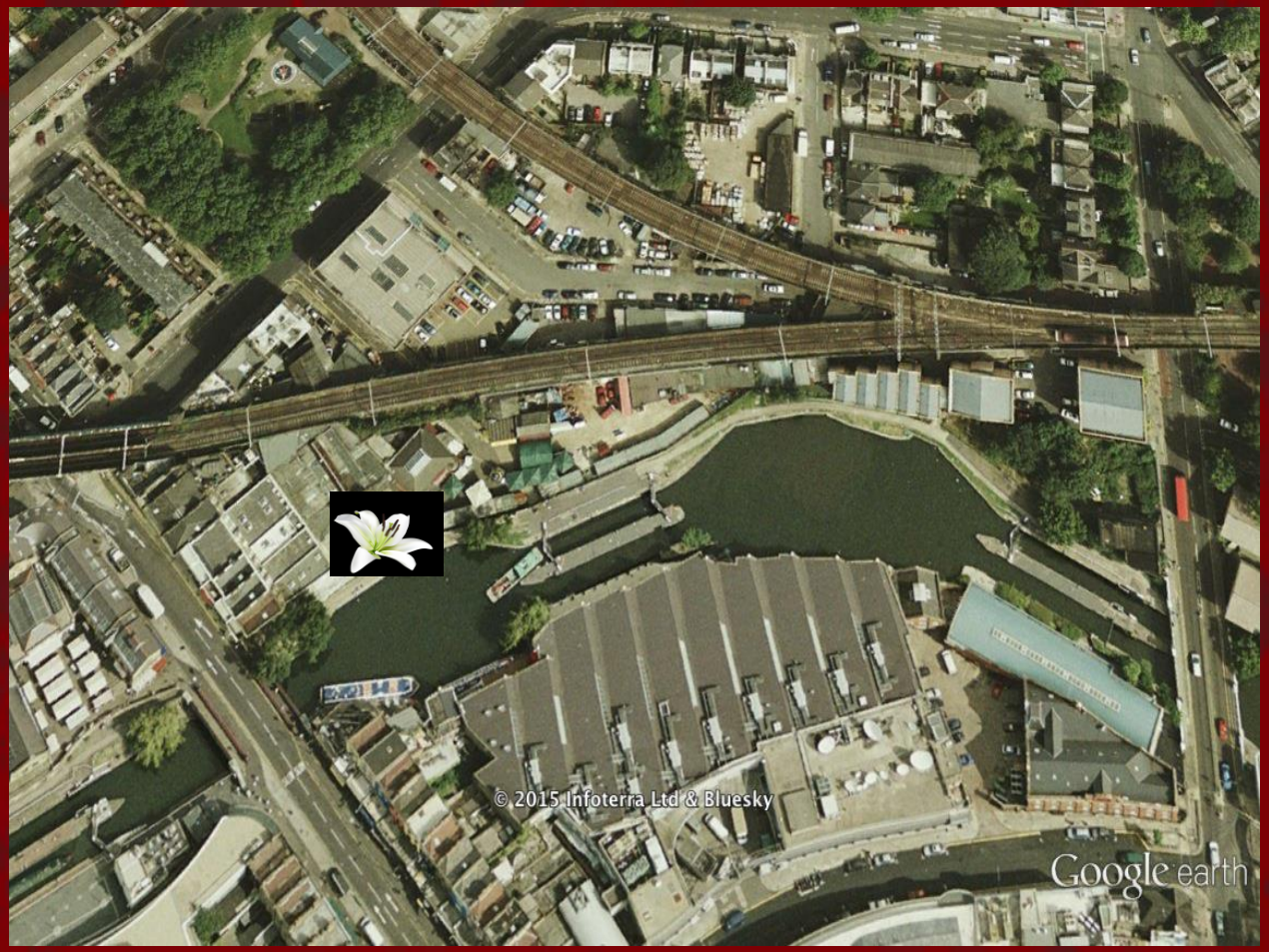
April 1st 2015, Turnford River, Hertfordshire – another body

April 13th 2015, Rochdale – more body parts

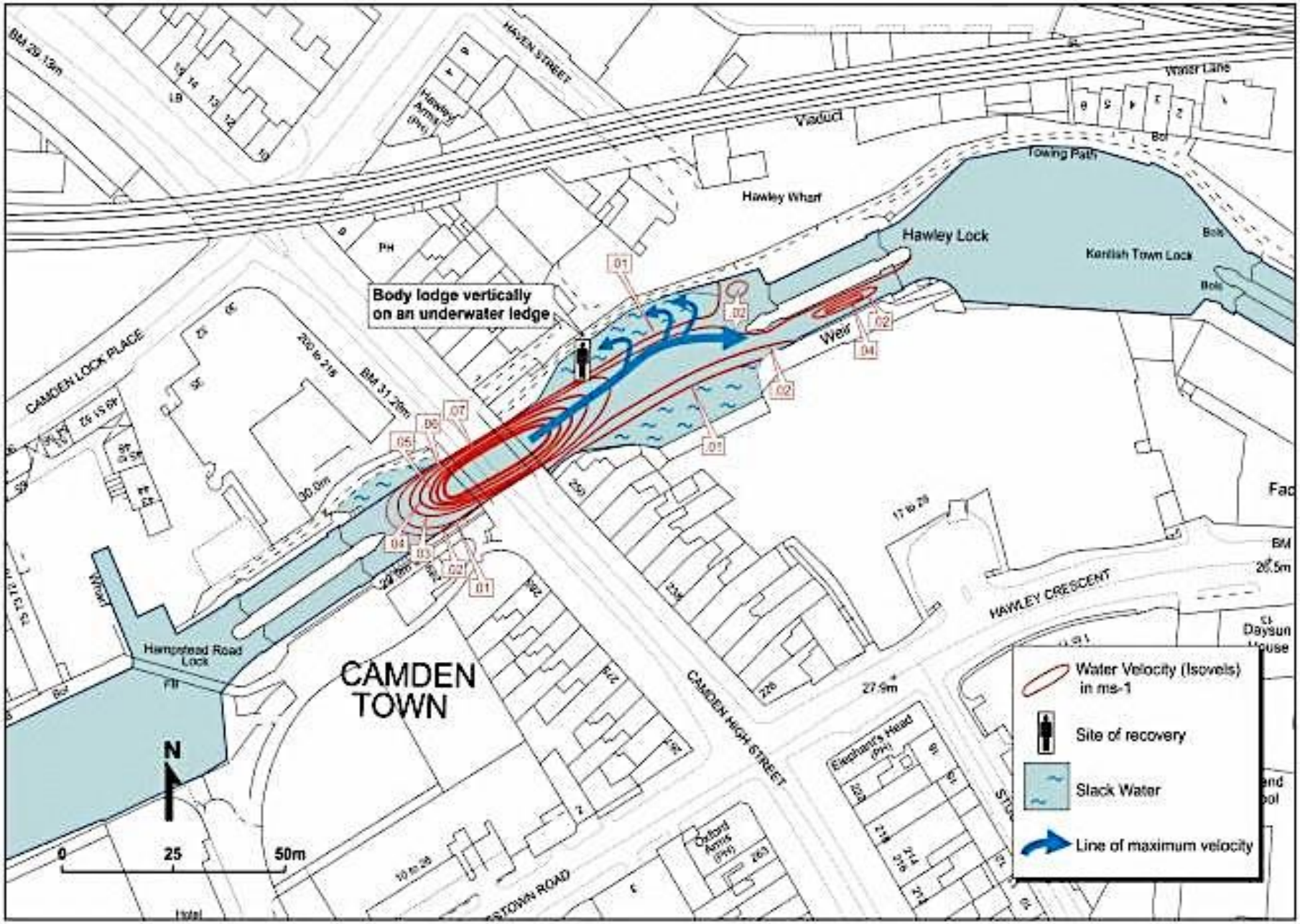
Man ‘murders adopted son with scaffolding pole before trying to dump body in River Thames’ Daily Telegraph, 1st June 2015

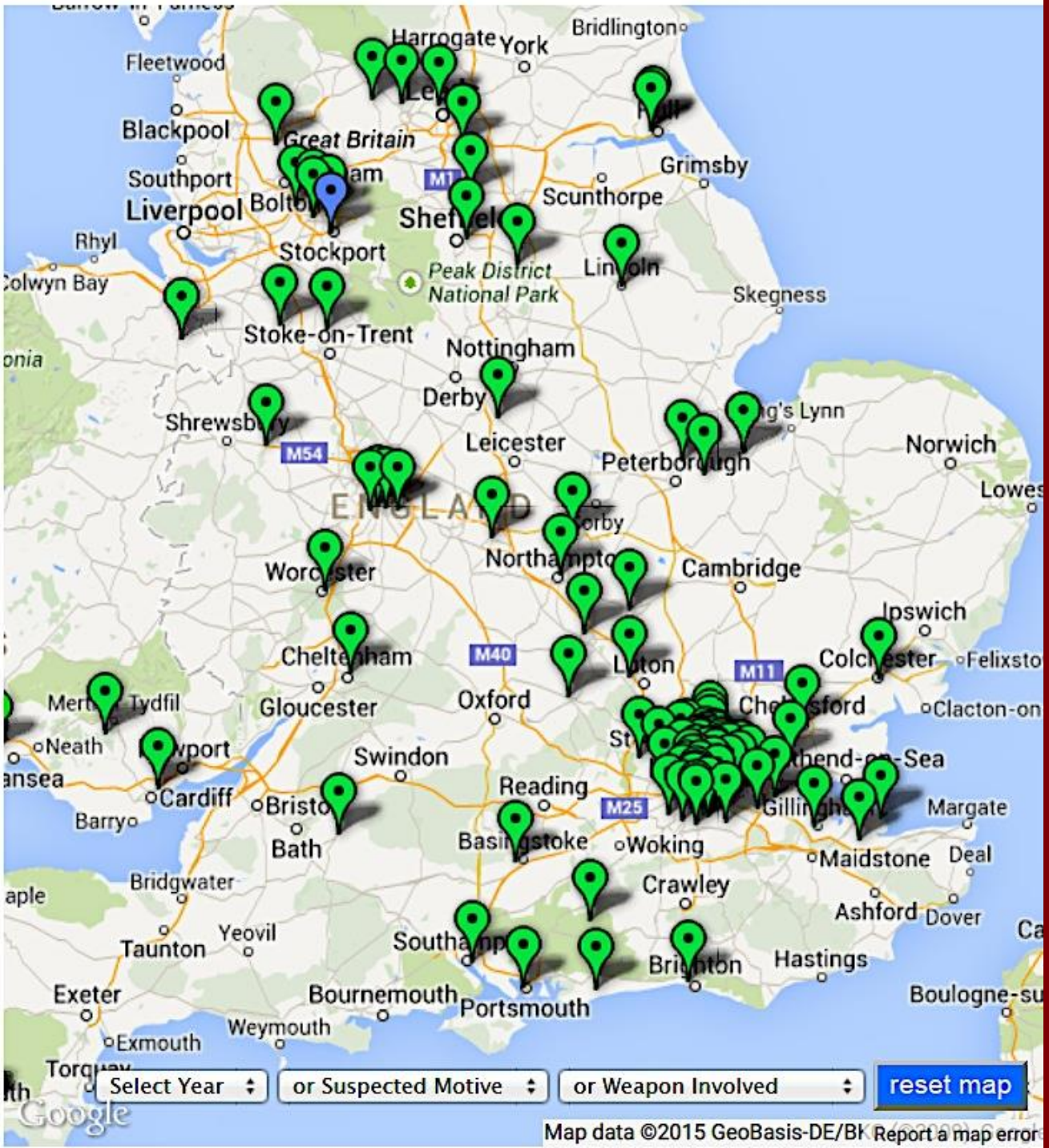
A simple case



'…I have been asked by the Metropolitan Police (Serious Crime Group) to investigate the likely movement of water through the Grand Union Canal at Camden Lock, London, in the period leading up to 11am on Sunday 8th October 2000, when a male body was discovered in the water…At the time I undertook my investigation it was unclear how long the body had been in the water..'

GRAND UNION CANAL AT CAMDEN LOCK



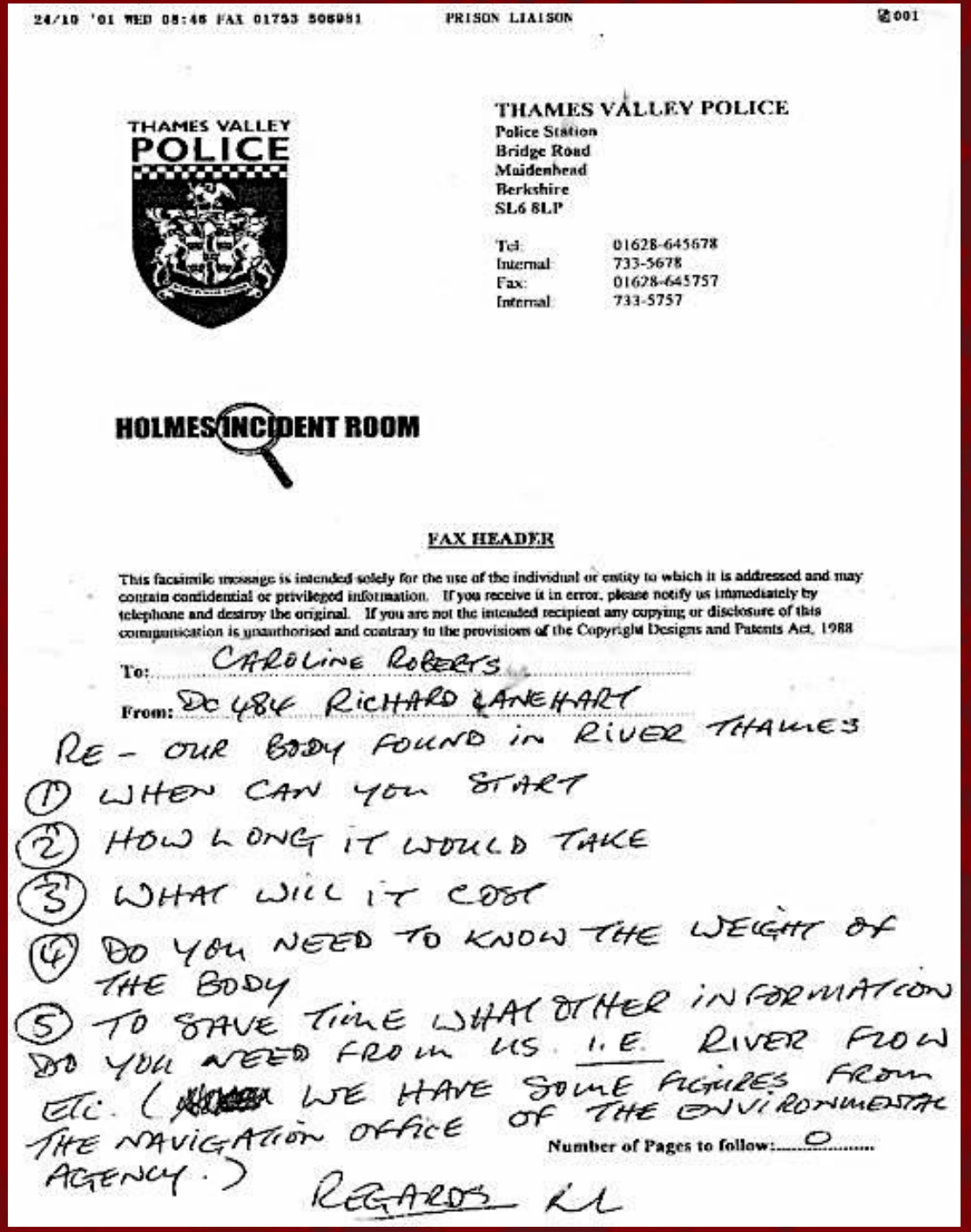

Harrogate
York
Bridlington
Fleetwood
Blackpool
Great Britain
Southport
Liverpool
Bolton
Grimsby
Scunthorpe
Rhyl
Stockport
Peak District National Park
Lincoln
Skegness
Stoke-on-Trent
Nottingham
Derby
Shrewsbury
Leicester
Peterborough
Norwich
ENGLAND
Worcester
Cambridge
Ipswich
Cheltenham
Gloucester
Oxford
Luton
Colchester
Felixstowe
Swindon
Reading
Cardiff
Bristol
Bath
Barry
Basingstoke
Woking
Maidstone
Margate
Deal
Crawley
Ashford
Dover
Bridgwater
Taunton
Yeovil
Southampton
Brighton
Hastings
Exeter
Bournemouth
Portsmouth
Weymouth
Exmouth
Boulogne-sur-Mer
M1
M54
M40
M11
M25
Select Year
or Suspected Motive
or Weapon Involved
reset map
Google
Map data ©2015 GeoBasis-DE/BK
Report a map error

Undertaking an inquiry

- Understanding the task
- Assembling the evidence
- Preparing the case
- Drawing conclusions
- Presenting the case
- Satisfying the client

Instructions can:

- Be given at short notice and require a rapid response
- Be unclear
- Require a very rapid grasp of the scientific and political context and the key issues
- Require decisions to be taken in the light of uncertainty
- Necessitate working within limited resources



24/10 '01 WED 08:46 FAX 01753 506981 PRISON LIAISON 001

THAMES VALLEY POLICE

THAMES VALLEY POLICE
Police Station
Bridge Road
Maidenhead
Berkshire
SL6 8LP

Tel: 01628-645678
Internal: 733-5678
Fax: 01628-645757
Internal: 733-5757

HOLMES INCIDENT ROOM

FAX HEADER

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To: CAROLINE ROBERTS

From: DC 484 RICHARD LANEHART

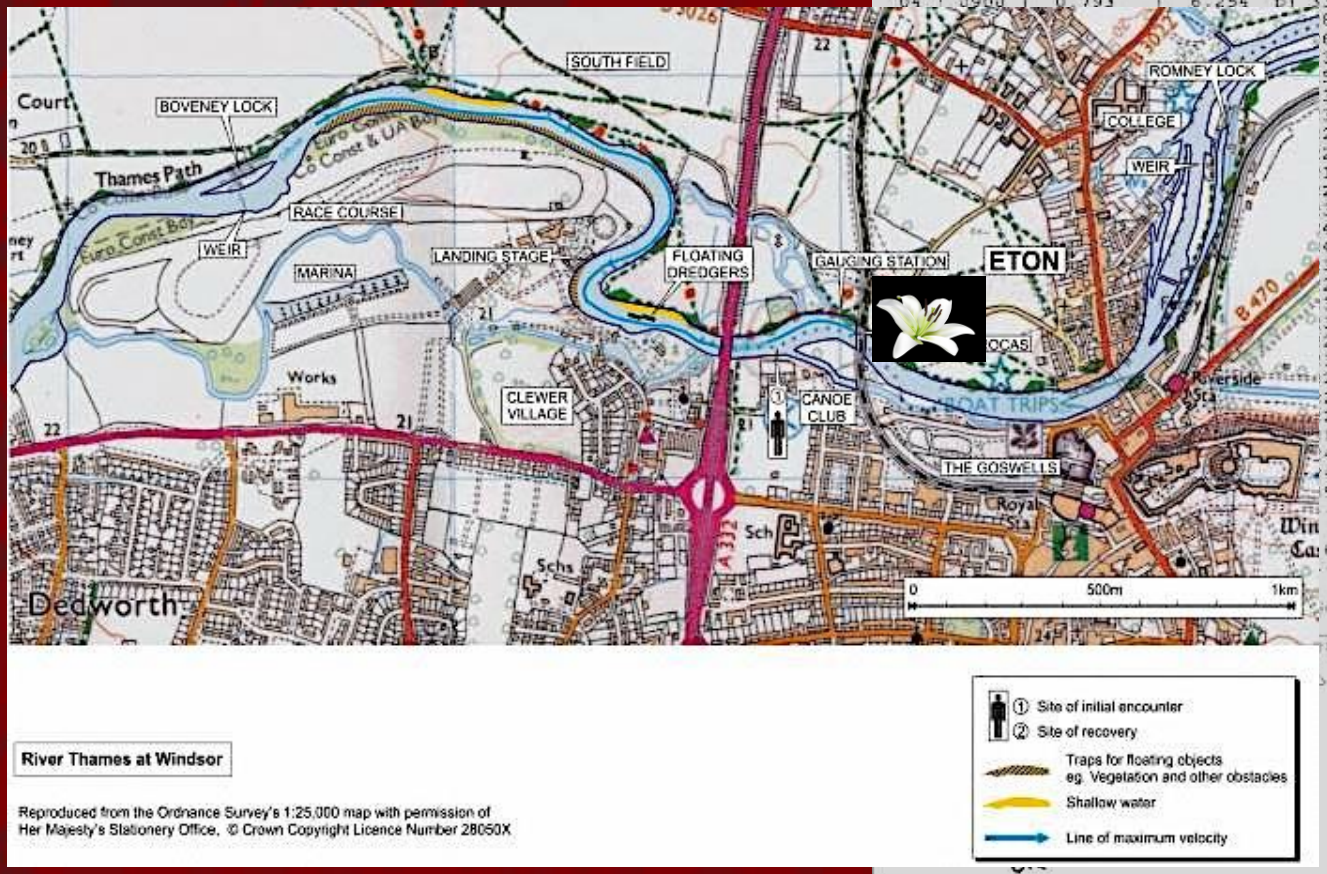
RE - OUR BODY FOUND in RIVER THAMES

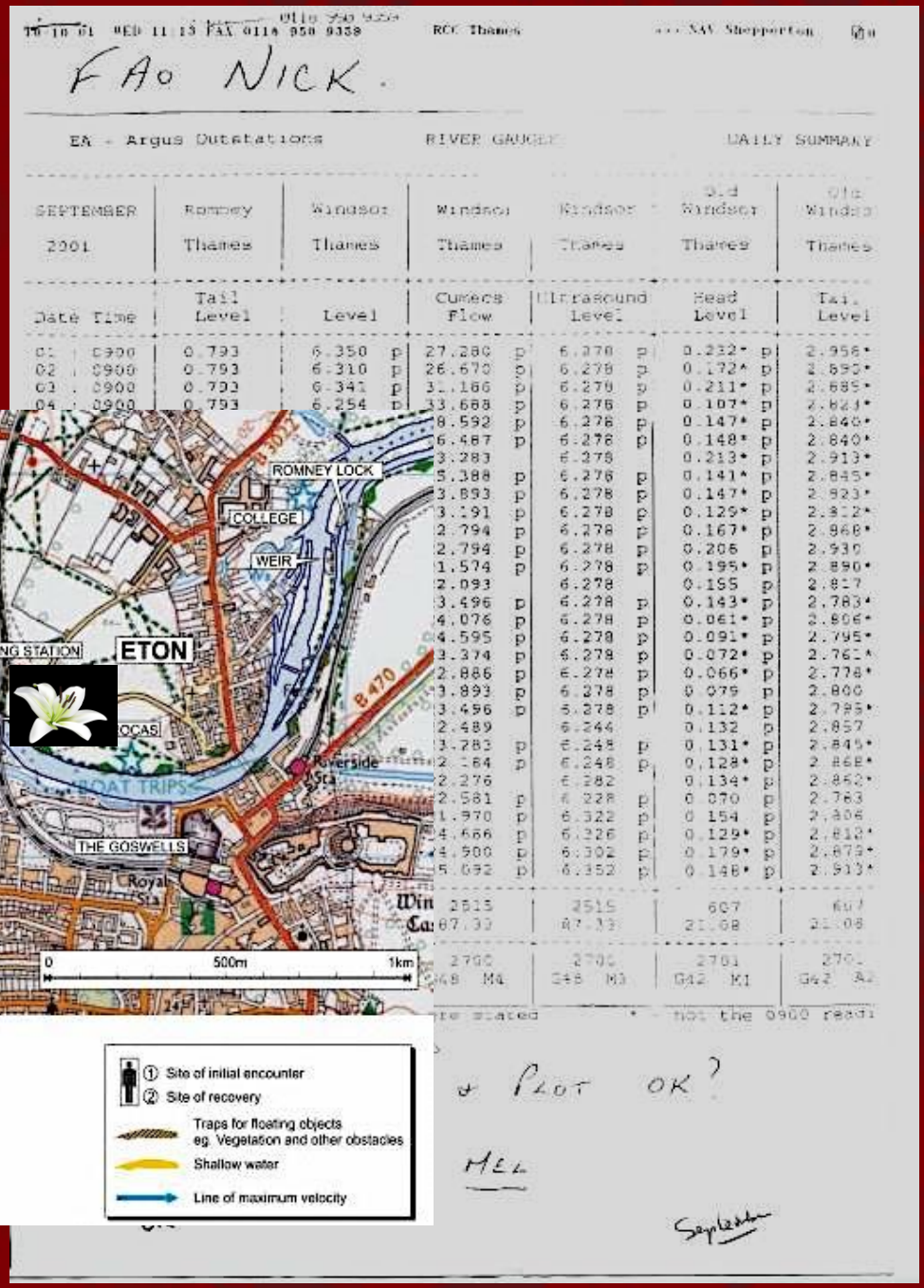
(1) WHEN CAN YOU START
(2) HOW LONG IT WOULD TAKE
(3) WHAT WILL IT COST
(4) DO YOU NEED TO KNOW THE WEIGHT OF THE BODY
(5) TO SAVE TIME WHAT OTHER INFORMATION DO YOU NEED FROM US I.E. RIVER FLOW ETC. ([redacted] WE HAVE SOME FIGURES FROM THE NAVIGATION OFFICE OF THE ENVIRONMENTAL AGENCY.)

Number of Pages to follow: 0

REGARDS RL

Evidence of different types





Witness Statements

‘…as I got approximately 1/3 of the way across the main river, I noticed what I first took to be a log floating in the river upstream of my position…As I watched, I saw some air bubbles come up around it, which aroused my curiosity…’

‘…I am a full time member of the Thames Valley Police Underwater Search Team….There is a lot of debris on the bottom of both banks for a distance of 8 metres from the bank, ie scaffolding poles, car parts, old fridges, shopping trolleys etc…’

‘I am the resident lock keeper at Boveney Lock…On Wednesday 19th September 2001 I set the gates to 10 feet crest, which is where the water was passing over the top of the gates. Eight of the gates were set at one foot below the surface, and…The gates remained in this position until Saturday 29th September 2001....’

Presenting the case

Form MG11(T)

NORFOLK CONSTABULARY

WITNESS STATEMENT

(CJ Act 1967, s.9, MC Act 1980 ss.5A(3a) & 5B, MC Rules 1981, r70.)

STATEMENT OF: CAROLYN ROSEMARY ROBERTS

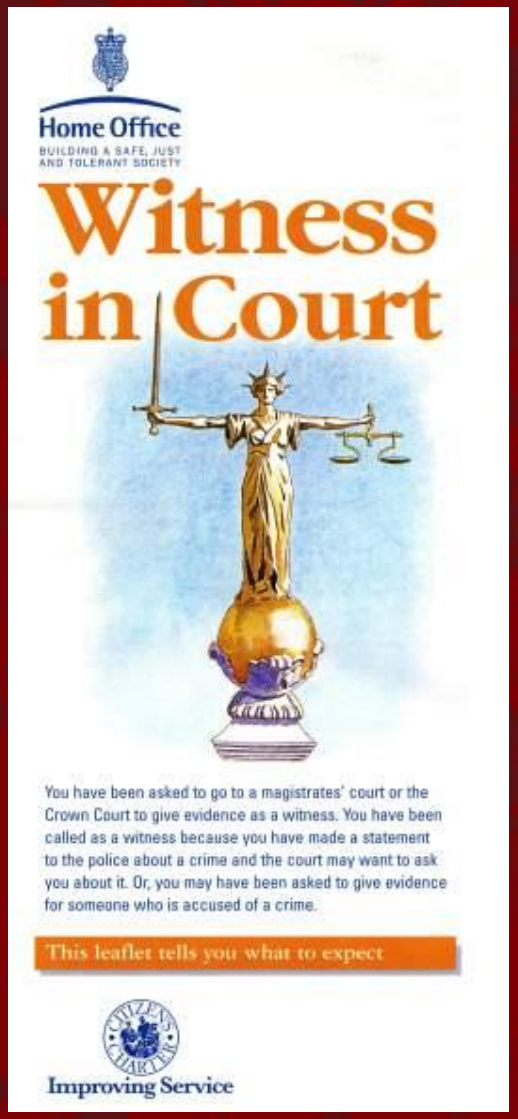
Age if under 18 OVER 18 (if over 18 insert 'over 18')

This statement (consisting of FIVE pages each signed by me) is true to the best of my knowledge and belief and I make it knowing that, if it is tendered in evidence I shall be liable to prosecution if I wilfully stated in it anything which I know to be false or do not believe to be true.

I AM PREPARED / ~~NOT PREPARED~~ (delete as appropriate) TO HAVE MY DETAILS PASSED TO THE VICTIM SUPPORT SERVICE / YOUTH OFFENDING TEAMS.

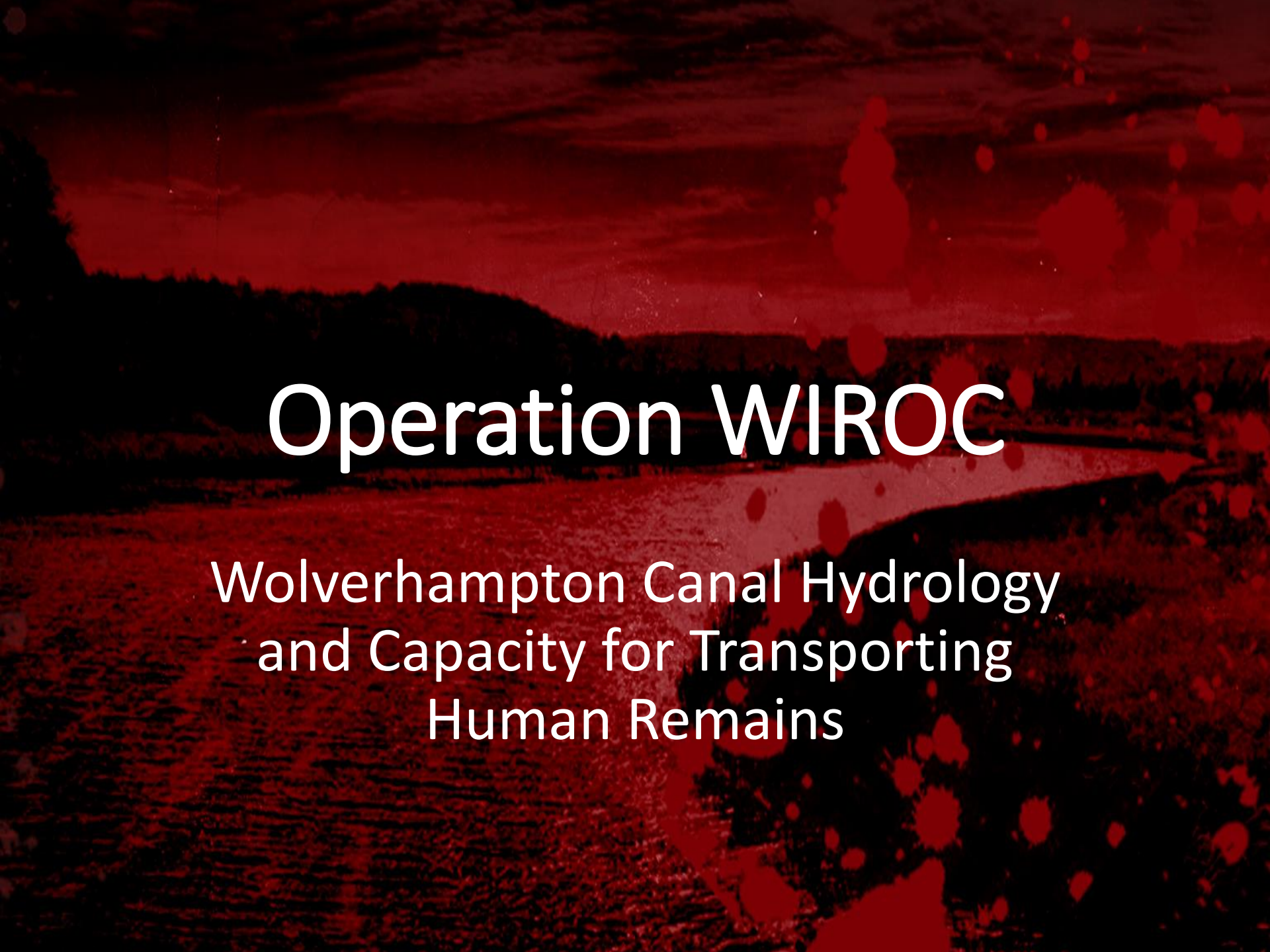
Dated the 10 day of March 2003

Signature :



Building a model of bodies in rivers

1. Entering the water
2. Decay and floatation
3. Moving with the water
4. Grounding



Operation WIROC

Wolverhampton Canal Hydrology and Capacity for Transporting Human Remains

Nº 5


150
Manual

Insect bites

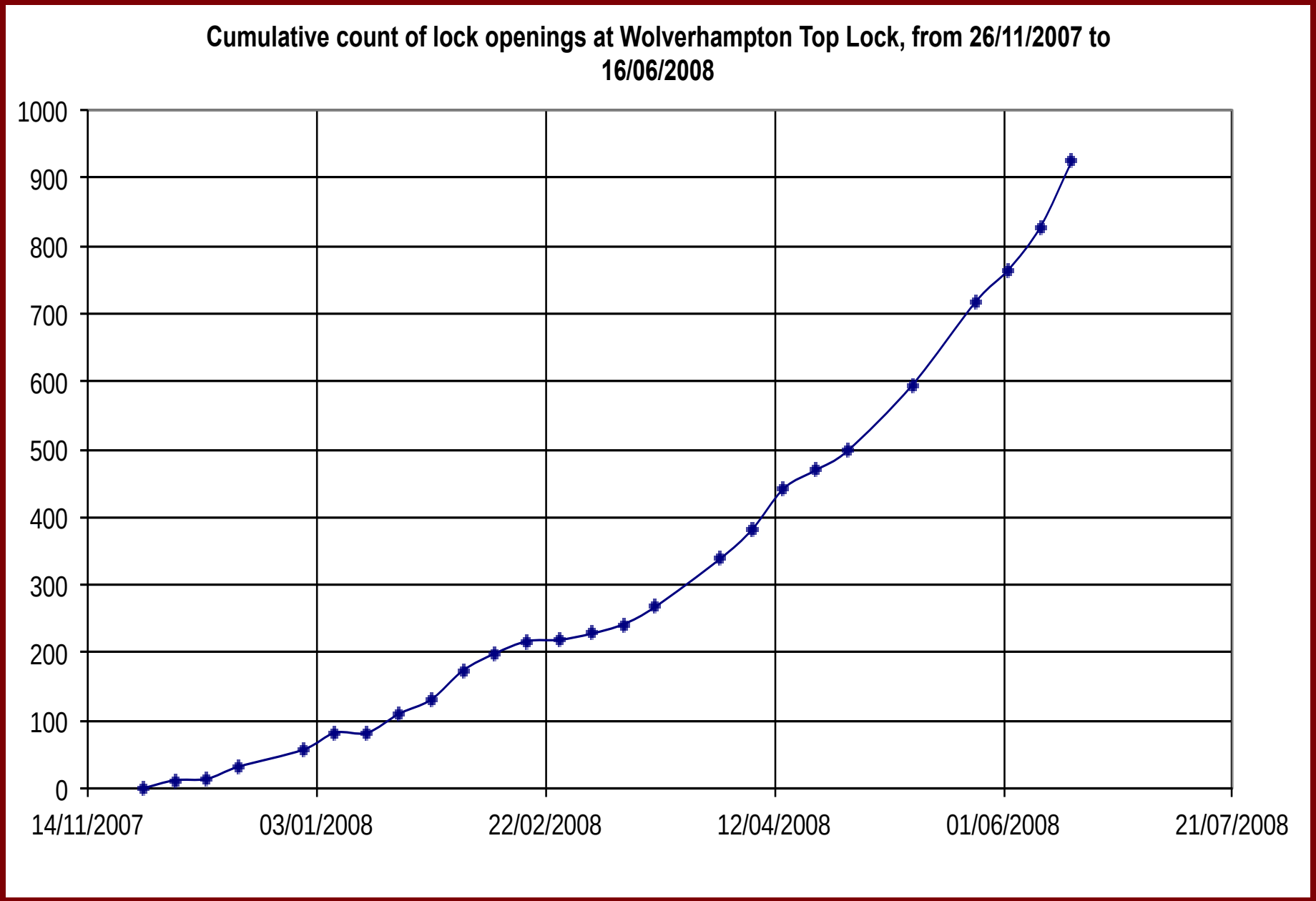
Mr D last sighted on 8th December 2007. Reports of body parts being seen in canal between January and March 2008.

Decomposed torso found 30th March 2008, by a walker.

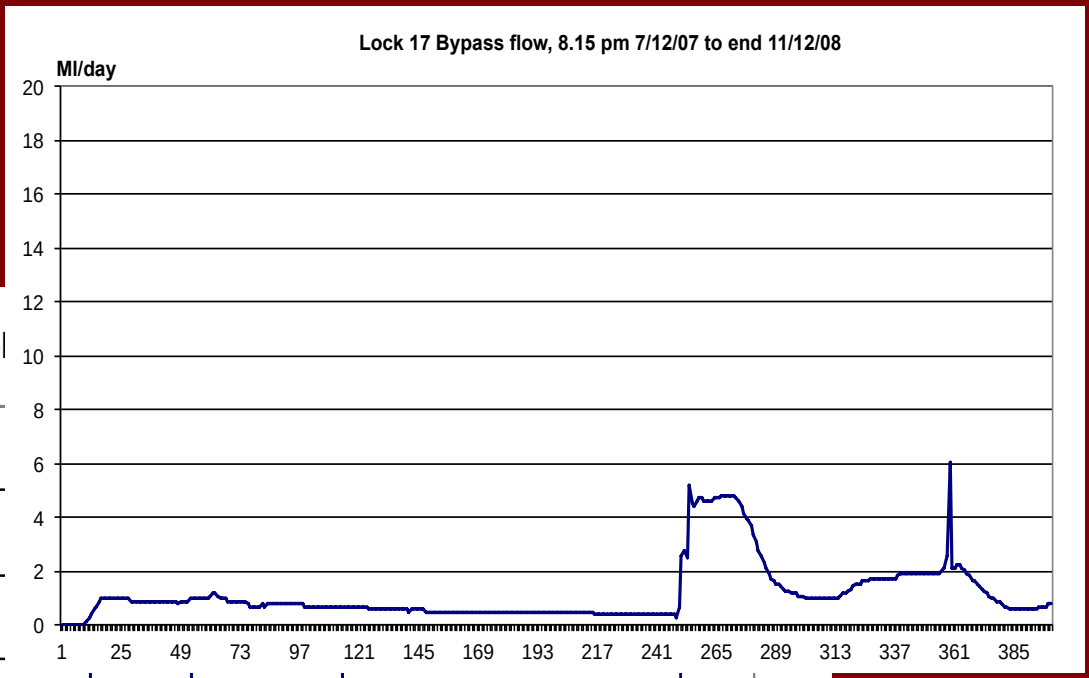
Entomological evidence suggested submersion or alternating periods of exposure and submersion, or potential isolation elsewhere, prior to recovery. However, the remains were unlikely to have been exposed to the atmosphere for long.

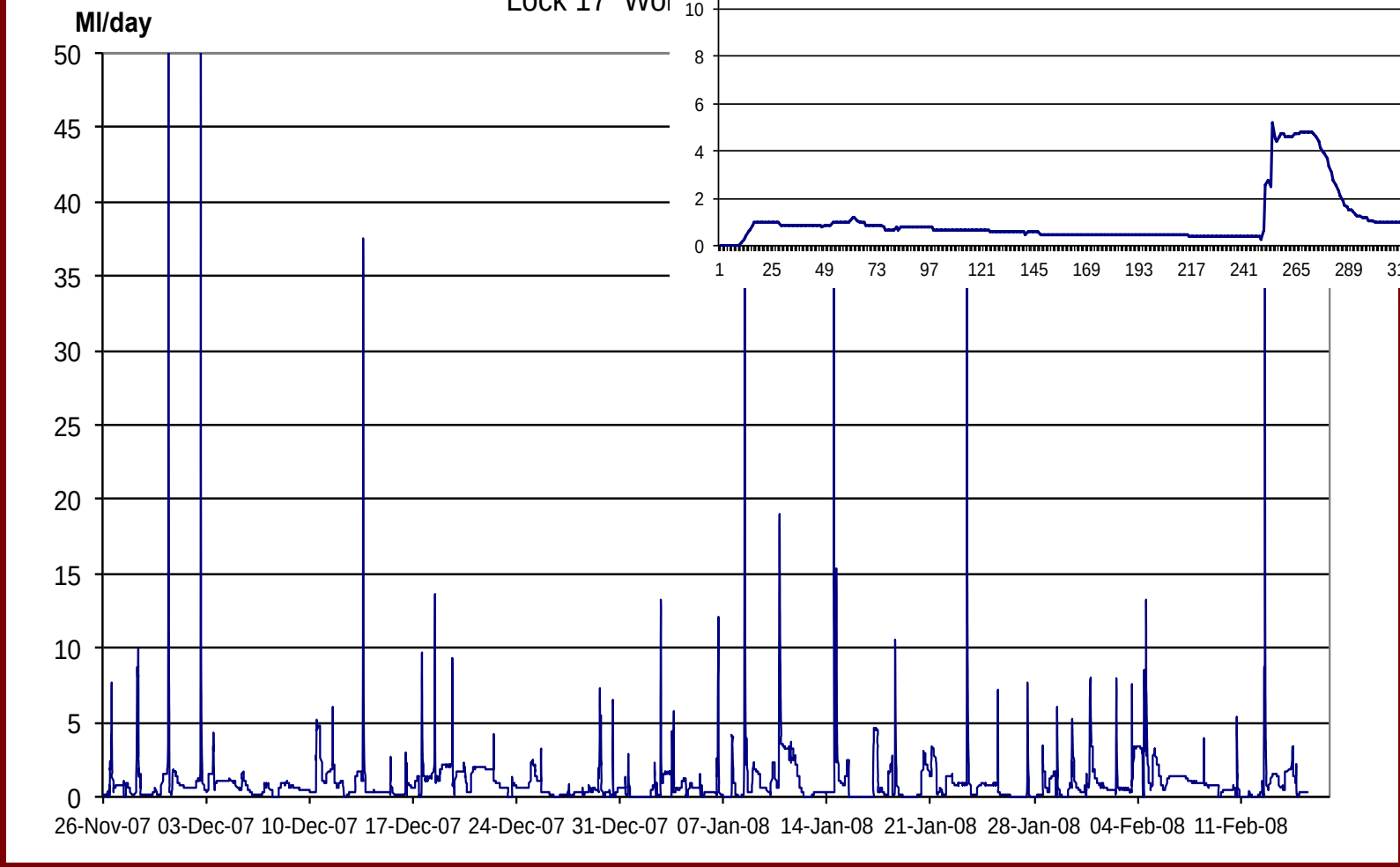
The pathologist estimated the torso to have been in the water from between two and eight months, but more realistically three to six months.

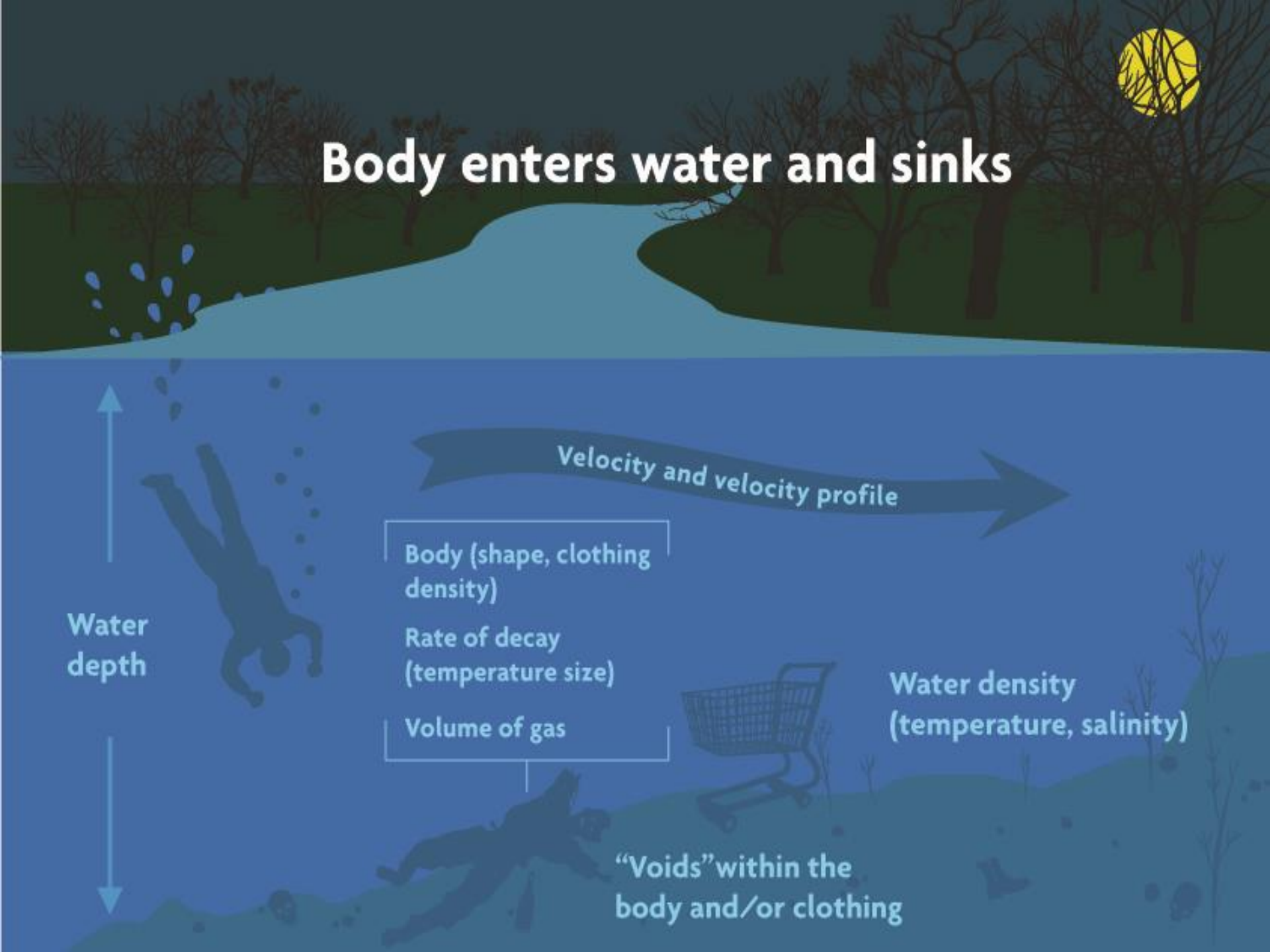
Experimentation with model heads: schematic


Cumulative count of lock openings at Wolverhampton Top Lock, from 26/11/2007 to 16/06/2008
1000
900
800
700
600
500
400
300
200
100
0
14/11/2007
03/01/2008
22/02/2008
12/04/2008
01/06/2008
21/07/2008

Estimating likely flows






Body enters water and sinks
Velocity and velocity profile
Body (shape, clothing density)
Rate of decay (temperature size)
Volume of gas
Water depth
Water density (temperature, salinity)
"Voids" within the body and/or clothing

Building a model of bodies in rivers

1. Entering the water
2. Decay and floatation
3. Moving with the water
4. Grounding

Extent of deterioration	Timescale typical for UK
‘Washerwomans’ fingers’	A few hours in cold water
Some putrefaction	Begins within a few days
Wrinkled skin	1 week
Maceration and detachment of epidermis on hands, feet and face	2 weeks in a temperate summer, perhaps longer if cooler
‘Bloat’ - Gas formation in abdomen and thorax	Variable
Skeletonisation	Variable

Operation Sanderling: Birmingham

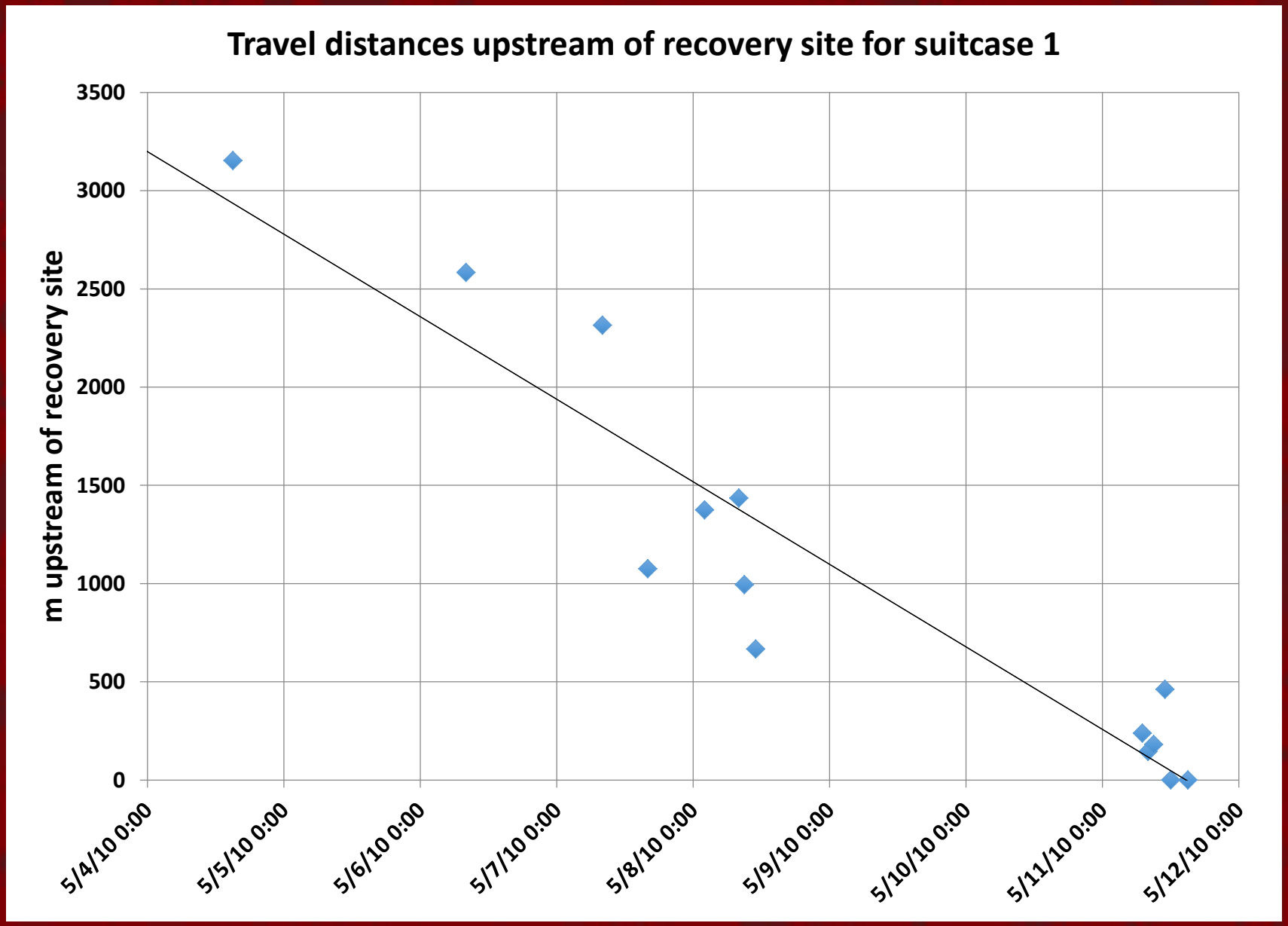
A body in two suitcases in the Birmingham Canal

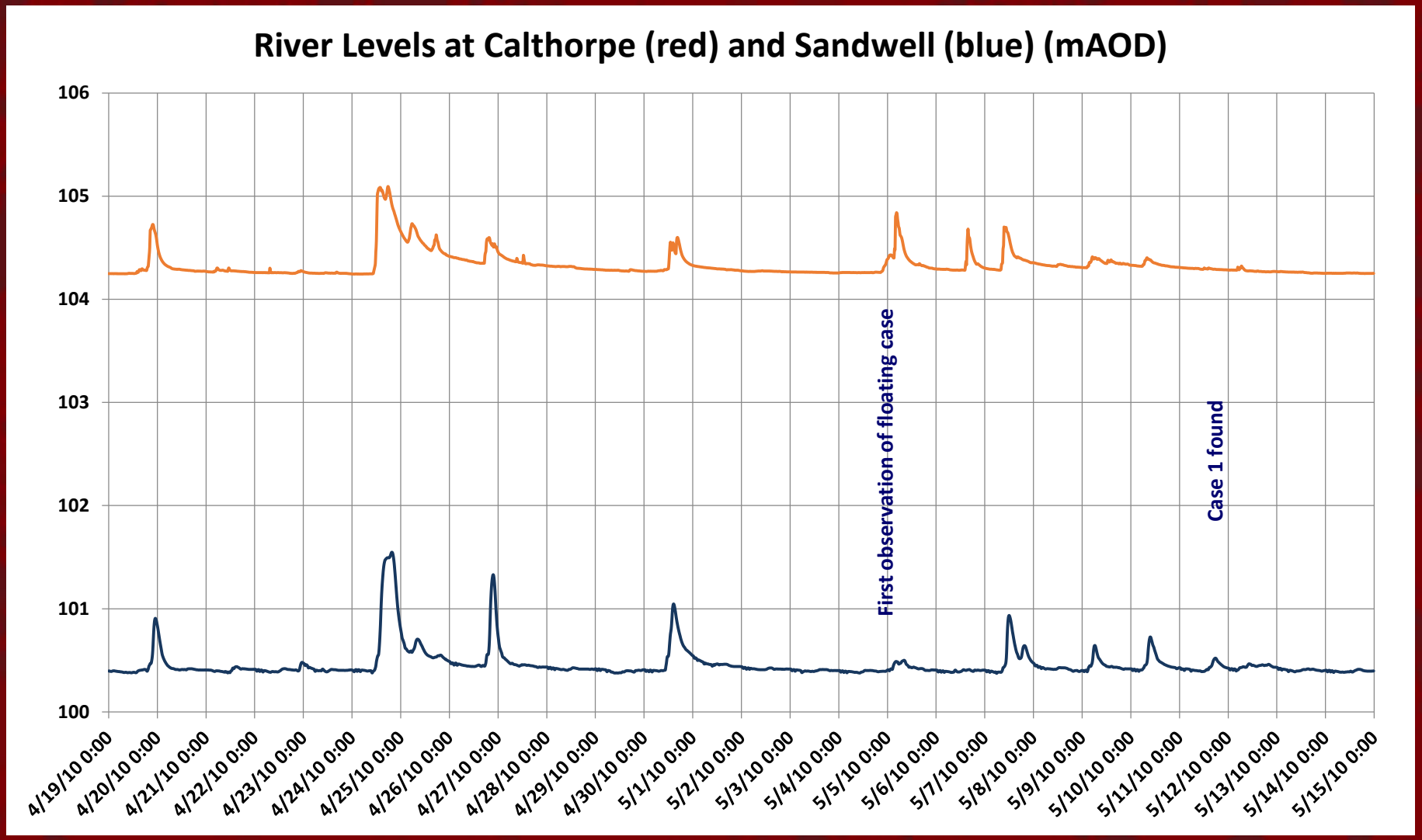

IVY MAY

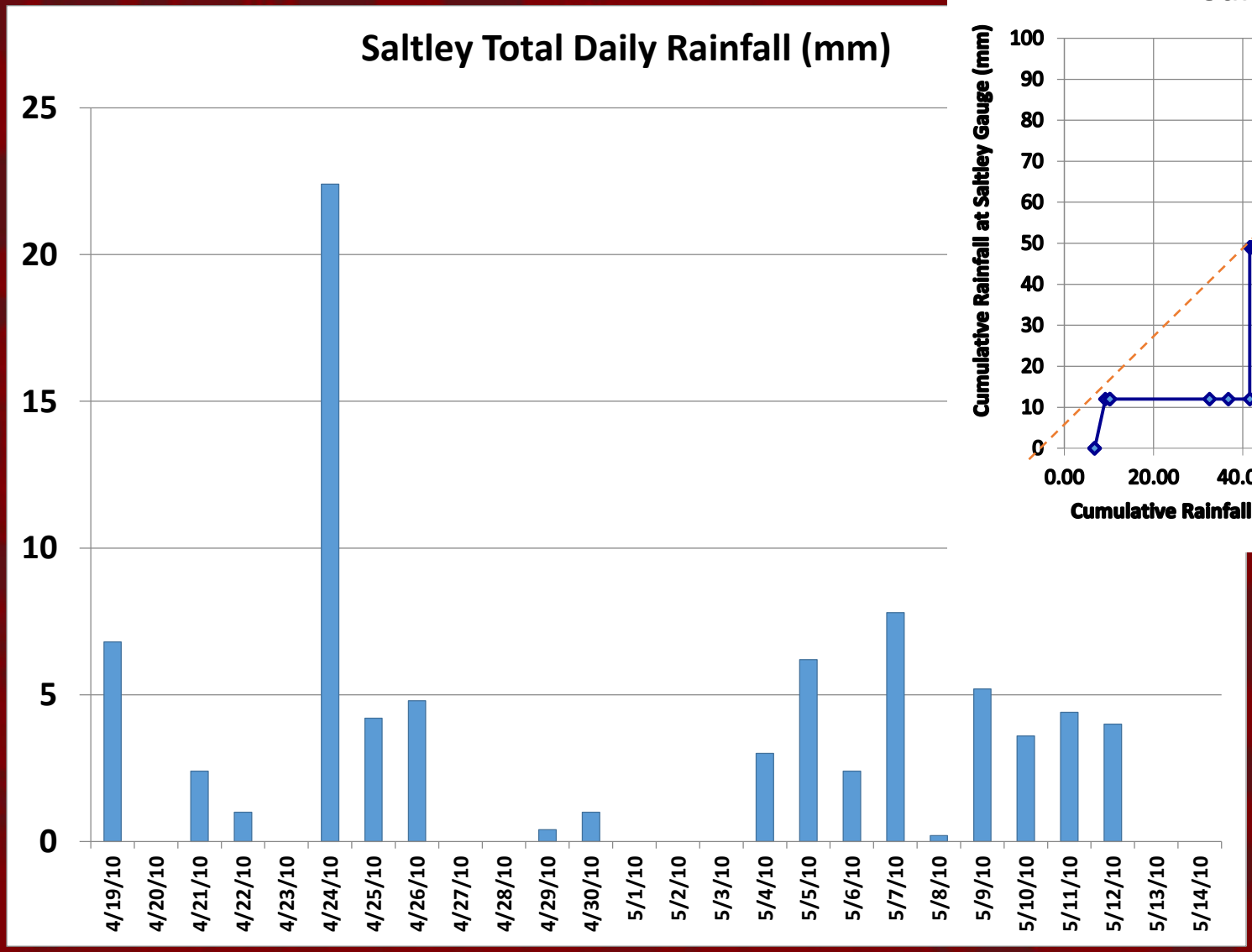
Witness Statements

Bridge Street North, Smethwick
Sighting 3pm, 5th May 2014 by S Biddle
Brasshouse Lane
Assumed entry point c 26th April 2014
Smethwick Junction
Railway Bridge
Sighting at 7.45am, 8th May 2014 by M Walton
Sighting at c. 8.30 Friday 9th May 2014 by T Cartwright
Soho Loop
Winson Green Junction
Sighting at c. 4pm, 8th May 2014 by P Griff
Winson Green Bridge
Sighting at c 10.30am, 9th May 2014
Lee Bridge
Sighting at c. 11.00am, 12th May 20
Sighting at c. 9.30am, 12th May 2014 by P Griffiths
Icknield Port Loop
Ladywood Middleway
Icknield Port Loop

Google earth


Travel distances upstream of recovery site for suitcase 1
m upstream of recovery site
3500
3000
2500
2000
1500
1000
500
0
5/4/10 0:00
5/5/10 0:00
5/6/10 0:00
5/7/10 0:00
5/8/10 0:00
5/9/10 0:00
5/10/10 0:00
5/11/10 0:00
5/12/10 0:00


River Levels at Calthorpe (red) and Sandwell (blue) (mAOD)
106
105
104
103
102
101
100
First observation of floating case
Case 1 found
4/19/10 0:00
4/20/10 0:00
4/21/10 0:00
4/22/10 0:00
4/23/10 0:00
4/24/10 0:00
4/25/10 0:00
4/26/10 0:00
4/27/10 0:00
4/28/10 0:00
4/29/10 0:00
4/30/10 0:00
5/1/10 0:00
5/2/10 0:00
5/3/10 0:00
5/4/10 0:00
5/5/10 0:00
5/6/10 0:00
5/7/10 0:00
5/8/10 0:00
5/9/10 0:00
5/10/10 0:00
5/11/10 0:00
5/12/10 0:00
5/13/10 0:00
5/14/10 0:00
5/15/10 0:00


Saltley Total Daily Rainfall (mm)
25
20
15
10
5
0
4/19/10
4/20/10
4/21/10
4/22/10
4/23/10
4/24/10
4/25/10
4/26/10
4/27/10
4/28/10
4/29/10
4/30/10
5/1/10
5/2/10
5/3/10
5/4/10
5/5/10
5/6/10
5/7/10
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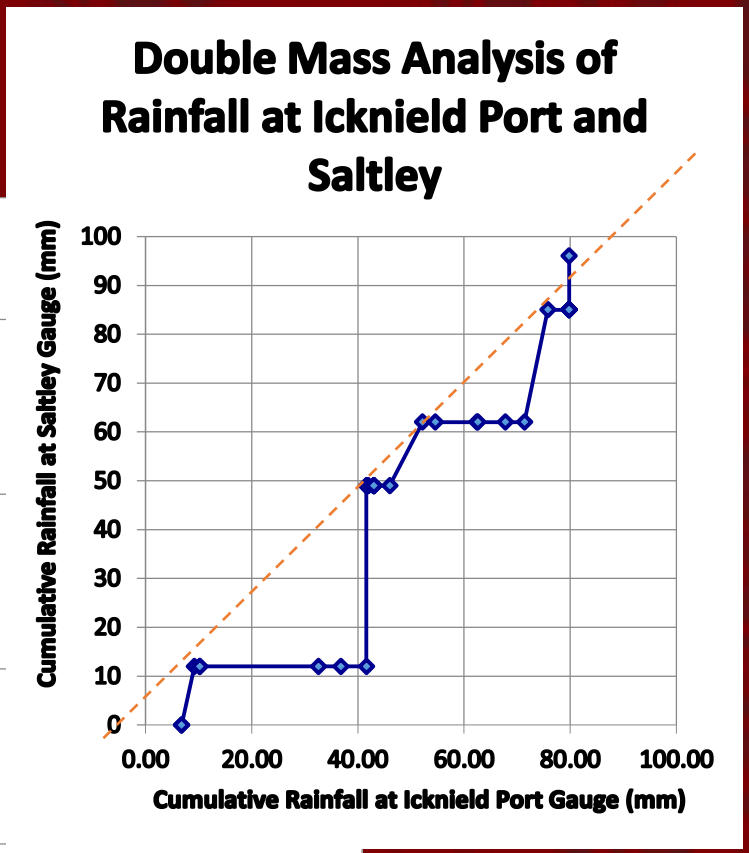
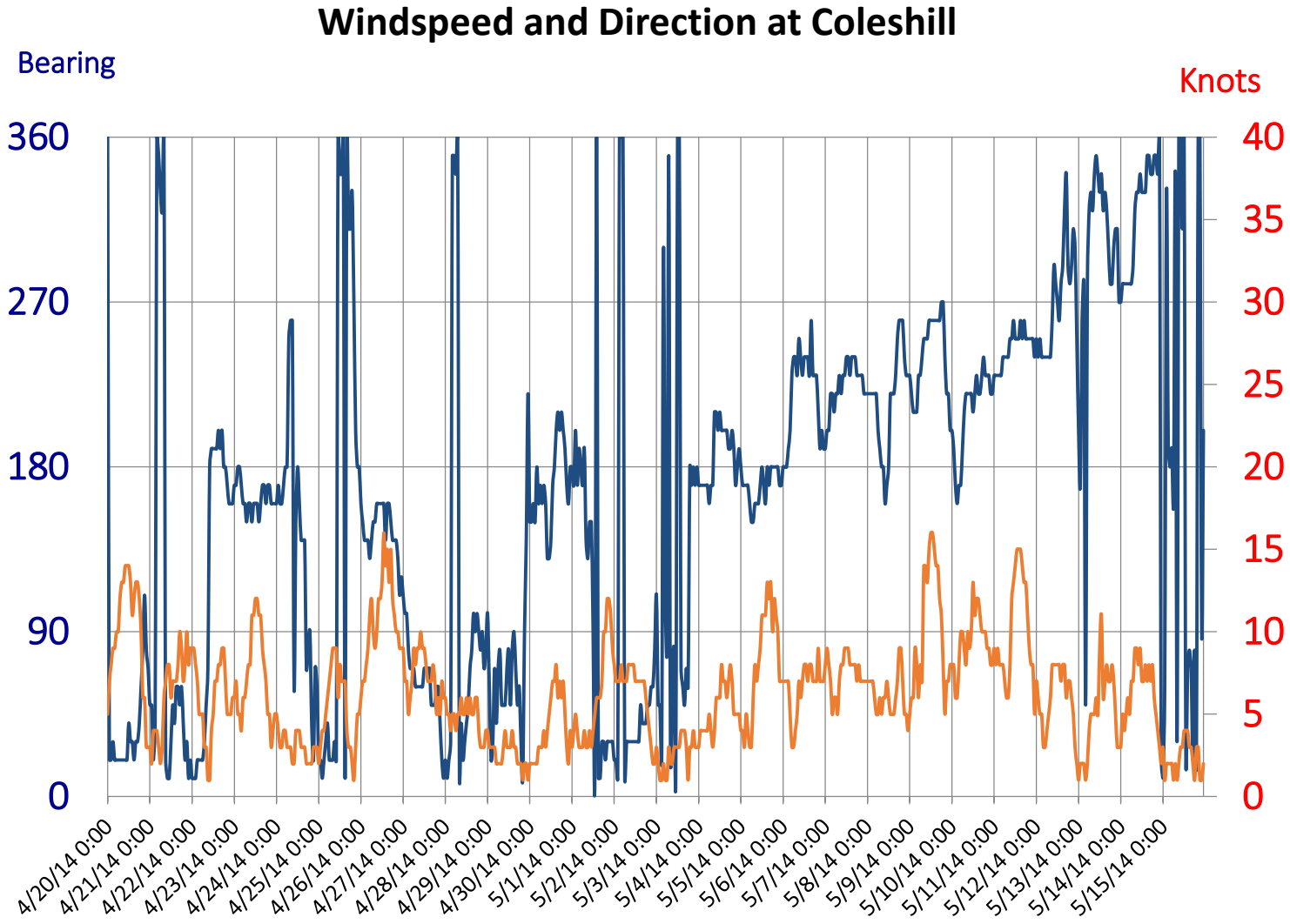
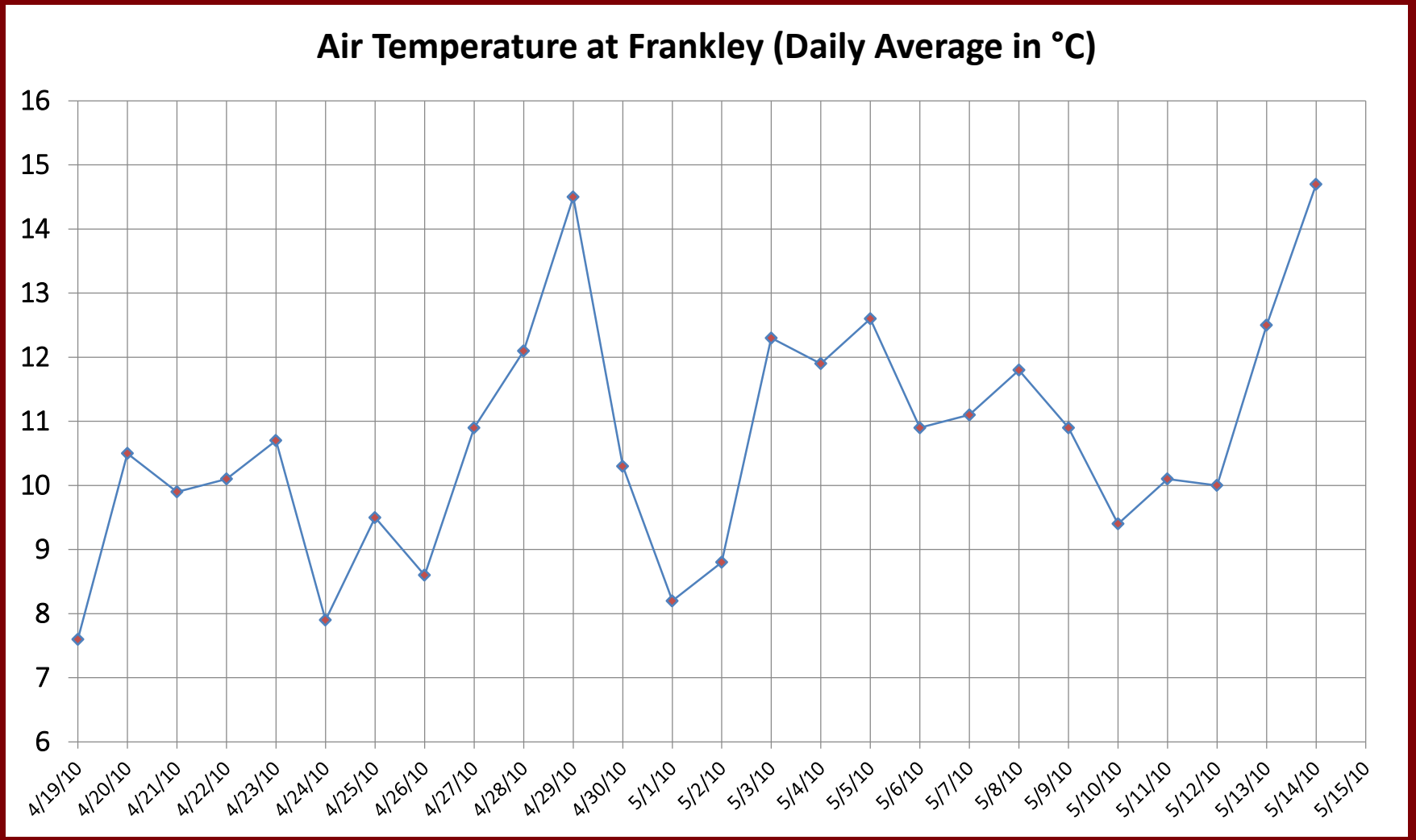
5/9/10
5/10/10
5/11/10
5/12/10
5/13/10
5/14/10


Double Mass Analysis of Rainfall at Icknield Port and Saltley
Cumulative Rainfall at Saltley Gauge (mm)
100
90
80
70
60
50
40
30
20
10
0
0.00
20.00
40.00
60.00
80.00
100.00
Cumulative Rainfall at Icknield Port Gauge (mm)


Windspeed and Direction at Coleshill
Bearing
Knots
360
270
180
90
0
40
35
30
25
20
15
10
5
0
4/20/14 0:00
4/21/14 0:00
4/22/14 0:00
4/23/14 0:00
4/24/14 0:00
4/25/14 0:00
4/26/14 0:00
4/27/14 0:00
4/28/14 0:00
4/29/14 0:00
4/30/14 0:00
5/1/14 0:00
5/2/14 0:00
5/3/14 0:00
5/4/14 0:00
5/5/14 0:00
5/6/14 0:00
5/7/14 0:00
5/8/14 0:00
5/9/14 0:00
5/10/14 0:00
5/11/14 0:00
5/12/14 0:00
5/13/14 0:00
5/14/14 0:00
5/15/14 0:00

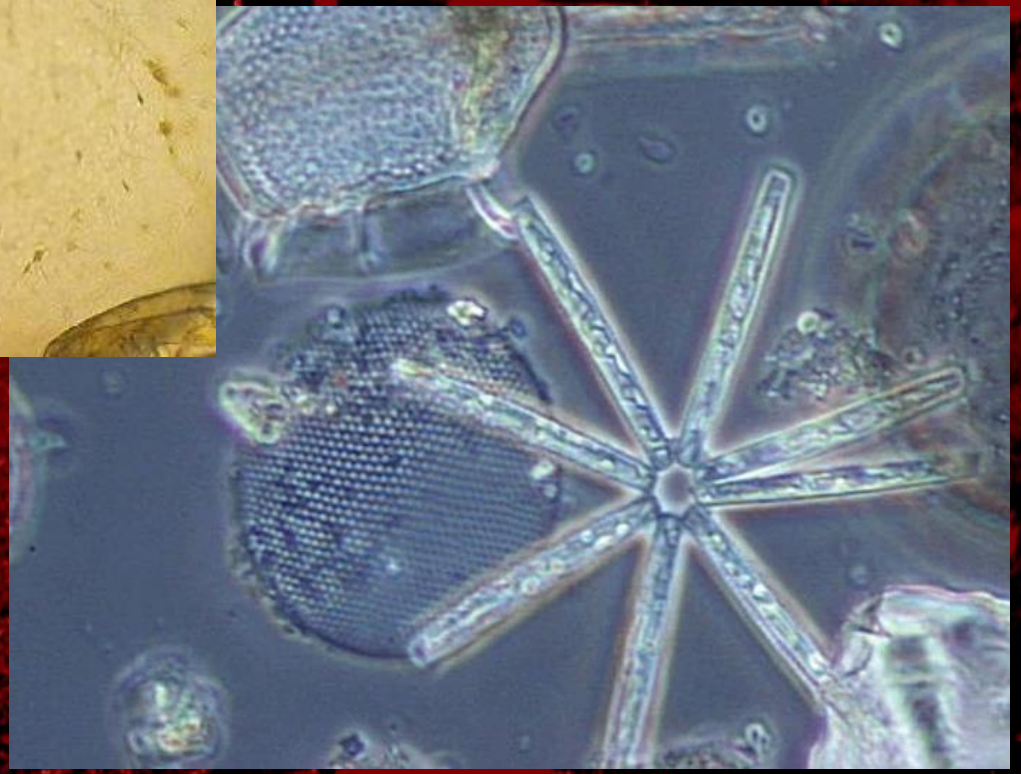

Air Temperature at Frankley (Daily Average in °C)
16
15
14
13
12
11
10
9
8
7
6
4/19/10
4/20/10
4/21/10
4/22/10
4/23/10
4/24/10
4/25/10
4/26/10
4/27/10
4/28/10
4/29/10
4/30/10
5/1/10
5/2/10
5/3/10
5/4/10
5/5/10
5/6/10
5/7/10
5/8/10
5/9/10
5/10/10
5/11/10
5/12/10
5/13/10
5/14/10
5/15/10

BBC reporting

Bone reconstruction by the University of Warwick

River and estuarine diatom frustules in clothing

Freshwater diatoms



Severn Estuary diatoms

Types of pollen in clothing

Next slide is a ‘Look away moment’

Insect infestation can establish the time of death, or whether the body has been exposed to air

Operation KELT

Murder or accident in the River Ouse at York?

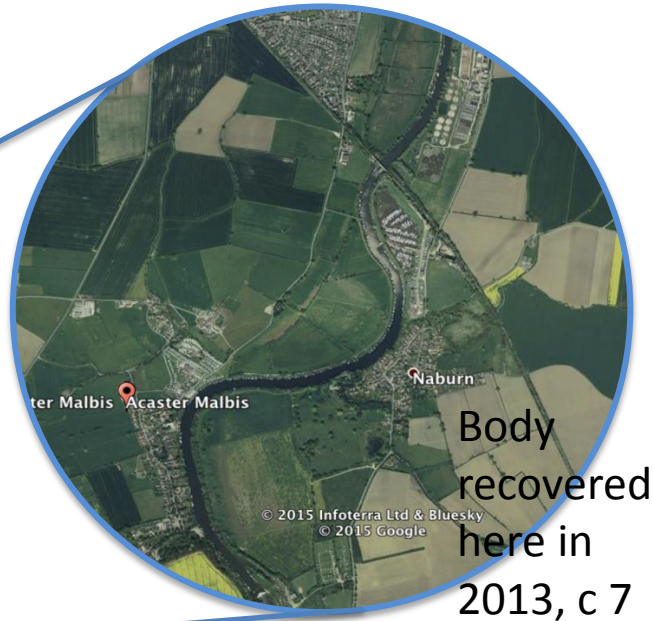

Clifton Bridge
Clifton Short Reach
WATER END
OUSECLIFFE G
WESTMINSTER ROAD
CLIFFE DRIVE
COMPTON S
ROSSLYN S
GROVE V
THE AVENUE
PETERSWAY
ST PETER'S GROVE
ST OLAVE'S ROAD
ROMAN ROAD
PW
School
PW
Pav
Playing Fields
Recn Gd
Boat House
Swimming Bath
NORTH PARADE
QUEEN ANNE'S ROAD
BOOTHAM TERRACE
SWINERTON A
ROSEBERY ST
CARNOT ST
LINCOLN STREET
BALFOUR STREET
STEPHENSON
SALISBURY TERR
CHUDLEIGH R
BROMLEY S
LIVINGSTONE ST
BRIGHT STREET
KINGSLAND TERR
JUBILEE TERRACE
BRUNEL
ALDBOROUGH WAY
STAMFORD ST EAST
PO
GARFIELD TERRACE
School
PW
School
Clifton Long Reach
The Esplanade (Path)
Cinder Lane (Path)
Recn Gd
SYCAMORE TERRACE
LONGFIELD TERRACE
ALMERY T
Car Park
ST MARY'S
ST MARY'S
MARYGATE
FREDERIC ST
Scarborough Bridge
CARLTON S
CARLISLE ST
LEEMAN ROAD
National Railway Museum
Reproduced from Ordnance Survey Data Crown Copyright [North Yorkshire Police] 100020717

Bootham

YORK

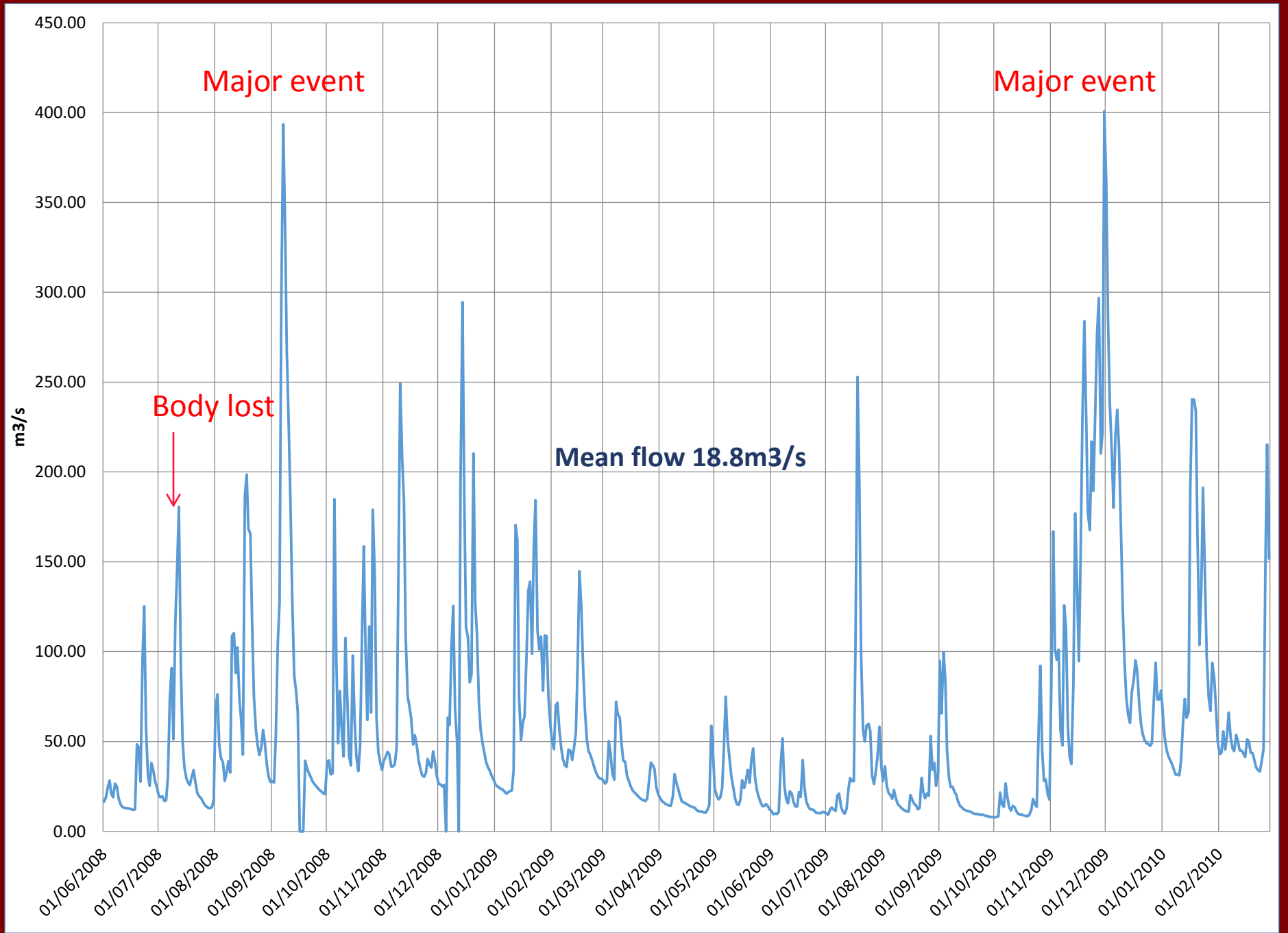
The Ouse is a slow, turbid, wide river (c 55m in the city), engineered with smooth banks

Acaster Malbis

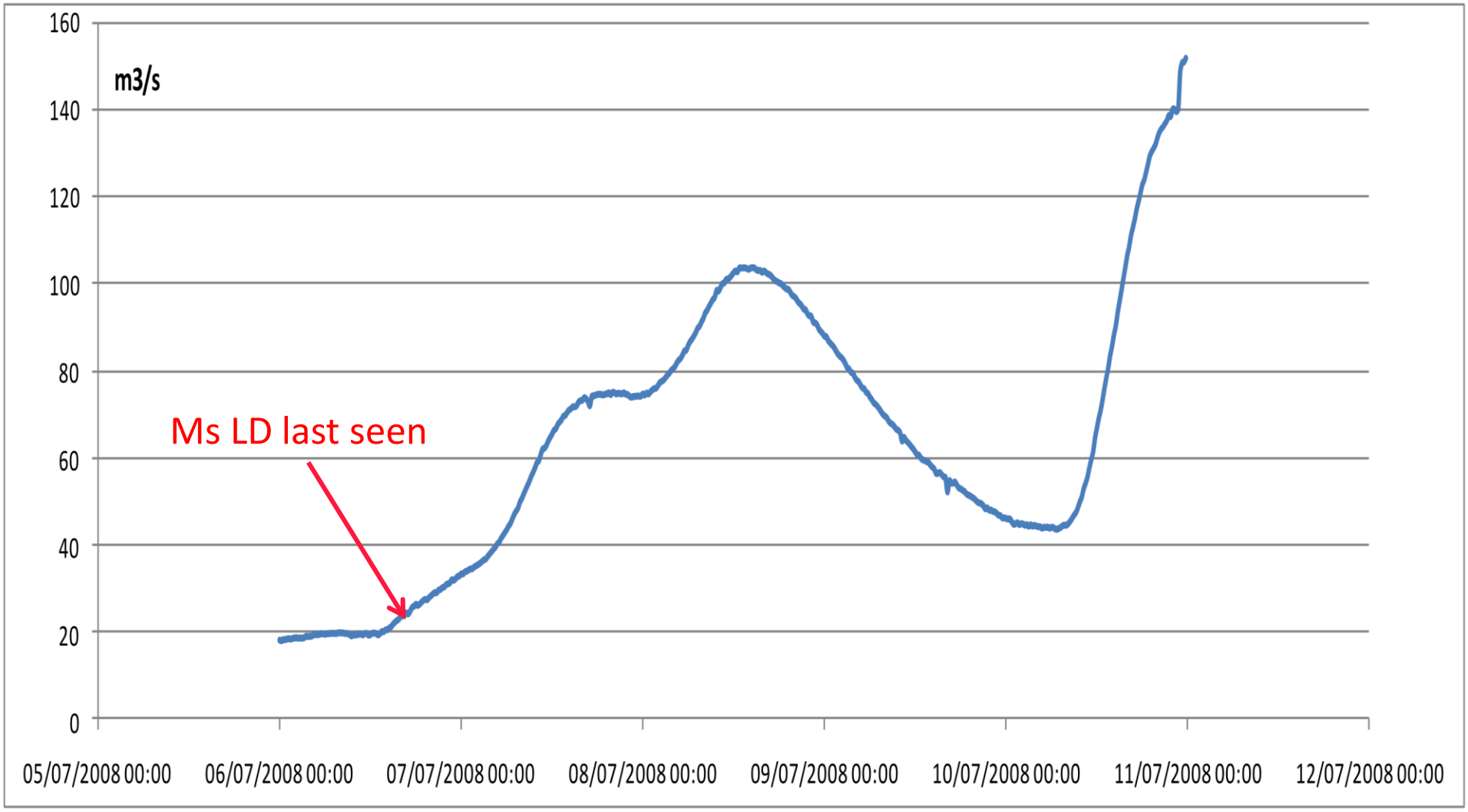


Body recovered here in 2013, c 7 miles

River Ouse at Skelton, June 2008 to February 2010



River Ouse flow, 6th to 11th July 2008



Calculating….

1. Establish flow at nearest stations, from Environment Agency data, and model any significant differences from site of investigation
2. Survey velocity and cross section at site at low flow, and using Manning's equation, estimate channel roughness
3. Survey channel section occupied by water at the incident time, estimate water gradient and using previously calculated channel roughness, calculate mean water velocity at the time of the incident
4. Model velocity at different points in the channel at the time of the episode, based on characteristics of typical channels, and observations of this channel at low flow
5. Adjust to match relevant time of incident ….

For conditions on 11th July a calculation can be based on Manning's Equation

$$V = (R^{2/3} S^{1/2})/n,$$

where R is the hydraulic radius of the channel, S the water surface slope, and 'n' the roughness coefficient, and where R = A/(w+2D), where A is the wetted cross sectional area, w the width and D the depth of the water. This can be cross checked with alternative methodologies.

A figure of 1m/s is estimated for the 11th July.

Scaling from this, on 6th July, flow velocities close to the bank where Ms LD allegedly entered the water are likely to be well below 1m/s. However, even a velocity of 0.5 m/s can cause people to have difficulty standing upright.

Building a model of bodies in rivers

1. Entering the water
2. Decay and floatation
3. Moving with the water
4. Grounding

Body rises into main flow line

Vertical velocity profile

Variable water depth

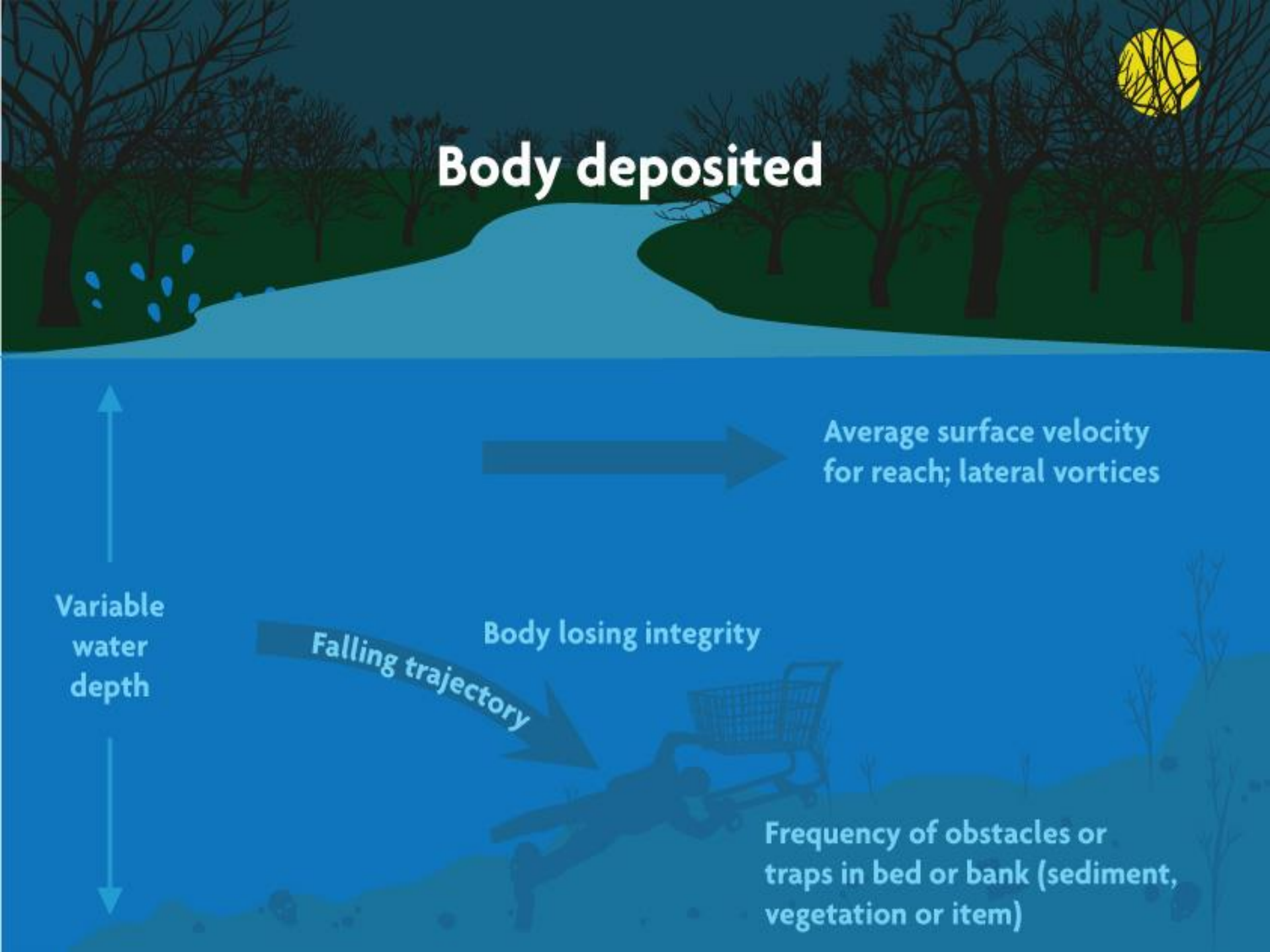
Decay continues

Rate of rise

Average surface velocity for reach; Pulses of high velocity in floods

Building a model of bodies in rivers

1. Entering the water
2. Decay and floatation
3. Moving with the water
4. Grounding


Body deposited
Average surface velocity for reach; lateral vortices
Variable water depth
Body losing integrity
Falling trajectory
Frequency of obstacles or traps in bed or bank (sediment, vegetation or item)

Cold Case: Operation BUTE

Baby K, missing near River Lippe at Schloss Neuhaus army base, Paderborn, Germany, November 1981


River Lippe
Site of Baby K's disappearance
Image © 2015 AeroWest
Google earth

Lippersee outline in 2010 (blue), based on satellite imagery (Google Earth 2009 base)

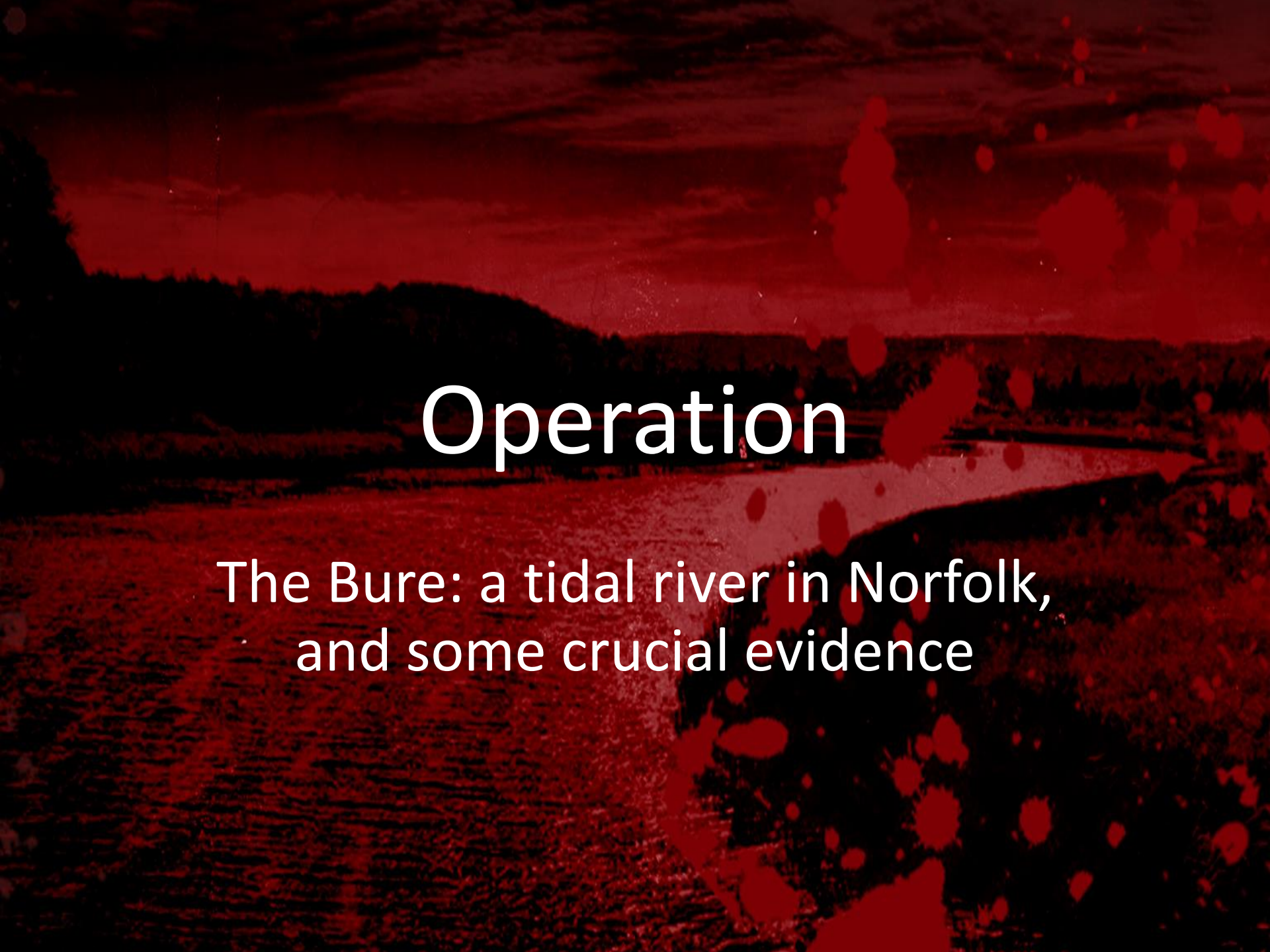
Lippersee outline in 1979 (purple), based on aerial photography (GoogleEarth 2009 base)

Lippersee outline in 1982 (green), based on 1:50,000 mapping (GoogleEarth 2009 base)

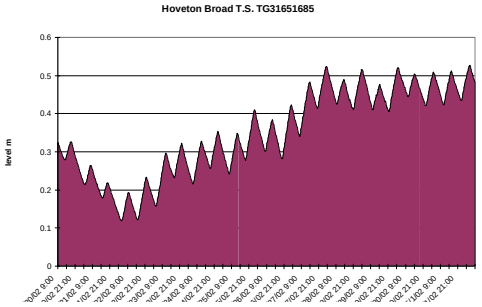
Lippersee outline in 1985 (yellow), based on aerial photography (GoogleEarth 2009 base)

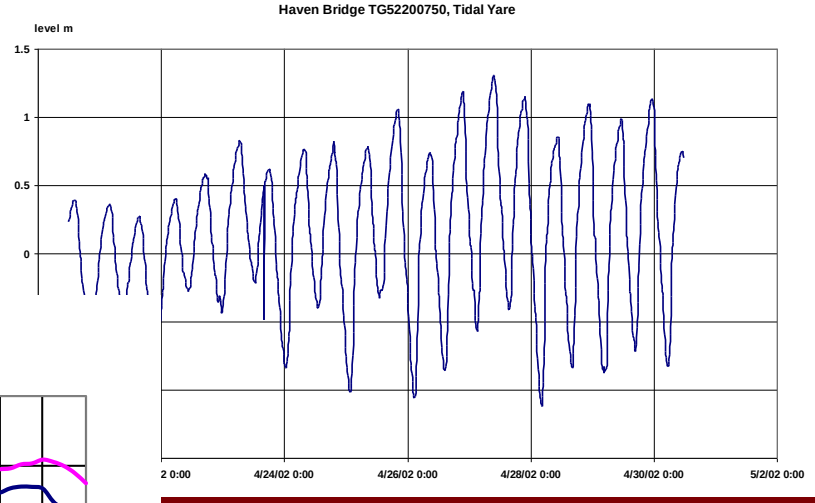
Lippersee outline in 1986 (red), based on 1:25,000 mapping (GoogleEarth 2009 base)

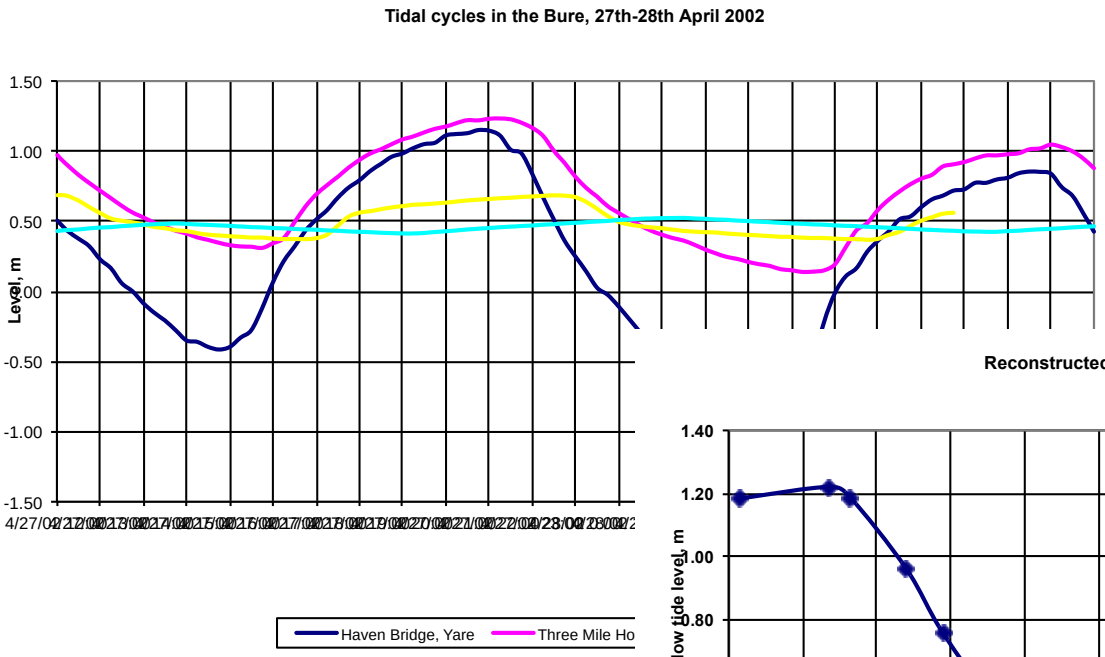
Lippersee outline in 2010 (blue), based on satellite imagery (Google Earth 2009 base)


Operation
The Bure: a tidal river in Norfolk,
and some crucial evidence

River Bure, Norfolk


Hoveton Broad T.S. TG31651685
level m


Haven Bridge TG52200750, Tidal Yare
level m
1.5
1
0.5
0
2 0:00
4/24/02 0:00
4/26/02 0:00
4/28/02 0:00
4/30/02 0:00
5/2/02 0:00


Tidal cycles in the Bure, 27th-28th April 2002
Level, m
1.50
1.00
0.50
-0.50
-1.00
-1.50
Haven Bridge, Yare
Three Mile Ho

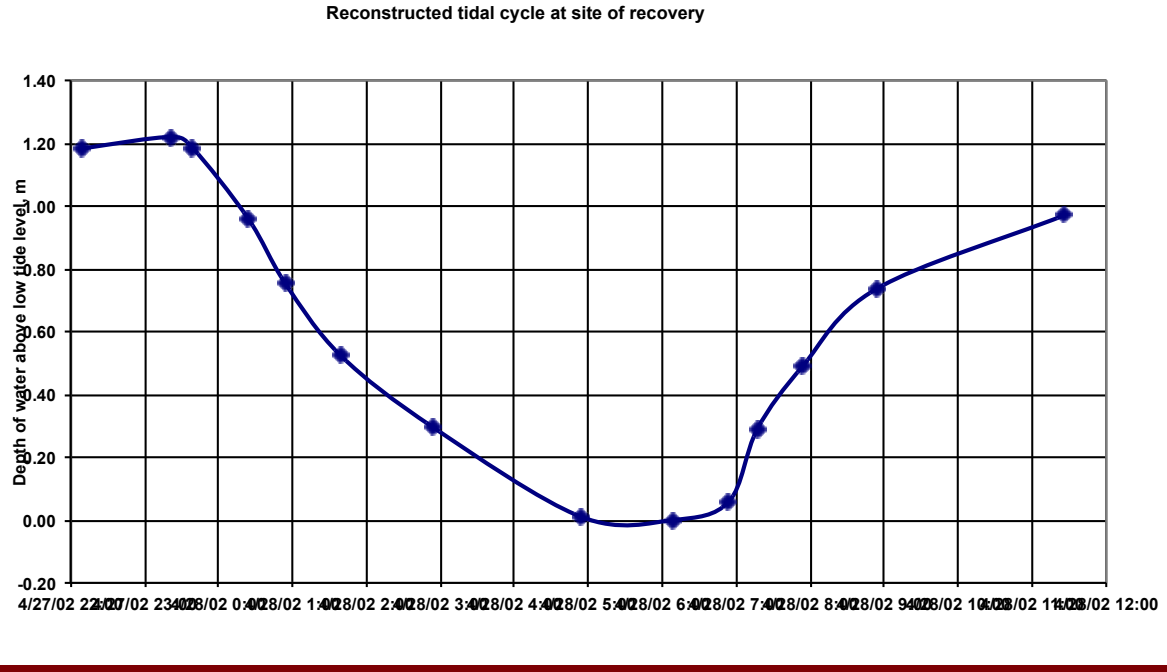
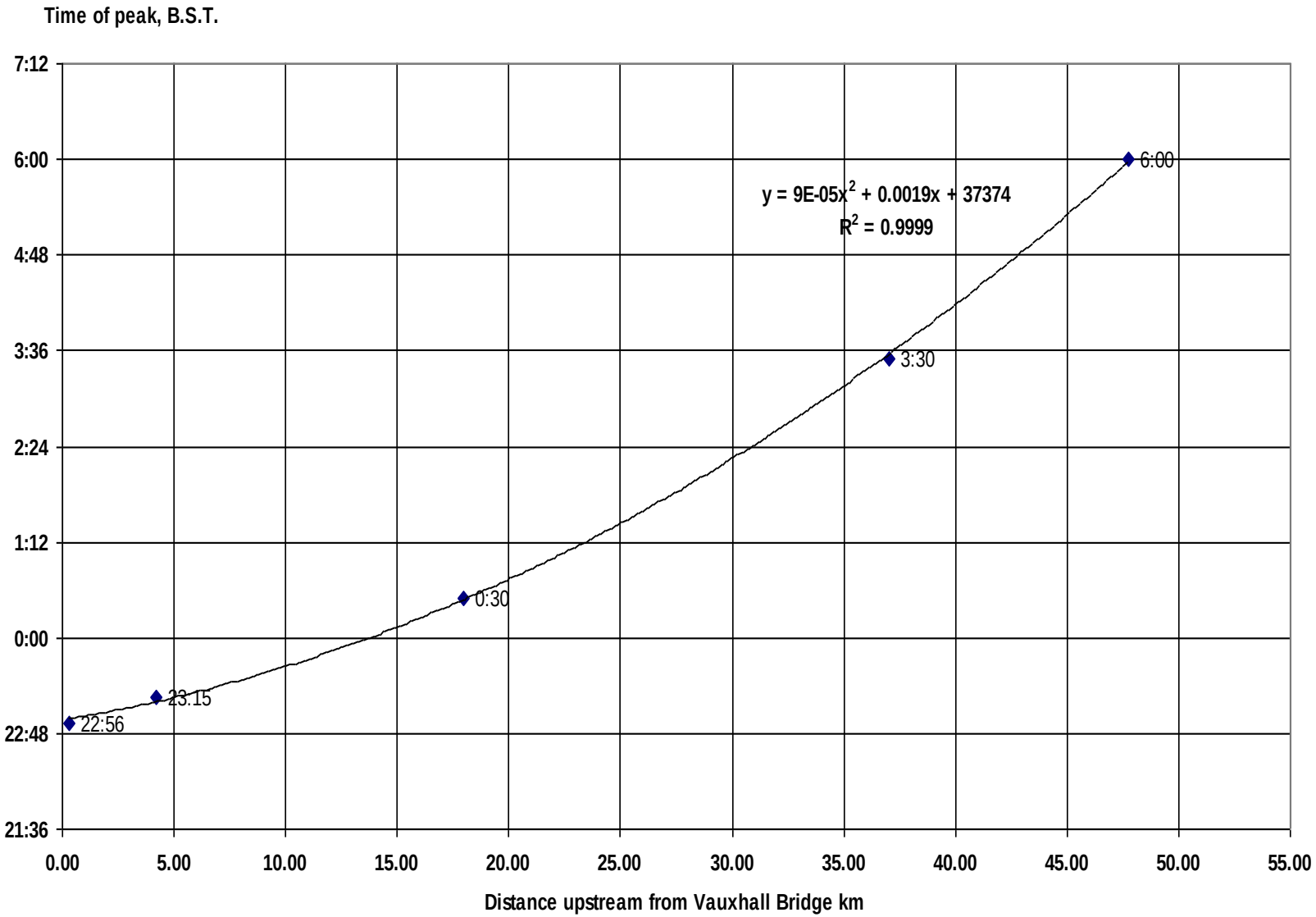

Reconstructed tidal cycle at site of recovery
Depth of water above low tide level, m
1.40
1.20
1.00
0.80
0.60
0.40
0.20
0.00
-0.20
4/27/02 22:00
4/27/02 23:00
4/28/02 0:00
4/28/02 1:00
4/28/02 2:00
4/28/02 3:00
4/28/02 4:00
4/28/02 5:00
4/28/02 6:00
4/28/02 7:00
4/28/02 8:00
4/28/02 9:00
4/28/02 10:00
4/28/02 11:00
4/28/02 12:00

Figure 3. Time of peak high tide in River Bure, 27th-28th April 2002



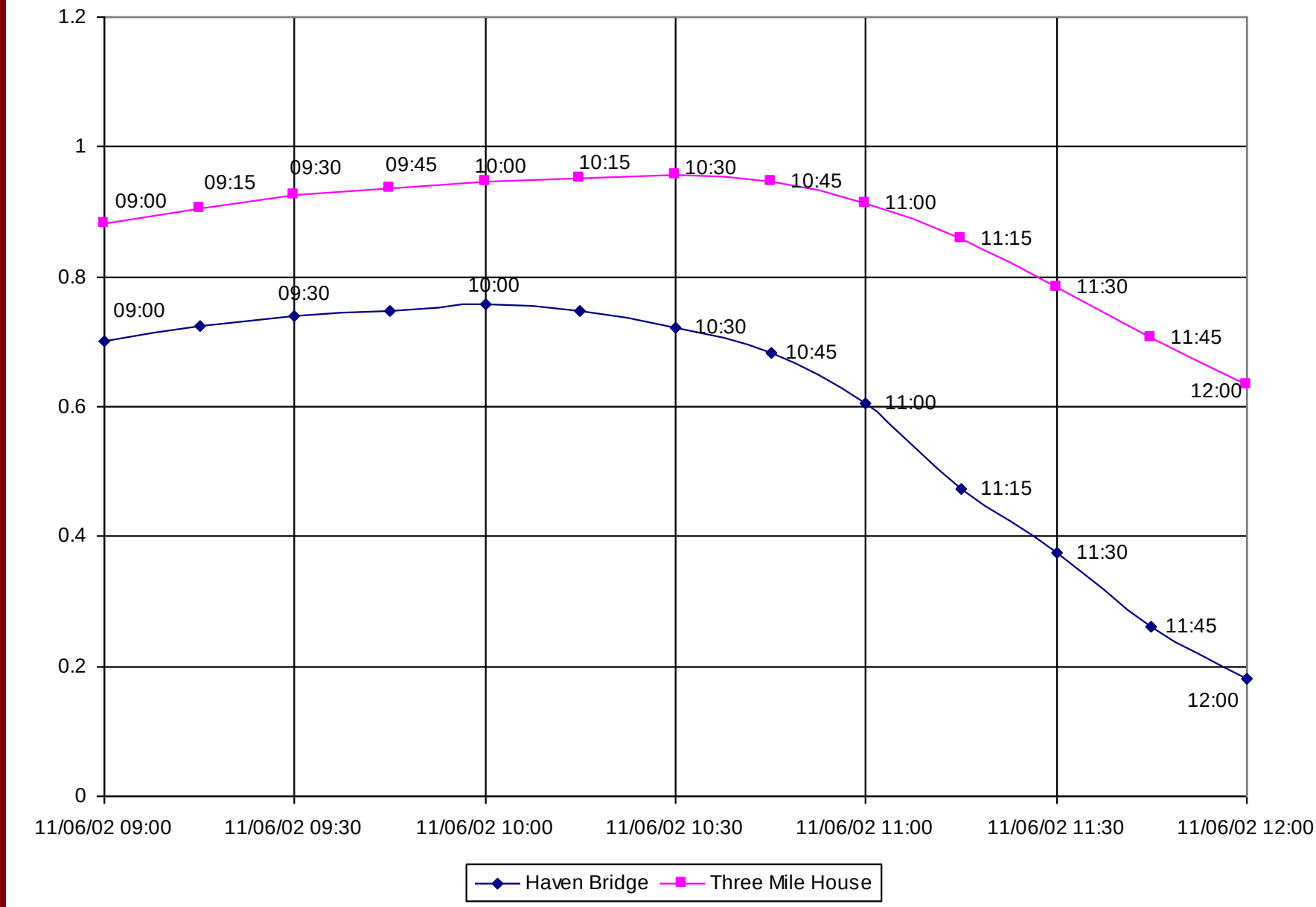
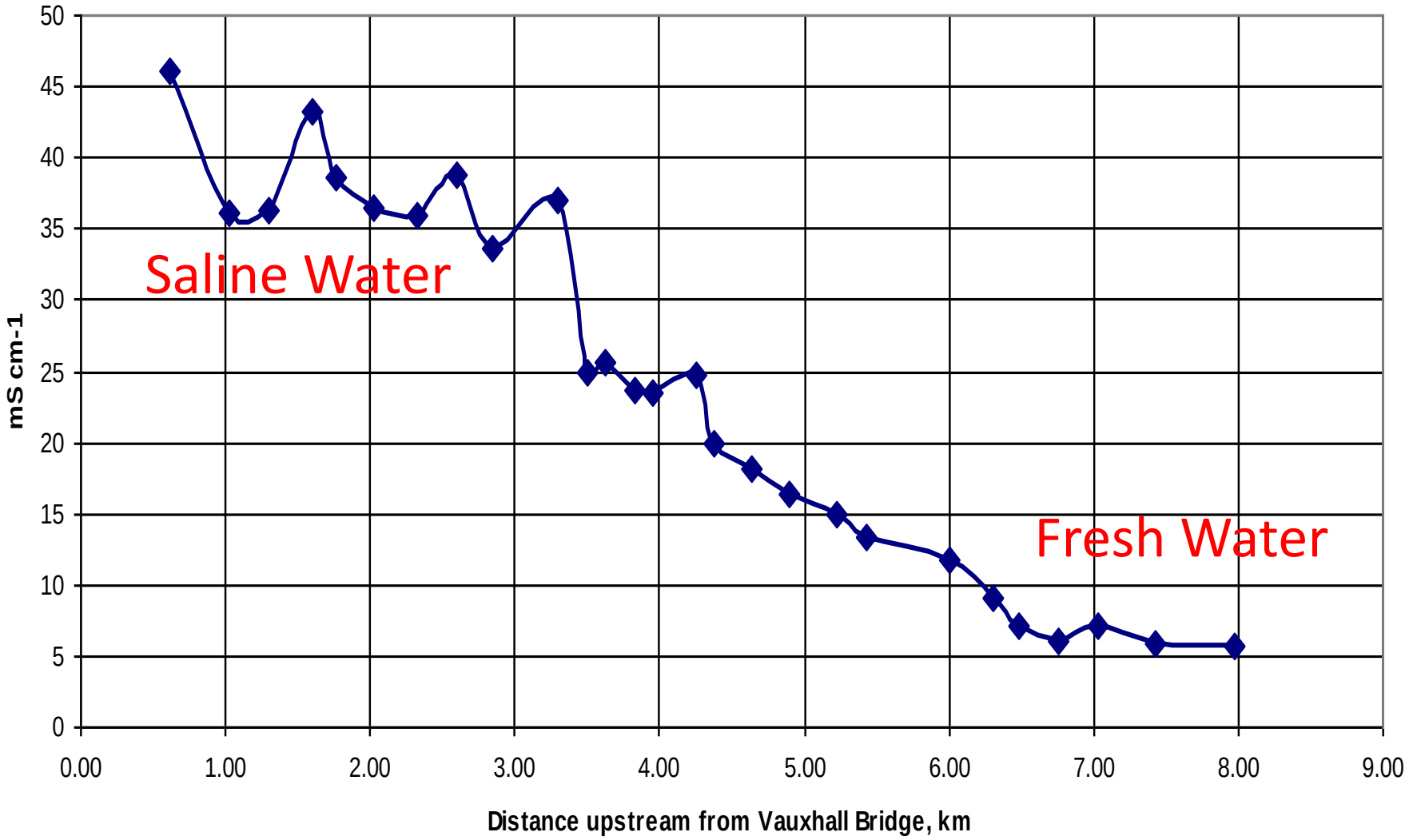
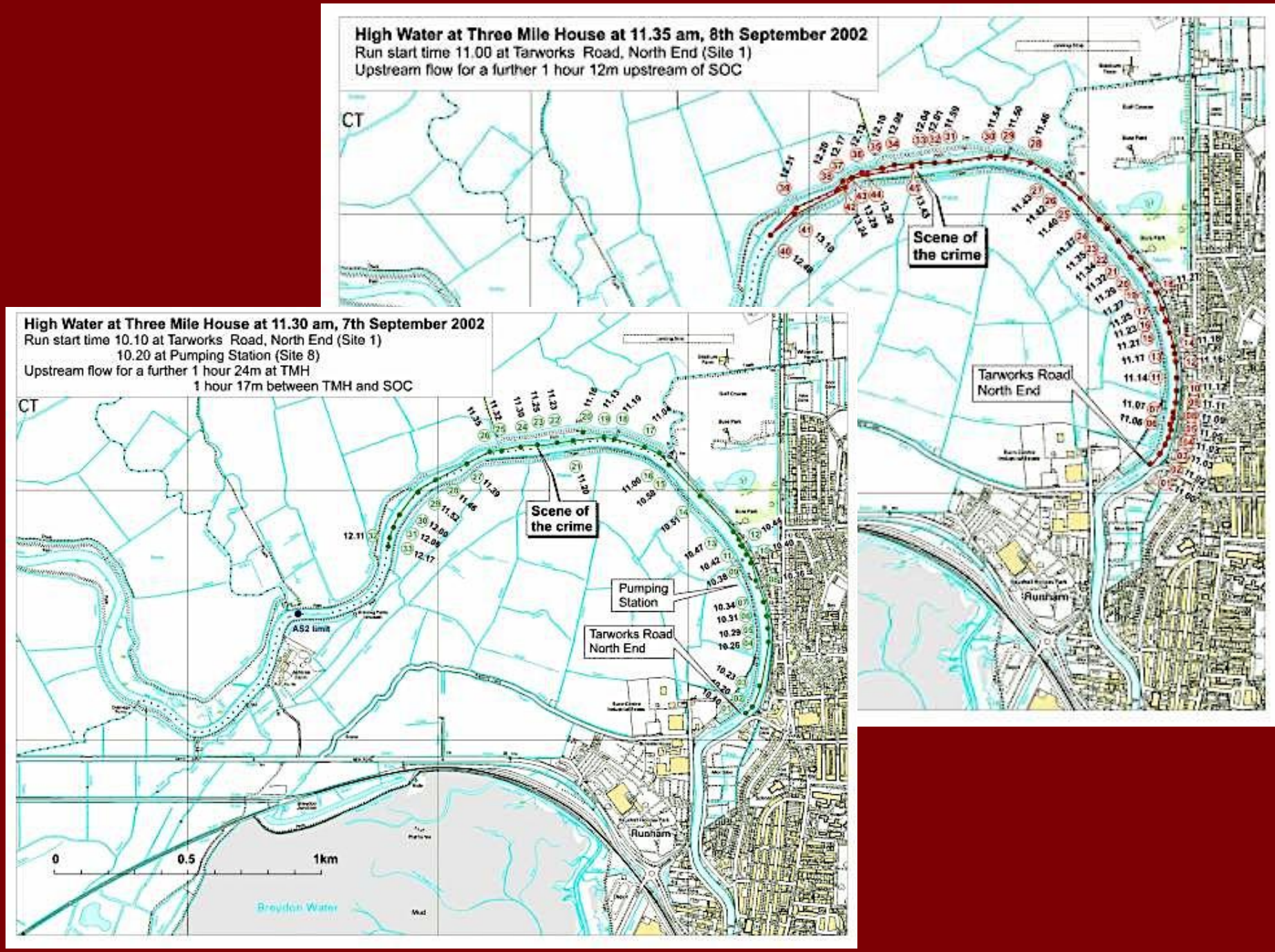
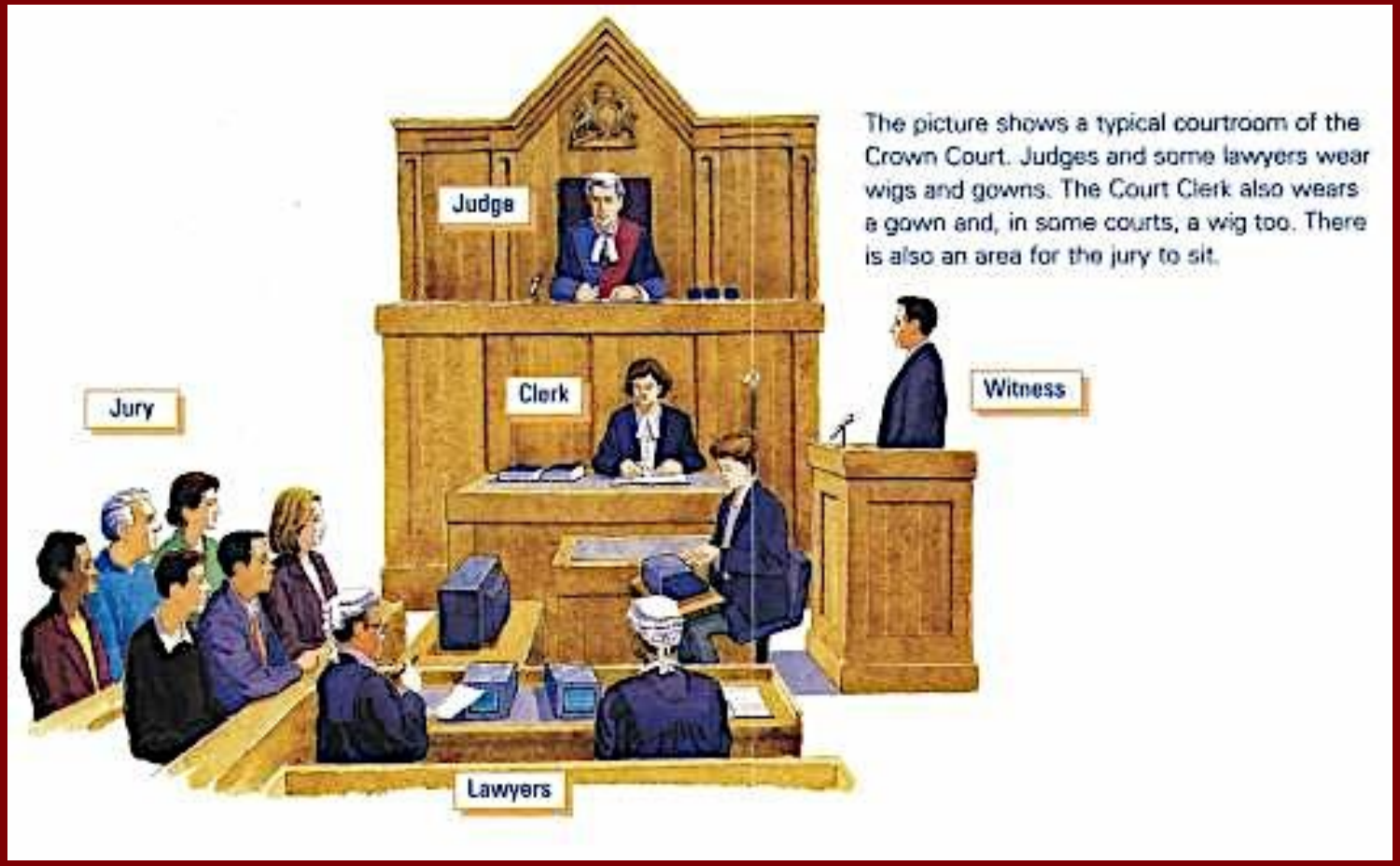

1.2
1
0.8
0.6
0.4
0.2
0
09:00
09:15
09:30
09:45
10:00
10:15
10:30
10:45
11:00
11:15
11:30
11:45
12:00
09:00
09:30
10:00
10:30
10:45
11:00
11:15
11:30
11:45
12:00
11/06/02 09:00
11/06/02 09:30
11/06/02 10:00
11/06/02 10:30
11/06/02 11:00
11/06/02 11:30
11/06/02 12:00
Haven Bridge
Three Mile House

Figure 1. Conductivity trend, 1/5/02 rising tide




High Water at Three Mile House at 11.35 am, 8th September 2002
Run start time 11.00 at Tarworks Road, North End (Site 1)
Upstream flow for a further 1 hour 12m upstream of SOC
CT
Scene of the crime
Tarworks Road North End
Runham
High Water at Three Mile House at 11.30 am, 7th September 2002
Run start time 10.10 at Tarworks Road, North End (Site 1)
10.20 at Pumping Station (Site 8)
Upstream flow for a further 1 hour 24m at TMH
1 hour 17m between TMH and SOC
CT
Scene of the crime
Pumping Station
Tarworks Road North End
A52 limit
Runham
0
0.5
1km
Breydon Water

‘…A more likely scenario is an earlier release time, the body travelling upstream beyond the recovery site and back downstream, lodging direct on the muddy river bed shortly before 01.50 B.S.T. I would estimate the likely time of release from Tarworks Road as 30-40 minutes before the recorded high water at Three Mile House, the body following an upstream track similar to that followed on 7th September 2002. The total travel time including the downstream element for these experimental conditions would be approximately three hours. The release time from Tarworks Road would hence be between approximately 22.40 and 22.50 B.S.T. on 27th April 2002.’



'On 14th October 2003 Filomeno Antonio LOPEZ was found guilty by a majority of 10 to 1 of an indictment of Murder and was sentenced to Life Imprisonment….Thank you for your assistance…'

Norfolk Constabulary, Criminal Justice Unit

Thank You

To the

Institution of Environmental Sciences

for producing some of the diagrams