Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Navigational Issues and Preliminary Risk Assessment

Doc Ref: **7.20.09**

Victoria Embankment Foreshore

APFP Regulations 2009: Regulation **5(2)(q)**

Hard copy available in

Box **57** Folder **B**
January 2013

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Thames Tideway Tunnel

Navigational Issues and Preliminary Risk Assessment: Victoria Embankment Foreshore

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Main Report

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1 Executive summary

1.1 Purpose

1.1.1 This report documents the activities and assessments undertaken to identify the navigational issues, risks and mitigation measures for the proposed permanent and temporary structures at the site known as Victoria Embankment Foreshore as part of the Thames Tideway Tunnel project.

1.1.2 It was developed through liaison and consultation with Port of London Authority (PLA) and the other key stakeholders. It is intended to support the application for development consent and identify the navigational issues at the site and how these are to be managed. The process was used to inform the design of the permanent and temporary works and a number of measures to address navigational hazards have been embedded into the design.

1.1.3 The preliminary risk assessment follows a project specific methodology proposed by the PLA rather than the methodology detailed within the PLA Safety Management System. The risk assessment reflects the level of development of the design in the application for development consent, that is, an outline design. The Contractor would be required to prepare detailed risk assessments and method statements and submit these to the PLA for approval before commencing any works in the river at this site.

1.1.4 The assessment was divided into four distinct project phases to assess hazards and develop risk reduction measures commensurate with the risk posed by different operations associated with the project. These phases were specific to this assessment and comprise:

Phase A: construction of cofferdam (including delivery of materials by barge)

Phase B: construction of drop shaft/culvert/connections (including removal of excavated materials by barge)

Phase C: cofferdam removal (including removal of materials by barge)

Phase D: permanent works site.

1.2 Issues to be addressed

1.2.1 The proposed Victoria Embankment Foreshore site is located between two permanently moored vessels, the Hispaniola and the Tattershall Castle, on the north bank of the River Thames and close to Charing Cross Railway Bridge (also known as Hungerford Bridge).

1.2.2 The proposed site lies in an area served by Embankment Pier, Westminster Pier, London Eye Pier and Festival Pier. This area of the river is considered to be one of the most densely populated in terms of number of vessel movements and is served by a wide variety of vessel types and operators.

1.2.3 The issues to be addressed for this site include:

a. interaction with existing river users

b. impact on operations at Embankment Pier - For example Thames Clippers

c. intrusion into the river - proximity to the authorised channel

d. bridge arch closures

e. changes in flow resulting from the temporary and permanent in-river structures.

1.3 Interaction with existing river users

1.3.1 The project conducted observations of freight, commuter, charter and recreational vessel traffic at this location.

1.3.2 The four piers in close proximity to this site – Embankment, Westminster, London Eye and Festival Pier – are regularly used by timetabled 'commuter' services, sightseeing services, and charter vessel operators.

1.3.3 Analysis of Automatic Identification System (AIS) data has been conducted for freight moving through this section of the river. Existing barge track evidence shows that the majority of freight movements are through arch No3 of Charing Cross Rail Bridge. This analysis is based on information provided by Cory Environmental Ltd and tracks tug and barge movements on inward-bound journies.

1.3.4 During observations, recreational craft including kayaks, narrow boats, Rigid Inflatable Boats (RIBs) and small leisure craft were witnessed transiting the area. The movements of these vessels are unpredictable and consideration is given to these vessels within this Navigational Issue and Risk Assessment.

1.4 Impact on operations at Embankment Pier

1.4.1 The proposed site is in close proximity to Charing Cross Railway Bridge and Embankment Millennium Pier and the cofferdam would be located approximately 50m upstream of Charing Cross Rail Bridge and arch No1. The pier is used by a number of commercial operators.

1.4.2 Thames Clippers operate at the western end of the pier, Bateaux London on the eastern end and the centre berth of the pier is available for other operators. The Thames RIB Experience Company picks up and sets down passengers from a 'V' berth on the western end of the pier.

1.4.3 Thames Clippers regularly traverse arch No1 en route to Millenium Pier, and would be impacted by narrowed waters outside the navigational channel.

1.5 Intrusion into the river

1.5.1 During the construction of the cofferdam there would be a requirement to use heavy plant and sheet piling machinery; this plant would be located within the area designated as 'limits of land to be acquired or used'

(LLAU). The boundary of this land is approximately 5m from the northern boundary of the authorised channel.

1.5.2 This report examines the impact of the temporary and permanent in-river structures on all vessel types (freight, tugs and tows, high speed passenger vessels, passenger vessels, leisure craft and emergency vessels) transiting the study area, with particular attention given to tugs and tows because of their limited manoeuvrability and operating requirements in the area.

1.5.3 AIS records and additional observations indicate that the temporary works area does not coincide with the area used by the majority of freight and passenger vessels. The permanent structure would be behind the line of the current restaurant vessels in this area and is assessed as having a minimal impact on existing river traffic.

1.6 Changes in flow

1.6.1 Any intrusion into the river would change river flow. The analysis in this report considered the worst cases, combining the extreme fluvial and tidal flows. It was established that, even in extreme cases, the change in **maximum** flow would be less than 0.5 knots for the temporary works and less than 0.25 knots for the permanent works. It should be noted that because the structures would displace the flow pattern, the maximum flow would be found in a different location.

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2 Site overview

2.1 Purpose of this report

2.1.1 The purpose of this report is to provide information on the navigational issues, risk assessment and mitigation measures associated with the proposed Victoria Embankment Foreshore site. The report informs the *Transport Assessment* and *Environmental Statement* and the PLA approval process.

2.2 Introduction

2.2.1 The Thames Tideway Tunnel project (the 'project') comprises tunnels to store and transfer discharges from combined sewer overflows (CSOs) from West to East London for treatment at Beckton Sewage Treatment Works. The primary objective of the project is to control CSO discharges in order to meet the requirements of the EU Urban Waste Water Treatment Directive (91/271/EEC) (UWWTD) and the related UK Urban Waste Water Treatment Regulations.

2.2.2 The project comprises the following elements:

a. a main tunnel from Acton Storm Tanks to Abbey Mills Pumping Station requiring five main tunnel sites (one of the sites would also intercept flows from one CSO)

b. control of 18 CSOs by diverting intercepted flows into the main tunnel requiring 16 CSO sites; two long connection tunnels (Frogmore connection tunnel and Greenwich connect tunnel) and 11 short connection tunnels

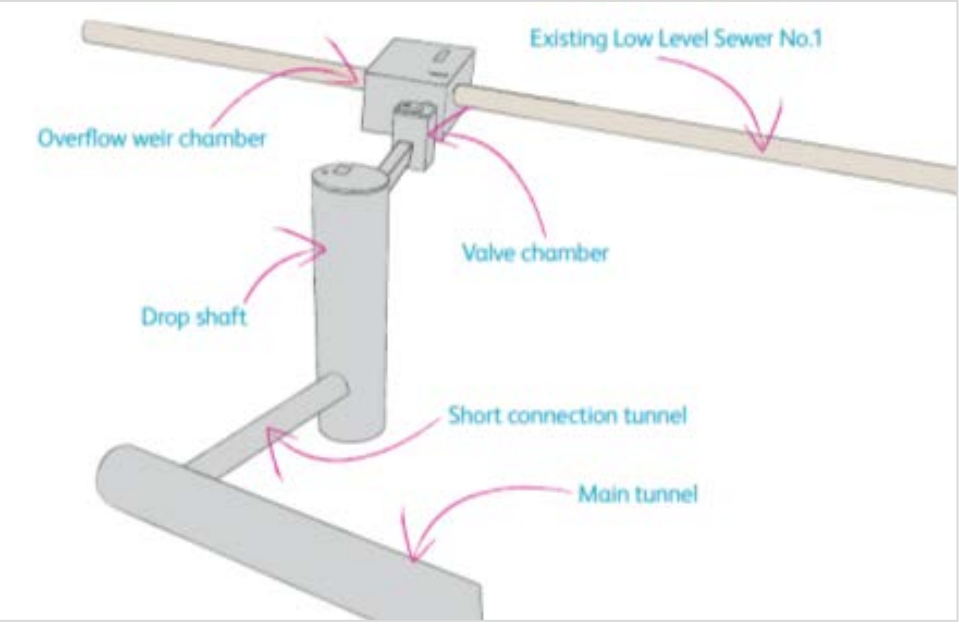
c. control of two CSOs by locally modifying the sewerage system requiring two system modification sites

d. works to drain down the system at Beckton Sewage Treatment Works.

2.2.3 The main tunnel would connect to the Lee Tunnel at Abbey Mills Pumping Station. All the flows from the Thames Tideway Tunnel and the Lee Tunnel would be transferred to Beckton Sewage Treatment Works via the Lee Tunnel.

2.2.4 The Victoria Embankment Foreshore CSO site would be required to control the adjacent Regent St CSO along with other CSOs located in central London via a connection to the northern Low Level Sewer No.1, and to connect to the main tunnel. The proposed structures at this site are illustrated in Figure 2.1.

Figure 2.1 CSO structures at Victoria Embankment Foreshore (below-ground)



2.2.5 It is proposed that the permanent in-river structure at the Victoria Embankment Foreshore site would accommodate:

a. a CSO drop shaft – 13m internal diameter, approximately 50m deep;
b. an overflow weir chamber on the northern Low Level Sewer No.1 located within the existing river wall structure
c. connection culverts and valve chambers
d. air management structures
e. a new section of river wall.

2.2.6 A cofferdam would be constructed, which would include the following areas to enable construction of the permanent in-river structure:

a. excavated material storage and handling facilities
b. cranes
c. maintenance workshop and storage
d. internal site roads
e. site support and welfare.

2.3 Limits of land to be acquired or used

2.3.1 The proposed limits of land to be acquired or used (LLAU) for this site would run south from the current location of the Tattershall Castle to line up with Whitehall Stairs (a total of approximately 250m in length). It extends approximately 55m from the foreshore into the River Thames. This area would not encroach into the authorised channel.

2.3.2 The LLAU encompasses the maximum working area required during construction. A cofferdam would be constructed within this area during the

construction phases. The permanent river wall works would take place within the cofferdam.

2.3.3 The LLAU would be used intermittently, depending on the progress, method and phasing of construction.

2.3.4 Appendix C details the various design, construction and site layout drawings and shows the LLAU.

2.4 Project phases

2.4.1 This assessment was divided into four distinct project construction phases to assess hazards and develop risk reduction measures commensurate with the risk posed by different operations associated with the project. These phases were identified for use during the navigation risk assessment and comprise:

Phase A: cofferdam construction (including delivery of materials by barge)

Phase B: drop shaft, culvert and connections construction (including removal of excavated materials by barge)

Phase C: cofferdam removal (including removal of materials by barge)

Phase D: permanent worksite.

2.5 Construction methodology

2.5.1 All works would be undertaken in accordance with the project's *Code of Construction Practice (CoCP)*.

2.5.2 The code sets out a series of objectives and measures to protect the environment and limit disturbance from construction activities as far as reasonably practicable. The topics covered by the *CoCP* include but are not limited to: working hours, traffic management, noise and vibration, air quality, waste management, recycling, ecology, archaeology and settlement.

2.5.3 The methodologies, layouts and plant requirements outlined in this document are for illustrative purposes only and may be varied by subsequent design and build construction contractors.

2.6 Phase A: Cofferdam construction

2.6.1 The cofferdam would be constructed by installing a sheet piled wall. It is currently envisaged that the cofferdam would be designed as a twin walled cofferdam to accommodate the various loading conditions including external tidal loading and internal plant/construction loading.

2.6.2 It is intended to use the river to access and service the cofferdam construction activities, and a jack-up or spud leg barge would be mobilised at the site. A jack-up barge is a hydraulically operated self-elevating platform, which provides a stable platform from which marine piling works can be undertaken. The barge would be equipped with a crawler crane for

off-loading and pitching the sheets for the sheet piled wall, a silent piling hammer, a small welfare cabin, a rescue boat and generated power.

2.7 Phase B: CSO drop shaft, culvert and connections construction

2.7.1 The CSO drop shaft would be constructed with precast segmental lining using caissons and underpinning. The connection tunnel would be constructed by sprayed concrete linings and the interception chambers by traditional reinforced concrete structures.

2.7.2 An attendant excavator would load the excavation material into a dumper, which would deposit excavated material into the excavated material muck bin. A long reach excavator would load the excavated material into a barge moored alongside the cofferdam wall.

2.8 Phase C: Cofferdam removal

2.8.1 On completion of the CSO drop shaft and connection chambers, the permanent river wall would be constructed. The area between the cofferdam and permanent river wall would be excavated.

2.8.2 Concrete blinding would be installed and then the permanent river wall constructed.

2.8.3 Only once the permanent river wall is in place would the cofferdam on the riverside be removed in order to maintain flood protection. The cofferdam piled wall would then be dismantled by jack-up barge.

2.9 Phase D: Permanent worksite

2.9.1 Once all temporary works structures have been removed and construction work is complete, a permanent in-river structure would remain at the site. Access to various elements of the site and underground works would be required for maintenance. River-based access during the permanent works phase would only anticipated in the event of failure of the outer flap valves on the permanent river walls.

2.9.2 The permanent structure would extend approximately 32m into the river; however, it would be set back from the authorised channel by approximately 35m and should not have an impact on navigation.

3 Study aim and area

3.1 Introduction

3.1.1 The aim of this assessment is to identify and assess navigational hazards specific to construction activities at the Victoria Embankment Foreshore site and to assess how the proposed phases of the project would likely impact on existing river users and river infrastructure.

3.1.2 This assessment considers all river users and the hazards that project activities could pose to navigation on the River Thames.

3.1.3 In compiling this assessment, the project undertook extensive consultation with the PLA and current river users, along with observations of current river operations.

3.1.4 In order to consider the navigation impact on the wider river community, the scope of this assessment comprised an area from Westminster Bridge to Waterloo Bridge. This study area captures the majority of vessel types likely to transit this section of the river and pass the worksite.

3.1.5 The proposed development site is in close proximity to Embankment Pier, and the effects on traffic using Embankment Pier were considered within this assessment.

3.1.6 The project proposes to use barges during site set-up, drop shaft construction, and the completion of works and site restoration phases.

3.2 General navigation

3.2.1 The Central London stretch of the River Thames is extensively used by commuter, passenger and private pleasure craft as well as tugs, barges and other working vessels that transport freight.

3.2.2 Safety is the responsibility of all river users; however, overall responsibility for facilitating the safety of navigation on the River Thames rests with the PLA.

3.2.3 As part of its activities in maintaining navigational safety, the PLA produces Notices to Mariners (NTMs), which provide essential, up-to-date information and advice to those navigating within the Port of London. NTMs can range from information on special events, notifications of works (eg, the Network Rail works on Blackfriars Bridge), and notification of new and updated navigation rules and regulations. A full list of extant NTMs is available on the PLA website, http://www.pla.co.uk/notice2mariners/index.cfm/site/navigation.

3.2.4 The River Thames becomes tidal downriver of Teddington Lock, with a tidal range of between five and seven metres at different locations.

3.2.5 On the flood tide, the tidal current flows up-river (ie, predominantly east to west) whereas on the ebb tide, the tidal current flows downriver (ie, predominantly west to east).

3.3 Bridges

3.3.1 Waterloo Bridge has five main arches, three of which are available for navigation; arches No2, 3 and 4 are designated as working arches.

Table 3.1 Individual arch bridge clearances above Mean High Water Springs (Waterloo Bridge)

Bridge Arch	1	2	3	4	5
Arch Clearance	6.2 m	8.5 m	8.6 m	8.6 m	6.1 m

Table 3.2 Main arch No3 bridge height clearance (Waterloo Bridge)

Tide Set	Chart Datum	MHWN	MLWN	MLWS	HAT
Arch Clearance	15.4 m	9.8 m	14.3 m	15.0 m	8.1 m

3.3.2 Charing Cross Rail Bridge has five main arches, three of which are available for navigation; arches No2 and 3 are designated as working arches. Arch No3 is not listed as a working arch, however, smaller vessels are encouraged to use it at most stages of the tide.

3.3.3 Arch No1 is not listed as a working arch or available for navigation, however, it is used by Thames Clipper vessels operating at Embankment Pier.

Table 3.3 Individual arch bridge clearances above Mean High Water Springs (Charing Cross Rail Bridge)

Bridge Arch	1	2	**3**	4	5
Arch Clearance	6.9 m	7.0 m	7.0 m	6.9 m	6.9 m

Table 3.4 Main arch No3 bridge clearance heights (Charing Cross Rail Bridge)

Tide Set	Chart Datum	MHWN	MLWN	MLWS	HAT
Arch Clearance	13.6	8.0	12.6	13.2	6.4

3.3.4 Westminster Bridge has seven main arches, all of which are available for navigation; arches No2, 3, 4 and 5 are designated as working arches.

Table 3.5 Individual arch bridge clearances above Mean High Water Springs (Westminster Bridge)

Bridge Arch	1	2	3	4	5	6	7
Arch	4.2 m	4.8 m	5.2 m	5.4 m	5.2 m	4.8 m	4.2 m

Clearance							

Table 3.6 Main arch No4 bridge clearance heights (Westminster Bridge)

Tide Set	Chart Datum	MHWN	MLWN	MLWS	HAT
Arch Clearance	12.2	6.5	11.1	11.8	4.8

3.4 The authorised channel

3.4.1 The authorised channel is marked on both Admiralty and PLA charts as a pair of pecked lines that define where the majority of commercial vessels generally navigate. However, vessels cannot always be expected to navigate 'within' the authorised channel.

3.4.2 In busy stretches of Central London, including this study area, the authorised channel is approximately 100m wide and incorporates the working arches of the various bridges. At peak times the authorised channel can become very congested.

3.4.3 The document *General Directions for Navigation in the Port of London 2011* states the following:

> *"36. REQUIREMENT TO USE THE AUTHORISED CHANNEL*
>
> *(1) This Direction applies only to vessels navigating between the Margaretness Limit and Putney Bridge.*
>
> *"(2) Except in an emergency or for the purposes of overtaking, or with the permission of the Harbourmaster, or when manoeuvring to or from piers, wharves, anchorages or other berths, all Reporting Vessels and vessels of 13.7 metres or more in Length Overall shall normally navigate only in the authorised channel as identified on PLA charts.*
>
> *"(3) Where there is sufficient room, vessels less than 13.7 metres in Length Overall should normally navigate outside the authorised channel unless constrained by their draught or otherwise restricted in ability to manoeuvre, or in an emergency".*

3.5 Tide set

3.5.1 During consultation for this and other sites associated with the project, the project determined that the 'tide set' in the Kings Reach area of the River Thames should be taken into consideration when assessing navigational hazards.

3.5.2 The term 'tide set 'is used to describe the movement of water into the bight or outside edge of a bend of a river. In a tidal river like the River Thames, which is embanked in the central area, it also leads to an increase in velocity.

3.5.3 Every vessel is affected by tide set in varying degrees. Smaller, faster-moving craft are affected less than larger, slow-moving vessels such as

tugs and tows, which have to make course and steering adjustments to counteract the impact of tide set.

3.5.4 The embankments of the River Thames deflect the water flow towards the outside of the next bend. This effect manifests itself particularly in the section of the river that contains the various bridges.

3.5.5 The tide set in and around Charing Cross Railway Bridge is assessed as 'Strong North' on both the flood and ebb tides.

3.6 Existing river users

3.6.1 The Central London stretch of the River Thames is acknowledged as one of the busiest sections of the tidal Thames in terms of vessel movements.

3.6.2 There are a number of freight operators that provide regular freight services within the study area. Cory Environmental Ltd operates a daily (currently weekday) waste transfer service. At present, Cory transports containerised waste from Wandsworth, Cringle Dock and Walbrook Wharf waste transfer stations to landfill; in the future it will also transport waste to its incinerator plant at Belvedere. Cory typically operates a service consisting of three tugs with up to four barges (per tug) in inward and outward bound directions.

3.6.3 Figure 3.5 illustrates Cory inbound barge movements through this section of the river. The image was produced using information collected in conjunction with Cory.

3.6.4 Additional freight operators that can be expected to operate within the study area include; Bennett's Barges, GPS Marine, JJ Prior and Livett's Launches.

3.6.5 Thames Clippers (fast ferries), timetabled passenger services, sightseeing tours and party boat tours all operate within the study area.

3.6.6 Embankment Pier is located close to the proposed CSO foreshore site, offering commuter passenger services and river tours to the following destinations:

a. Embankment to Woolwich Arsenal
   i Monday to Friday (excluding Public Holidays)
   ii Thames Clippers (www.thamesclippers.com)
b. Blackfriars Pier to Putney Pier
   i Monday to Friday (peak hours only)
   ii Thames River Taxi (www.thamesrivertaxi.com)
c. Westminster to St Katharine Pier
   i daily
   ii Crown River Cruises (www.crownriver.com)
d. Tate to Tate
   i Thames Clippers (www.thamesclippers.com).

3.6.7 Private hire cruise vessels occasionally transit past Victoria Embankment . While it is not feasible to provide exact numbers for these vessels, it is assumed that vessels from the following companies operate in the study area:

a. Thames Cruises
b. Capital Pleasure Boats
c. Westminster Part Boats
d. London Party Boats
e. Thames Executive Charters
f. Crown River Cruises
g. Viscount Cruises
h. Bateaux London.

3.6.8 It is estimated that during peak operating periods up to 25 charter vessels may pass the site heading eastbound on any given day, and approximately the same number passing westbound.

3.6.9 Crown River Cruises operate a circular cruise departing from Westminster Pier. The cruise starts at Westminster Pier and stops at the following locations:

a. Embankment Pier
b. Festival Pier
c. Bankside Pier
d. St Katherine Pier.

3.6.10 The PLA actively encourages recreational boat users to use the tidal Thames, and hosts a dedicated website (www.boatingonthethames.co.uk) that provides advice, guidance and safety information to a wide variety of leisure users.

3.6.11 Recreational traffic on the River Thames that can be expected to transit within the study area includes narrow boats, motor yachts, rigid inflatable boats (RIBs), speed boats, rowing boats, kayaks and sailing yachts.

3.7 Existing vessel traffic movements

3.7.1 The majority of inward bound freight movements can be expected to pass through the study area two to three hours before high water (HW), which provides them with a sufficient operating window to reach their final destination around an hour before the HW mark. Outbound freight can typically be found in the study area around HW.

3.7.2 Cory's current passage plan requires tugs to depart Cringle Dock (Wandsworth Reach) one hour before HW on the spring tides and 30 minutes before HW on the neap tides in order to clear the various bridges in Central London.

3.7.3 The River Thames is used by tourists as a means of sightseeing; consequently, traffic levels are seasonal and the highest tourist traffic is around lunchtime in the summer months.

3.7.4 Charter vessels also have an element of seasonality and the majority of chartered vessels operate in the summer months (April to September). There are some increases around the Christmas party season.

3.7.5 The project has conducted observations and analysis of Cory tug and tow operations through Charing Cross Rail Bridge. Full details of this analysis are provided in Annex B: Freight Tracks and AIS Analysis.

3.7.6 During consultation with the PLA, it was highlighted that Crown River Cruises has been authorised to transit from Westminster Pier to Embankment Pier against the conventional flow of river traffic. Crown River Cruises boats are authorised to transit along the north bank of the river and use Charing Cross Rail Bridge arch No1 en route to Embankment Pier.

3.7.7 Crown River Cruises received this authorisation following the production and presentation of a Navigational Issues and Risk Assessment.

3.7.8 Currently, the distance between the Tattershall Castle and the authorised channel is 25m. The distance between the LLAU and the authorised channel at this point would be approximately 8m.

3.7.9 The proposed temporary works would likely impact on Crown River Cruises' ability to transit between Westminster Pier and Embankment Pier on the north side of the river. This would likely be for a short period of time during the construction of the outer boundary of the cofferdam.

3.7.10 Construction of the cofferdam outside of the peak operating season (ie, between October and March) would most likely reduce the impact on Crown River Cruises.

3.8 River usage survey

3.8.1 In May 2012, the project commissioned Peter Brett Associates to conduct a River Usage Survey in order to determine typical boat and pedestrian activity in proximity to a number of specific worksites relevant to the project.

3.8.2 The combined number of craft that arrived, departed and passed the piers in proximity to the Victoria Embankment Foreshore site over the four-day survey totalled 2,794 vessels: of which 891 passed the piers and 1,903 stopped at them.

Table 3.7 Embankment Pier usage

Vessel type	10 May 2012	11 May 2012	12 May 2012	13 May 2012	Total
Motor dinghy	3	2	9	1	**15**
Private cruiser	1	1	0	0	**2**
River cruise	24	27	33	35	**119**
River bus	33	36	36	34	**139**

Motor barge	1	1	0	0	**2**
Launch	4	0	0	0	**4**
Total	**66**	**67**	**78**	**70**	**281**

3.8.3 The length of time that vessels were moored at each pier between arrival and departure was recorded. Embankment Pier results are provided in Table 3.8.

Table 3.8 Average time moored at Embankment Pier

Date	Embankment Pier
10 May 2012	0:03:47
11 May 2012	0:02:32
12 May 2012	0:05:01
13 May 2012	0:05:14

3.9 Vessels using Embankment Pier

3.9.1 Observations of vessels using Embankment Pier were conducted on several occasions, encompassing various stages of the tide and weather conditions.

3.9.2 Embankment Millennium Pier is used by a number of commercial operators, including Thames Clippers, Complete Pleasure Boats, Crown River Services and Bateaux London.

3.9.3 Thames Clippers operate at the western end of the pier, Bateaux London on the eastern end, and the centre berth of the pier is available to other operators. The Thames RIB Experience Company operates from a ‘V’ berth at the western end of the Pier.

3.9.4 The following photographs illustrate a Thames Clipper vessel berthed at Embankment Pier prior to departure to London Eye Pier.

3.9.5 The following figures demonstrate that the Thames Clippers berth with the majority of the vessel situated underneath Charing Cross Rail Bridge. Passengers embark and disembark from the stern of the vessel.

Figure 3.1 Thames Clipper at Embankment Pier

Figure 3.2 Passengers disembarking at Embankment Pier

3.9.6 Bateaux London currently uses the facilities at Embankment Pier to store/load vessels and to embark passengers. Bateaux London operates a staggered lunchtime and evening service, using three vessels. Vessels depart at approximately 12.15pm, 1pm and 3pm on the afternoon service and at 7.30pm and 8pm on the evening service.

3.9.7 Typical Bateaux London cruises run from Embankment Pier, upriver to Westminster and downriver as far as the O2 Arena/Millenium Dome.

Figure 3.3 Bateaux London at Embankment Pier

3.10 Freight movements

3.10.1 The image below illustrates inbound Cory barge movements transiting through the area, heading upstream to Cringle Dock.

Figure 3.4 Cory tugs in transit past London Eye

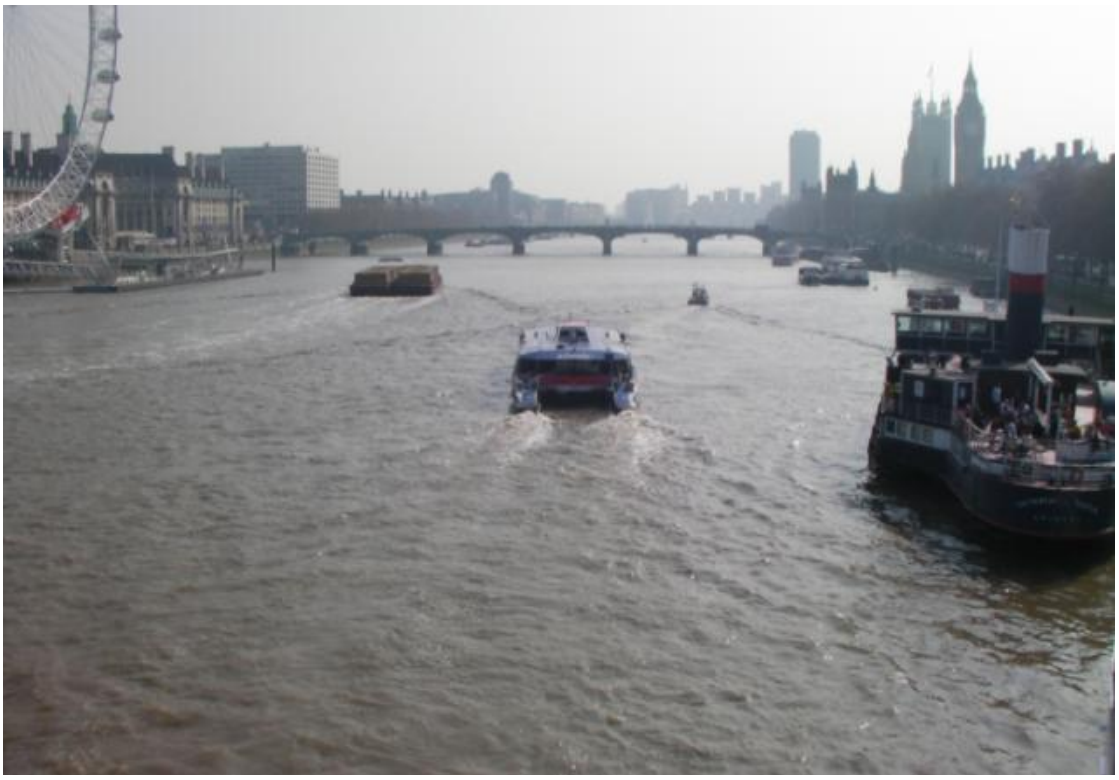
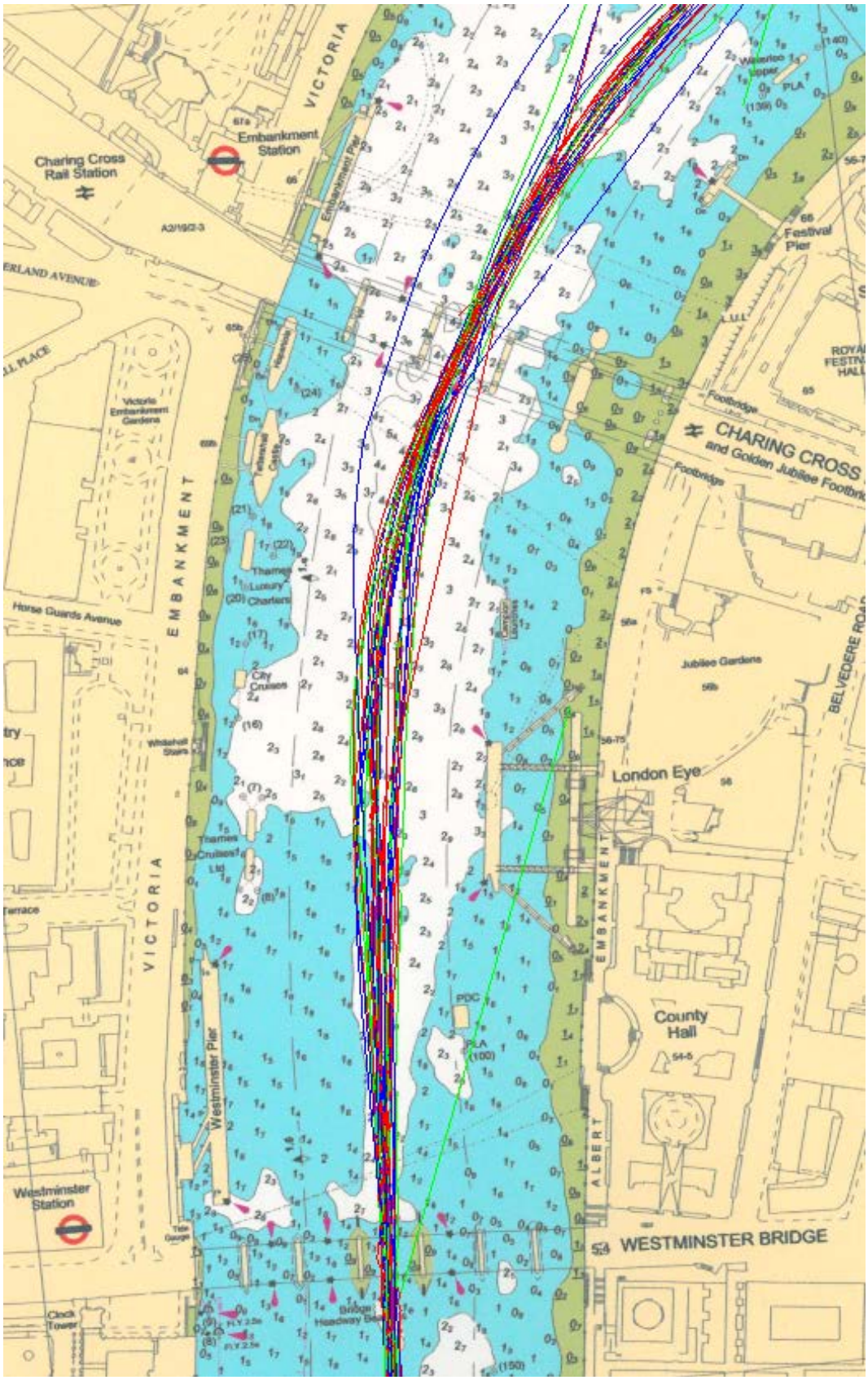


Figure 3.5 Cory vessel inbound tracks



4 Summary of navigational issues

4.1 Impact on operations at Embankment Pier

4.1.1 The proposed site is in close proximity to Charing Cross Railway Bridge and Embankment Millennium Pier.

4.1.2 Embankment Millennium Pier is used by a number of commercial operators, including Thames Clippers, Complete Pleasure Boats, Crown River Services and Bateaux London.

4.1.3 Thames Clippers operates at the western end of the pier, Bateaux London at the eastern end, and the centre berth of the pier is available to other operators. The Thames RIB Experience Company picks up and sets down passengers from a 'V' berth at the western end of the pier.

4.1.4 The impact on operations at Embankment Pier as a result of the proposed structures and plant within the river at Victoria Embankment is assessed as a key marine issue within this report.

4.2 Proximity to the authorised channel

4.2.1 The temporary cofferdam extends approximately 40m into the river. The authorised channel would lie approximately 28m from the edge of the cofferdam.

4.2.2 The boundary of the LLAU is approximately 8m from the authorised channel at its closest point. The LLAU provides working room to install and remove the temporary cofferdam, and for barges to service the site.

4.2.3 The permanent structure would intrude approximately 27m into the river (which is less than the current protrusion of the Tattershall Castle into the river). The authorised channel would be approximately 38m from the outer boundary of the permanent structure.

4.2.4 Heavy plant and sheet piling machinery would be required to construct the cofferdam. This plant would be located within the LLAU.

4.2.5 The intrusion into the river and proximity of plant and machinery to the authorised channel is assessed as a key marine issue for this site.

4.3 Number of tugs/barges travelling through the area

4.3.1 The number of additional tugs and tows that the project is expected to use throughout construction was identified as an issue that could have an adverse impact on existing navigational safety.

4.4 Charing Cross Rail Bridge arch closures

4.4.1 Closure of any of the main working arches (No2, 3 and 4) of Charing Cross Rail Bridge may have an adverse impact on vessel traffic within the area.

4.4.2 The bridge has five arches and arches No. 2 and No. 3 are designated as working arches in the PLA's *Mariners Guide to Bridges on the Tidal Thames*.

a. No2 arch should be used by inbound traffic to leave No3 arch clear for larger and reporting vessels.

b. No3 arch should be used by larger and reporting vessels travelling both up- and downstream.

c. No4 arch should be used by smaller outbound vessels at most stages of the tide.

d. Arch No1 is used by vessels accessing/leaving Millennium Pier.

4.4.3 A requirement to close any of the arches, either for planned or emergency reasons, could have an adverse impact on existing river traffic.

4.5 Relocation of the Tattershall Castle

4.5.1 In order to gain sufficient working area to construct and operate the cofferdam and temporary worksite, the project proposes temporarily to relocate the Tattershall Castle.

4.5.2 The vessel would be temporarily relocated to a position approximately 130m to the south of its current mooring. On completion of the project works, it would be moved approximately 40m north to a new permanent mooring.

4.6 Proximity to the Hispaniola

4.6.1 The proximity of the temporary and permanent structures to the permanently moored vessel the Hispaniola was originally considered as a navigational issue at the Victoria Embankment Foreshore site.

4.6.2 The proposed methodology for the site is for the Hispaniola to remain at its current location.

4.6.3 It was determined that the vessel would not present a navigational hazard; therefore the proximity of project works to the Hispaniola is not assessed further within this report.

4.6.4 Should there be a requirement to move the Hispaniola at any point during construction, an assessment of the move and the impact on existing river usage and navigation would be carried out.

4.7 Changes to in-river flow

4.7.1 Changes to the hydrodynamics of the River Thames may affect passing vessels, particularly through the arches of Charing Cross Rail Bridge.

4.7.2 The shape, location and size of the permanent structure in the river at the Victoria Embankment Foreshore site would lead to a change in river velocity that could have an adverse effect on existing passing river traffic, and certain vessel types would be likely to be affected more than others. However, based on fluvial modelling work carried out by HR Wallingford,

the introduction of the proposed temporary and permanent structures is expected to have a minimal effect on existing river users. The changes in flow are predicted to be low (less than 0.5 knots peak to peak) and the majority of vessels that use this area are unlikely to be affected.

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5 Stakeholder consultation

5.1 Consultation meetings

5.1.1 On 28 June 2012, representatives from the project team met with Thames Clippers to present proposals for a number of potential sites, including Blackfriars Foreshore and Victoria Embankment Foreshore.

5.1.2 Thames Clippers provided information on the ownership of Embankment Pier and noted that, in the event that Clippers are relocated on the pier, a suitable fender unit would be required to assist Clipper vessels on to and off the berth.

5.1.3 During the meeting Thames Clippers indicated that, provided that the works would not prevent them from using Embankment Pier, they were content with the hazards identified at Victoria Embankment.

5.1.4 On 20 June 2012, project representatives met with Cory Environmental Ltd to discuss a number of potential project sites. Cory was shown the proposed layout of the temporary and permanent structures at Victoria Embankment Foreshore, along with AIS data analysis of the tracks of their vessels past the site. Cory representatives indicated during that meeting that they had no concerns regarding the proposed works at Victoria Embankment Foreshore.

5.1.5 Further, the project met with Bateaux London, which operates from Embankment Pier and is in the process of engaging local RIB operators.

5.1.6 Project liaison with operators in the area is on-going.

5.2 Observation notes

5.2.1 Passenger vessels using Embankment Pier were observed on a number of occasions, and observations focused on the operations of Thames Clippers using the western end of Embankment Pier.

5.2.2 The project conducted observations and analysis of freight movements through Charing Cross Rail Bridge. Full details of the analysis are provided in Appendix A: Freight Tracks and AIS Analysis.

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6 Risk assessment

6.1 Risk assessment: Methodology

6.1.1 For each of the identified hazards, the associated risk was assessed and classified. The following definitions were applied for the purposes of this report:

a. Hazard: eg, an object, activity or phenomenon that can cause an adverse effect.

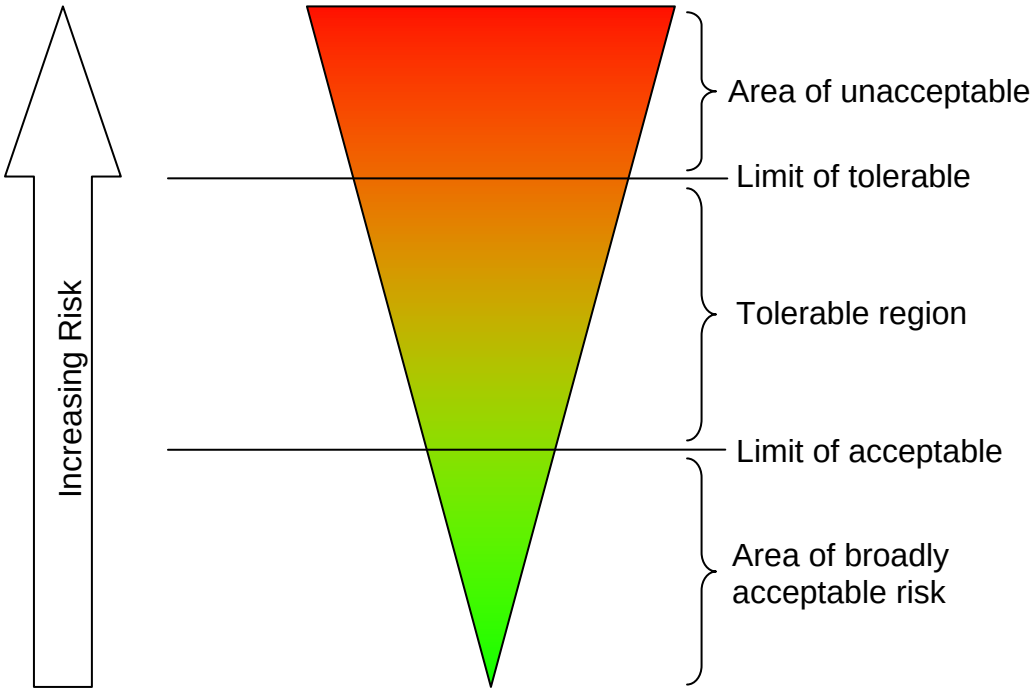
b. Risk: a relative measure of harm or loss, derived from the combination of the severity of a particular consequence together with the probability of the consequence occurring.

c. Consequence: a particular scenario (expressed as harm to people, damage to the environment, an operational impact and/or negative media attention) that results from a hazardous situation.

d. Probability: the 'chance' of a particular hazard consequence occurring, measured as a frequency (per year).

6.1.2 The assessment used the principle of reducing navigational risks to a level that is As Low As Reasonably Practicable (ALARP). ALARP is part of the Health and Safety at Work Act 1974 and involves assessing the acceptability of a risk against the difficulty, time and expense needed to control it. The ALARP concept is illustrated in Figure 6.1.

Figure 6.1 The ALARP Principle



6.1.3 At the lower end of the ALARP triangle, risks are small due to either low probability or insignificant consequences. These risks can generally be accepted provided that common safeguards are implemented. Moving up the ALARP triangle to the tolerable region, risks increase in magnitude

due to either an increase in probability or an increase in severity of consequences. Risks in the tolerable region can be accepted provided that risk controls are implemented that demonstrate that the risk is reduced to a level deemed to be ALARP; where any further risk reduction would be disproportionate in terms of cost, time and resources required to implement it compared to the benefit it would introduce. At the top of the ALARP triangle is a region of unacceptable risk that cannot be accepted without risk controls to reduce the risk to a tolerable and ALARP level.

6.1.4 This risk assessment was undertaken on a qualitative basis, using the engineering and operational judgement of representatives from the project team and representatives from river users and operators. Hazard consequences were considered based on most likely outcomes.

6.2 Risk assessment: Criteria

6.2.1 When commencing the assessment of the risk posed by the project's activities, the project's marine consultant recommended using the risk assessment criteria and methodology within the existing PLA Safety Management System (SMS). The rationale behind this recommendation was to provide the project team and the PLA with a consistent assessment score that could be transferred across into the PLA's existing SMS and enable an appreciation of the increase in risk resulting from the project's temporary and permanent works.

6.2.2 Consultation with the PLA highlighted the PLA's desire to use an alternative risk terminology, as well as an alternative assessment matrix and risk classification scorecard. These changes have now been incorporated as requested.

6.2.3 This section details the risk criteria used throughout this assessment. The assessment process identifies four distinct areas of risk and the probable consequences associated with each hazard assessed in terms of harm or loss to:

a. people (life)

b. environment

c. operational impact

d. media attention.

6.2.4 Table 6.1 details the 'probability' criteria used to assess how likely each hazard is to occur in terms of average frequency in the PLA's jurisdiction.

Table 6.1 Probability Criteria

	Frequency	Score
Rare	Has not occurred in the in the last ten years	1
Unlikely	Has not occurred in the in the last three years	2
Possible	Has not occurred in the in the last year	3
Likely	Has occurred in the in the last year	4
Almost certain	Occurs several times per year	5

6.2.5 Table 6.2 details the severity criteria applied to the safety- related consequences of each hazard.

Table 6.2 Severity Criteria: People	Level
First aid case / Medical treatment case	1
Restricted work case	2
Lost Time Injury / Moderate permanent partial disability injury	3
Single Fatality / Severe permanent partial disability	4
Multiple fatalities	5

6.2.6 Table 6.3 details the severity criteria applied to the environmental loss related consequences of each hazard.

Table 6.3 Severity Criteria: Environment	Level
Low impact with no lasting effect	1
Temporary effect / Minor effect to small area	2
Short to medium term impact	3
Medium to long term effect / large area affected	4
Long term impact / severe impact on sensitive area	5

6.2.7 Table 6.4 details the severity criteria applied to the property loss/damage related consequences of each hazard.

Table 6.4 Severity Criteria: Operational Impact	Level
Insignificant or no damage to vessel / equipment	1
Minor or superficial damage to vessel / equipment	2
Moderate damage to vessel / equipment requiring immediate repairs	3
Major damage to vessel / equipment and detention	4
Very serious damage to vessel or equipment possible criminal proceedings	5

6.2.8 Table 6.5 details the severity criteria applied to negative media attention/coverage consequences of each hazard.

Table 6.5 Severity Criteria: Media Attention	Level
No Coverage	1
Local coverage	2
Regional coverage	3
National coverage	4
International coverage	5

6.3 Risk matrix

6.3.1 The risk matrix in Table 6.6 was used to provide a risk score, combining severity of a particular consequence with the likelihood (probability) of the consequence occurring.

Table 6.6 Risk Assessment Matrix

Likelihood	Rare	**1**	**2**	**3**	**4**	**5**
	Unlikely	**2**	**4**	**6**	**8**	**10**
	Possible	**3**	**6**	**9**	**12**	**15**
	Likely	**4**	**8**	**12**	**16**	**20**
	Almost certain	**5**	**10**	**15**	**20**	**25**
	Severity	Level 1	Level 2	Level 3	Level 4	Level 5

6.3.2 The risk score in Table 6.7 indicates the magnitude and acceptability of the risk in accordance with the ALARP principle. The PLA method applies this to both individual and average risk.

Table 6.7 Risk Classification

Score	Classification	Definition
1 to 2	**Slight**	No action is required.
3 to 4	**Minor**	No additional controls are required, monitoring is required to ensure no changes in circumstances.
5 to 9	**Moderate**	Efforts should be made to reduce risk to ALARP level. Job can be performed under direct supervision of Senior Officer.
10 to 14	**High**	Efforts should be made to reduce risk to ALARP level. Job can only be performed after authorisation from Harbour Master and after further additional controls required under the circumstances.
15 to 25	**Extreme**	Intolerable risk. Job is not authorised.

6.4 Hazard identification

6.4.1 A hazard can be defined as 'the potential for an adverse consequence', and may be associated with a situation that could cause harm to people, damage to the environment, an operational impact or negative media attention.

6.4.2 In order to facilitate a comprehensive overview of potential maritime hazards, various river users and operators were consulted throughout the risk assessment process, including:

a. Thames Clippers;

b. Cory Environmental Limited;

c. City Cruises;

d. Livett's Launches;

e. Bennett's Barges;

f. London Duck Tours;

g. Metropolitan Police Marine Policing Unit;

h. Royal National Lifeboat Institute (RNLI).

6.4.3 The project also made several site visits to HR Wallingford's physical model during the risk assessment process. This provided Captain David Phillips (at the time, PLA Harbour Master (Upper)), freight (Cory Environmental) and commercial (Thames Clippers) operators with the opportunity to understand the impact of the proposed developments on the river flow patterns and to visualise the scale of the temporary and permanent work at various locations. However, the site at Victoria Embankment Foreshore was not included in this physical model.

6.5 Mitigation strategy

6.5.1 Throughout the assessment process, it was evident that potential hazards presented by the project would require mitigation measures throughout the project lifecycle.

6.5.2 The following section will identify and detail the navigational issues and proposed mitigation measures.

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7 Navigational issues and mitigation meausures

7.1 General

7.1.1 It is acknowledged that mitigation measures may themselves introduce further hazards that also require mitigation. Where appropriate, these have been considered.

7.1.2 Mitigation measures were developed with an emphasis on measures that are within the project's control (e.g. design of in-river structures).

7.1.3 For the purpose of this assessment, mitigation measures (risk control options) were classified as three types;

a. Design: measures that can be implemented by the project at the design stage.

b. Physical: measures that the project can implement during the construction and operational phases.

c. Operational: measures that the project can implement in conjunction with the PLA at all stages of the project.

7.1.4 Of course, some proposed mitigation measures would be beyond the project's control, such as emergency plans, operating procedures and NtMs.

7.2 Interaction with existing river traffic

7.2.1 The proposed structures at the site are in close proximity to Charing Cross Rail Bridge, Westminster Pier, London Eye Pier and Festival Pier. This area of the river is considered to be one of the most densely populated in terms of numbers of vessel movements, and is served by a wide variety of vessel types and operators.

7.2.2 The piers are used by a large number of operators for commuter services, passenger sightseeing services and charter (party boat) services throughout the year.

7.2.3 The project proposes to use barges to transfer excavated material and imported cofferdam fill to/from this site by river during phases A to C.

7.2.4 Project barges working from this site and the associated interaction between operators using the piers in this section of the river was identified as a potential navigational hazard.

Actions required

7.2.5 A number of actions, specific to this issue, have been commenced or completed in order to assist the project to provide a robust and evidence-based assessment to the PLA. These actions include:

a. Collate AIS data to allow detailed assessment and site specific drawings to be produced and overlaid, showing the extent of the interaction.

b. Produce images illustrating Thames Clippers movements through the area, including approaching Embankment Pier.

c. Identify typical river traffic using this section of the river and its frequency.

d. Analyse other passenger vessels movements through this section of the river.

e. Review permanent and temporary working layouts and issues with the project's engineering team.

Mitigation of issues: Design

7.2.6 Designing the project has been an iterative process influenced by the on-going navigational issues and risk assessment process. Measures to eliminate or reduce navigational hazards identified in early risk assessments were embedded into the design of the temporary and permanent works. This assessment therefore assesses the residual risks assuming the effective implementation of these measures. The embedded measures include:

a. The design and in-river footprint of the temporary and permanent worksite was minimised in order to reduce intrusion into the river as far as possible while incorporating the necessary works. The footprint would also be set back from the authorised channel. In particular, following phase two consultation, the design of the structure was amended to increase the distance between the structure and the authorised channel. This would reduce the extent to which the worksite would project into the river and thereby reduce the likely impact on existing river users.

b. The permanent works would not extend past the existing line of the two permanently moored vessels: the Tattershall Castle and the Hispaniola.

7.2.7 In addition to the above design changes, operational planning included optimising barge sizes for use at this site in order to minimise the number of tows to/from the site.

7.2.8 The following sections set out the proposed mitigation measures to address the residual risks.

Mitigation of issues: Physical

a. assess and understand operating procedures to ensure minimum disruption/interaction with existing users

b. meet with Cory, Thames Clippers, Bateaux London and RIBs to seek their views and input into interaction issues and possible working relationships

c. schedule barge movements/passage planning and publish planned operations

Mitigation of issues: River operations

a. appoint Berthing Co-ordination Manager: to liaise and be in communication with all operators in the local area and be on hand to deal with potential areas of concern/conflict

b. issue NTMs informing operators and river users of planned operations in the area, highlighting times when project river vessels would likely be servicing the site.

7.3 Impact on operations at Embankment Millennium Pier

7.3.1 The proposed permanent structure would be located approximately 50m south of Charing Cross Rail Bridge arch No1; Embankment Millennium Pier is located north of the arch. Embankment Millennium Pier is used by a number of commercial operators, including Thames Clippers, Complete Pleasure Boats, Crown River Services and Bateaux London.

7.3.2 The Thames RIB Experience Company operates from a 'V' berth the western end of the pier.

7.3.3 Thames Clippers uses the western end of the pier, and the majority of the vessels lie under arch No1 when moored. The vessels then proceed through the arch towards London Eye Millenium Pier. Passengers embark and disembark from the stern of the vessel.

7.3.4 Crown River Cruises gained permission from the PLA to intermittently traverse arch No1 from the south and against the normal vessel traffic, when safe to do so.

7.3.5 Closure of arch No1 could have a negative impact on the operations of Thames Clippers and other users of arch No1.Unless alternative arrangements can be made, this pier could be temporarily unavailable for their operations.

Actions required

7.3.6 A number of actions, specific to this issue, have been commenced or completed in order to assist the project to provide a robust, evidence-based assessment to the PLA. These actions include:

a. Observe Thames Clipper operations at this pier.

b. Produce images illustrating Thames Clipper approach/departure routes to this pier.

c. Observe other operators using this pier.

d. Meet with Bateaux London/Thames Clippers.

Mitigation of issues: Design

7.3.7 The following measures are embedded in the designs and this assessment only assesses the residual risk assuming the effective implementation of these measures.

a. The design and in-river footprint of the permanent structures and the temporary cofferdam was minimised as set out above.

b. Constraints have been placed on the working areas within the river to minimise the duration of a potential, short-term closure of arch No1 to through traffic.

7.3.8 The following sections set out proposed mitigation measures to address the residual risks.

Mitigation of issues: Physical

a. Assess and understand operating procedures to ensure minimum disruption/interaction with existing users.

b. Meet with Thames Clippers and Bateaux London to seek their views .

Mitigation of issues: River operations

a. Restrict the types of vessel that pass through arch No1 during construction and at certain stages of the tide, for example:

   i Limit the use of arch No1 to Thames Clippers only.

   ii Reduce speeds through arch No1.

b. NTMs: inform operators and river users of planned operations in this area, highlighting times when project tugs and tows would likely be operated.

Outcome of actions required

7.3.9 During initial consultation with an existing operator, it was suggested that Bateaux London and Thames Clippers exchange locations on Embankment Millennium Pier. Thames Clippers could use the eastern end of the pier, which would enable them to approach and depart the pier with minimum impact on existing operations. Bateaux London could use the western end of the pier to berth and store its vessels. Bateaux London vessels could berth stern end on with the bow under the bridge and, when ready to depart, could manoeuvre to the centre of the pier prior to departing up or down river.

7.3.10 This proposal was discussed with Bateaux London's General Manager and Head of Marine Operations and it was established that this arrangement would not be feasible.

7.3.11 Since the initial navigational assessment, the project conducted additional analysis of vessel routes in and around Embankment Pier, including Thames Clipper tracks. The results of this analysis provided additional information to the project team.

7.3.12 Analysis of Thames Clipper vessel tracks past the site demonstrated that:

a. 38 per cent traverse the northern edge of the LLAU near the Hispaniola

b. 17per cent pass less than 5m from the LLAU, and less than 25m from the edge of the proposed cofferdam

c. 17per cent pass less than 10m from the LLAU, and less than 30m from the edge of the proposed cofferdam

d. 28per cent pass greater than 10m from the LLAU, and less than 30m from the edge of the proposed cofferdam.

7.3.13 During the construction of the cofferdam, which would take a relatively short period of time in the context of the project, jack-up barges may be placed inside the LLAU with their outer edges at least 15m away from the navigational channel. This would restrict the available area that vessels (primarily Thames Clippers) could use to travel between Embankment Millenium Pier and the London Eye Millenium Pier.

7.3.14 Thames Clipper vessels are highly manoeuvrable and therefore should be able to manoeuvre safely from the upstream end of Embankment Pier via arch No1 of Charing Cross Rail Bridge. Discussions with stakeholders are on-going.

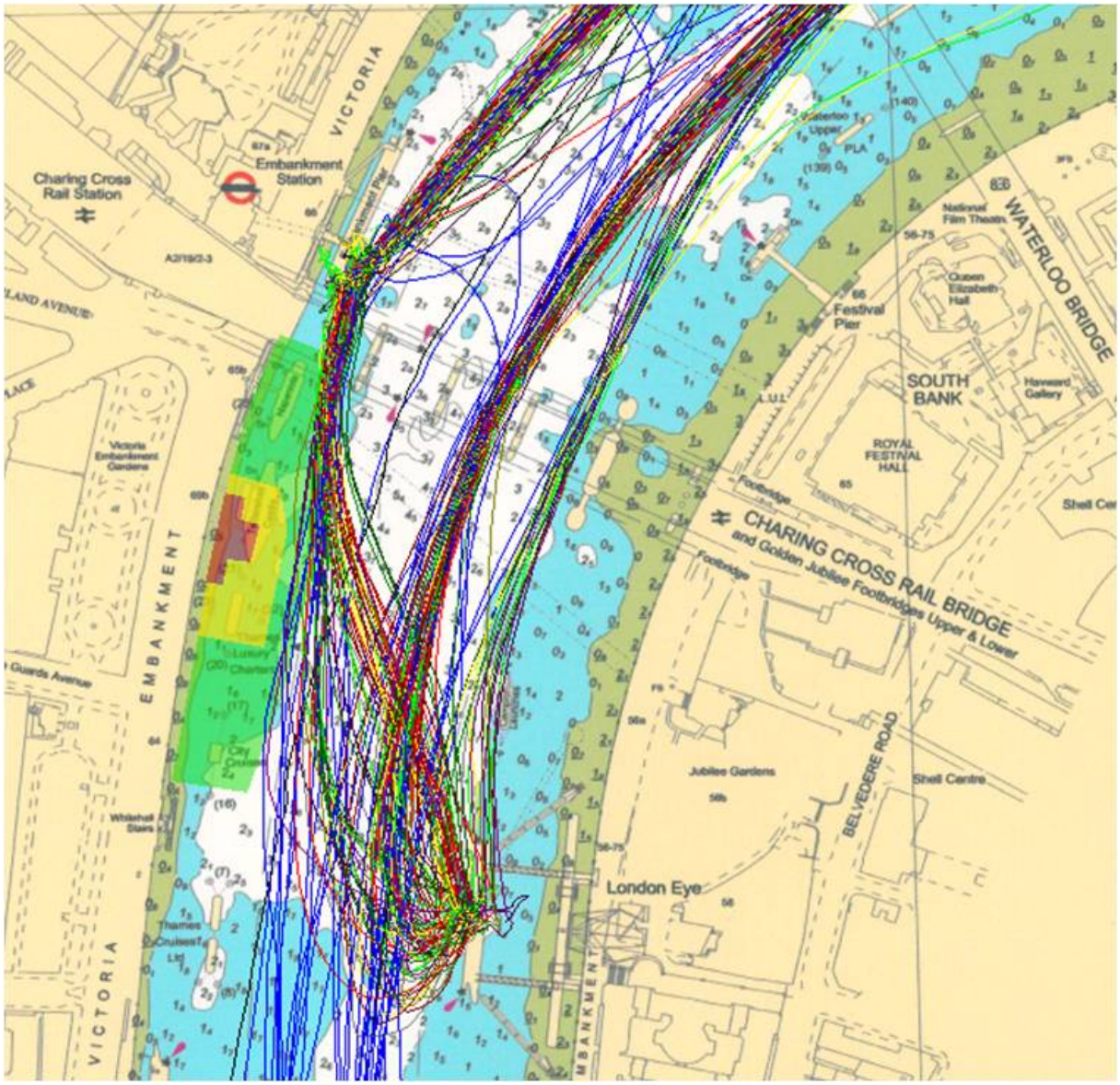
7.3.15 The following figures show the results of recent tracking exercises indicating the distances of Thames Clipper vessels passing the Hispaniola and the site.

Table 7.1 Thames Clipper past the LLAU and proposed cofferdam

Date	Vessel	Total past site	Traverse northern LLAU near Hispaniola	< 5m from LLAU and 25m from cofferdam	<10m from LLAU and 30m from cofferdam	>10m from LLAU and 30m from cofferdam
170712	Monsoon	6	1	1	3	1
170712	Cyclone	6	2	3	1	0
170712	Sky	10	6	2	0	2
170712	Tornado	5	0	1	1	3
180712	Aurora	4	1	1	0	2
180712	Typhoon	6	2	1	3	0
180712	Cyclone	6	0	4	0	2
190712	Monsoon	5	2	0	1	2
190712	Hurricane	5	2	2	0	1
200712	Tornado	4	0	0	2	2
200712	Aurora	5	2	1	1	1
200712	Cyclone	3	3	0	0	0
240712	Tornado	8	2	2	1	3
240712	Cyclone	7	3	1	1	2
240712	Typhoon	8	2	1	2	3
250712	Cyclone	4	1	0	2	1
250712	Tornado	7	5	1	1	0
250712	Meteor	7	3	0	1	3
250712	Typhoon	7	3	0	0	4
270712	Meteor	7	5	1	0	1

Date	Vessel	Total past site	Traverse northern LLAU near Hispaniola	< 5m from LLAU and 25m from cofferdam	<10m from LLAU and 30m from cofferdam	>10m from LLAU and 30m from cofferdam
270712	Cyclone	1	1	0	0	0
270712	Tornado	6	3	0	1	2
	Total	127	49	22	21	35
	%	100%	38%	17%	17%	28%

Figure 7.1 Thames Clipper past the LLAU and proposed cofferdam



7.4 Proximity to authorised channel

7.4.1 The temporary worksite at Victoria Embankment would intrude into the river by approximately 40m, whereas the permanent structure would extend no further than the Tattershall Castle.

7.4.2 Heavy plant and sheet piling machinery would be required to construct the cofferdam; this plant would be located within the LLAU. The boundary of the LLAU is approximately 5m from the northern boundary of the authorised channel.

7.4.3 Freight and larger reporting vessels transit through Charing Cross Rail Bridge arch No3 in both directions and it was determined that they would not be affected by the worksite. The special signal light on Charing Cross Rail Bridge is located above arch No3.

7.4.4 During construction phases A and C, it was determined that the intrusion into the river and proximity to the authorised channel at this location could present a hazard to existing navigation.

Figure 7.2 TheTattershall Castle

Actions required

7.4.5 A number of actions, specific to this issue, have been commenced or completed in order to assist the project to provide a robust, evidence-based assessment to the PLA. These actions include:

a. Conduct analysis of vessel movements through this area.

b. Produce images illustrating Thames Clippers movements through the area, including Thames Clippers departing Embankment Pier.

c. Identify typical river traffic that uses this section of the river and its frequency.

Mitigation of issues: Design

7.4.6 The following measures are embedded in the designs and this assessment only considers the residual risk assuming that these measures are effectively implemented.

a. The design and in-river footprint of the temporary and permanent worksite was minimised as described above.

b. The permanent works would not extend past the existing line of the two permanently moored vessels: the Tattershall Castle and the Hispaniola;

c. Constraints have been placed on the working areas within the river to minimise the duration and extent of obstructions in the river.

7.4.7 The following sections set out the proposed mitigation to address the residual risks.

Mitigation of issues: Physical

a. Assess and understand operating procedures to ensure minimum disruption/interaction with existing users.

b. Schedule barge movements/passage planning and publish planned operations.

Mitigation of issues: River operations

a. Appoint Berthing Co-ordination Manager to liaise and be in communication with all operators in the local area and to be on hand to deal with potential areas of concern/conflict.

b. Issue NTMs informing operators and river users of planned operations in this area and highlighting times when project tugs and tows would likely be operated.

7.5 Arch closures: Charing Cross Rail Bridge

7.5.1 Closure of any of the main working arches (No2 and 3) of Charing Cross Rail Bridge may have an adverse impact on local vessel traffic.

7.5.2 Charing Cross Rail Bridge has five arches and arches No2 and 3 are designated as working arches in the PLA's *Mariners Guide to Bridges on the Tidal Thames*:

a. Arch No2 should be used by inbound traffic to leave arch No3 clear for the larger and reporting vessels.

b. Arch No3 should be used by larger and reporting vessels travelling both up and down stream.

c. Arch No4 should be used by smaller outbound vessels at most stages of the tide.

7.5.3 The arches of Charing Cross Rail Bridge are illustrated in below:

Figure 7.3 Charing Cross Rail Bridge: Proceeding upstream

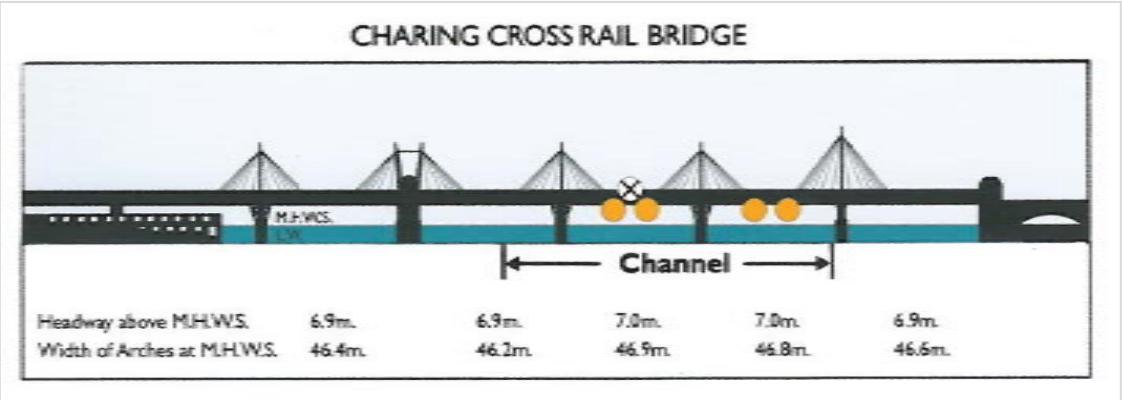
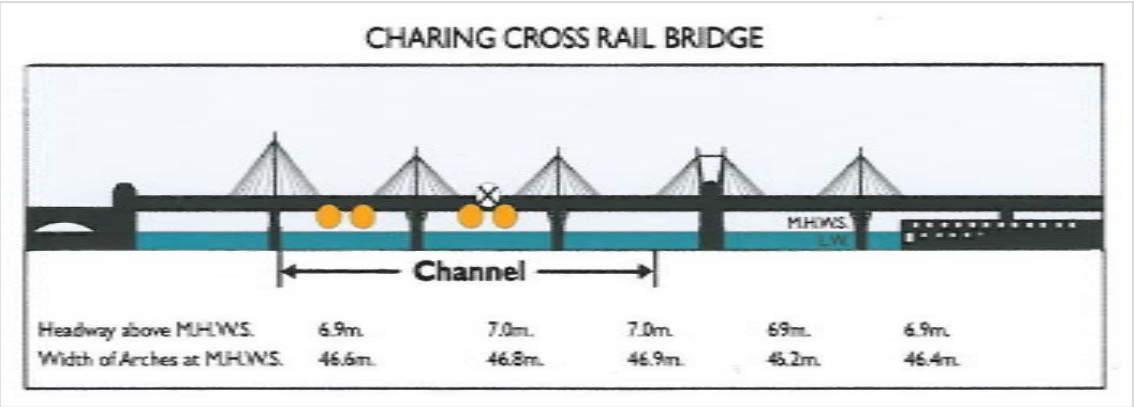


Figure 7.4 Charing Cross Rail Bridge: Proceeding downstream



7.5.4 A requirement to close any of the arches, either for planned or emergency reasons, could have an adverse impact on existing river traffic.

Actions required

7.5.5 A number of actions, specific to this issue, have been commenced or completed in order to assist project to provide a robust, evidence-based assessment to the PLA. These actions include:

a. Analyse vessel movements through Charing Cross Rail Bridge to ascertain the extent to which the project works would impact on an arch closure.

Mitigation of issues: Design

7.5.6 The following measures are embedded in the designs and this assessment considers the residual risk, assuming that these measures are implemented effectively.

a. Planned closure of arch No2 or 3 would not take place during the construction or removal of the temporary cofferdam (Construction phases A and C).

   i General Inspection every two years (this would not require closure of the arch)

   ii Principal Inspection every six years(to be conducted immediately prior to commencing project works).

7.5.7 The following sections set out the proposed mitigation to address the residual risks.

Mitigation of issues: Physical

7.5.8 None identified.

Mitigation of issues: River Operations

a. The project would remove plant and equipment from the river to enable navigation through arch No2 or 3 in the event of an unplanned closure.

b. Safety boats would maintain a continuous VHF watch on Channel 14 in the event of arch No3 closure.

7.6 Relocation of the Tattershall Castle

7.6.1 In order to ensure that the project would have sufficient working area to construct and operate the cofferdam and the temporary worksite, the project proposes temporarily to relocate the Tattershall Castle.

7.6.2 The project proposes to move the Tattershall Castle from its current mooring to a position approximately 130m west along the embankment. On completion of the works, the Tattershall Castle would be returned to a position close to its current mooring.

7.6.3 There are two options for moving the vessel:

a. Option 1: Tow the vessel from its current location to the proposed new location.

b. Option 2: Winch the vessel from its current location to the proposed new location.

7.6.4 Option 2 was determined to be the most feasible

7.6.5 The purpose of this assessment is to provide a high-level overview to the likely issues to review in greater detail once a method statement for moving the Tattershall Castle has been produced. For the purposes of this assessment, relocating the Tattershall Castle was divided into three separate phases:

a. Upgrade existing moorings and the access system for the proposed new location.

b. Option 1: tow the Tattershall Castle to the proposed new location, or Option 2: winch the Tattershall Castle to the proposed new location.

c. Return the Tattershall Castle to a location closer to its current mooring.

Actions required

7.6.6 A number of actions, specific to this issue, have been commenced or completed in order to assist the project to provide a robust, evidence-based assessment to the PLA. These actions include:

a. an independent review of the proposed mooring system at the new location, which would include an assessment of the suitability of mooring system to secure the Tattershall Castle in place given the expected tidal conditions on the River Thames.

b. A structural analysis of the mooring system used to secure the Tattershall Castle onto its new position.

Mitigation of issues: Design

7.6.7 The following measures are embedded in the designs and this assessment considers the residual risk, assuming that these measures are implemented effectively.

a. The proposed new location was set back more than 15m from the northern boundary of the authorised channel. It was therefore determined that it would not adversely impact on existing navigational safety.

7.6.8 The following sections set out the proposed mitigation measures to address the residual risks.

Mitigation of issues: Physical

a. Undertake a structural analysis of the mooring system used to secure the Tattershall Castle into its new position and into its final position once work is complete (assumed to meet the requirements to secure a vessel of this size and weight in the tidal conditions expected on the River Thames).

b. Vessel relocation activities, hazards and operational mitigations are set out in Table 7.2.

Table 7.2 Relocation of the Tattershall Castle

Stage	Main activity	Hazards	Mitigation measures
1	Upgrade moorings and access system for new location.	Same as constructi on of other in–river structures.	Same as construction of other in–river structures
2a	Tow the Tattershall Castle to new location.	Vessel drifts into other traffic.	• Identify a window when moving the vessel would cause least disruption. • Use a reputable marine contractor, fully conversant and experienced in this type of marine operation. • Ensure that the marine contractor has a method statement for moving vessels. • Practice the move to ensure that all stakeholders are aware of the procedures. • Temporarily close bridge arches to navigation. • Issue a temporary NTM to highlight the works in progress in this area. • Arrange an independent assessment of the tow arrangement.
2b	Winch the Tattershall Castle to the new location.	Vessel drifts into other traffic.	• Identify a window when moving the vessel would cause least disruption. • Use a reputable marine contractor, fully conversant and experienced in this type of marine operation. • Ensure that the marine contractor has a method statement for moving vessels. • Practice the move to ensure that all stakeholders are aware of the procedures. • Temporarily close bridge arches to navigation. • Issue a temporary NTM to highlight the works in progress in this area. • Arrange an independent assessment of the winching scheme.

7.7 Increased flow effect on passing vessels: All phases

7.7.1 The shape, location and size of the temporary and permanent structure in the river at the site could lead to an increase in river flow that could have an adverse impact on existing river users.

7.7.2 The project understands that the increase in river flow could be of concern to the PLA due to the effect that it would have on existing passing river traffic. Certain vessel types would likely be more affected than others.

7.7.3 HR Wallingford carried out fluvial modelling of the proposed structures in the river at Victoria Embankment Foreshore.

7.7.4 Analysis of the work carried out by HR Wallingford identified that the introduction of the proposed temporary and permanent structures at this site would have a minimal effect on existing river users. The changes in flow were predicted to be low and the majority of vessels using this area would be likely to be unaffected.

7.7.5 Analysis of the fluvial modelling results established the following:

a. The greatest change in maximum flow for the temporary works across a given cross section in the Victoria Embankment area would be approximately 0.4 knots, which is associated with a peak ebb spring tide with strong river flow (800m^3/s) in line with the bridge. The maximum change in flow is also approximately 0.4 knots adjacent to the widest part of the development.

b. The greatest change in maximum flow for the permanent works across a given cross section in the Victoria Embankment area would be approximately 0.2 knots, which is associated with a peak ebb spring tide with strong river flow (800m^3/s) in line with the bridge. It is also approximately 0.2 knots adjacent to the widest part of the development.

7.7.6 Further fluvial modelling analysis is provided in Appendix B, including a tabulation of the changes in maximum flow for the available tidal and fluvial conditions.

Actions required

7.7.7 One action, specific to this issue, has been undertaken to assist the project to provide a robust, evidence-based assessment to the PLA:

a. Inform the PLA of reports produced to date and clarify the precise extent of the increases in flow (see Appendix B).

Mitigation of issues: Design

7.7.8 The following measures are embedded in the designs and this assessment considers the residual risk, assuming that these measures are implemented effectively.

a. The extent of encroachment of the permanent structure (and therefore the temporary cofferdam) into the river was reduced; the structure was

made longer but narrower following phase two consultation. This would reduce the impact on flows in the river.

b. Grab chains and life-saving equipment would be provided on permanent and temporary structures

7.7.9 The following sections set out the proposed mitigation measures to address the residual risks.

Mitigation of issues: Physical

a. physical and computational modelling of in-river structures

b. analysis of modelling results to determine likely increases/decreases in flow and vessel types most likely to be affected by changes.

Mitigation of issues: River operations

c. none identified.

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8 General navigational hazards

8.1.1 In addition to the navigation issues considered within this report, navigational hazards associated with day-to-day river operations were also identified. These hazards relate to the interaction of project-related marine traffic with existing river users. Full hazard details are provided in Annexes A1 to B3.

8.1.2 'Worst Credible' consequences and the probability of the consequences were considered in the assessment. As a result, in some cases the Worst Credible score was lower than the 'Most Likely' score. This is explained by the probability that a 'moderate injury', for example, is higher than the probability of a 'single fatality'.

8.2 Construction phases A to D: Most likely

Table 8.1 Most likely risk scores

				Score			
Hazard Id	Hazard title	Hazard description	Phase	People	Environment	Operational	Media
1	Emergency arch closure - arch No2 or 3	There may be an emergency requirement to close arch No2 or 3.	A	8	4	6	6
			B	8	4	6	6
			C	8	4	6	6
			D	8	4	6	6
2	Planned arch closure - arch No2 or 3	There may be a requirement to close arch No2 or 3 for maintenance.	A	8	4	6	6
			B	8	4	6	6
			C	8	4	6	6
			D	N/A	N/A	N/A	N/A
3	Planned arch closure - arch No1	During construction/use/deconstruction of the cofferdam, the project proposes to close arch No1 to all navigation.	A	12	6	12	6
			B	12	6	12	6
			C	12	6	12	6
			D	N/A	N/A	N/A	N/A
4	Increase in flow	Changes to the hydrodynamics of the river may affect passing vessels, particularly through the arches of Charing Cross Rail Bridge.	A	9	6	6	9
			B	9	6	6	9
			C	9	6	6	9
			D	9	6	6	9
5	Contact - High	A High Speed Passenger	A	8	4	6	8

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
	Speed Passenger Vessel with worksite	Vessel comes into contact with project's temporary or permanent worksite at Victoria Embankment Foreshore.	B	8	4	6	8
			C	8	4	6	8
			D	9	6	9	12
6	Contact - Class V passenger vessel with worksite	A Class V passenger vessel comes into contact with Project temporary or permanent worksite at Victoria Embankment.	A	8	4	6	8
			B	8	4	6	8
			C	8	4	6	8
			D	9	6	9	12
7	Contact - private leisure vessel with worksite	A private leisure vessel comes into contact with Project temporary or permanent worksite at Victoria Embankment.	A	8	4	6	8
			B	8	4	6	8
			C	8	4	6	8
			D	9	6	9	12
8	Contact - commercial freight operator with worksite	A commercial freight operator comes into contact with Project temporary or permanent worksite at Victoria Embankment.	A	6	4	6	6
			B	6	4	6	6
			C	6	4	6	6
			D	6	4	6	6
9	Contact - tug and tow with worksite	A tug and tow comes into contact with Project temporary or permanent worksite at Victoria Embankment.	A	6	4	6	6
			B	6	4	6	6
			C	6	4	6	6
			D	6	4	6	6
10	Grounding - All vessels due to 'Squat Effect'	At periods of low water, vessels may be affected by the 'Squat Effect', causing them to be closer to the river bed than expected.	A	6	2	6	6
			B	6	2	6	6
			C	6	2	6	6
			D	6	2	6	6
11	Mooring breakout	A vessel involved in project activities breaks free from moorings.	A	6	4	6	4
			B	6	4	6	4
			C	6	4	6	4
			D	N/A	N/A	N/A	N/A
12	Collision - High Speed Passenger Vessel	A vessel conducting project construction/deconstruction activities collides with a High Speed Passenger Vessel (eg, ,	A	6	4	6	8
			B	N/A	N/A	N/A	N/A
			C	6	4	6	8

				Score			
Hazard Id	**Hazard title**	**Hazard description**	**Phase**	**People**	**Environment**	**Operational**	**Media**
	(construction/de construction)	Thames Clipper) in the vicinity of Victoria Embankment.	D	N/A	N/A	N/A	N/A
13	Collision - Class V passenger vessel (construction/de construction)	A vessel conducting project construction/deconstruction activities collides with a Class V passenger vessel in the vicinity of Victoria Embankment.	A	6	4	6	8
			B	N/A	N/A	N/A	N/A
			C	6	4	6	8
			D	N/A	N/A	N/A	N/A
14	Collision - private leisure vessel (construction/de construction)	A vessel conducting project construction/deconstruction activities collides with a private leisure vessel in the vicinity of Victoria Embankment.	A	9	6	9	9
			B	N/A	N/A	N/A	N/A
			C	9	6	9	9
			D	N/A	N/A	N/A	N/A
15	Collision - commercial freight operator (construction/de construction)	A vessel conducting project construction/deconstruction activities collides with a commercial freight operator in the vicinity of Victoria Embankment.	A	6	9	6	9
			B	N/A	N/A	N/A	N/A
			C	6	9	6	9
			D	N/A	N/A	N/A	N/A
16	Collision - tug and tow (construction/de construction)	A vessel conducting project construction/deconstruction activities collides with a tug and tow in the vicinity of Victoria Embankment.	A	6	9	6	9
			B	N/A	N/A	N/A	N/A
			C	6	9	6	9
			D	N/A	N/A	N/A	N/A
17	Contact with Hungerford Bridge (construction/de construction)	A vessel conducting project construction/deconstruction activities makes contact with Hungerford Bridge, including arches, abutments and any associated bridge superstructure.	A	6	9	6	9
			B	N/A	N/A	N/A	N/A
			C	6	3	6	6
			D	N/A	N/A	N/A	N/A
18	Collision - High Speed Passenger Vessel (delivery/materia l removal)	A vessel conducting project delivery/material removal activities collides with a High Speed Passenger Vessel (eg, Thames Clipper) in the vicinity of Victoria Embankment	A	N/A	N/A	N/A	N/A
			B	6	4	6	8
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
19	Collision - Class V passenger vessel (delivery/materia	A vessel conducting project delivery/material removal activities collides with a Class V passenger vessel in the	A	N/A	N/A	N/A	N/A
			B	6	4	6	8
			C	N/A	N/A	N/A	N/A

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
	l removal)	vicinity of Victoria Embankment.	D	N/A	N/A	N/A	N/A
20	Collision - private leisure vessel (delivery/materia l removal)	A vessel conducting project delivery/material removal activities collides with a private leisure vessel in the vicinity of Victoria Embankment.	A	N/A	N/A	N/A	N/A
			B	9	6	9	9
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
21	Collision - commercial freight operator (delivery/materia l removal)	A vessel conducting project delivery/material removal activities collides with a commercial freight operator in the vicinity of Victoria Embankment.	A	N/A	N/A	N/A	N/A
			B	6	9	6	9
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
22	Collision - tug and tow (delivery/materia l removal)	A vessel conducting project delivery/material removal activities collides with a tug and tow in the vicinity of Victoria Embankment.	A	N/A	N/A	N/A	N/A
			B	6	9	6	9
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
23	Contact with Charing Cross Rail Bridge (delivery/materia l removal)	A vessel conducting project delivery/material removal activities makes contact with Hungerford Bridge, including arches, abutments and any associated bridge superstructure.	A	N/A	N/A	N/A	N/A
			B	6	3	6	6
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A

8.3 Construction phases A to D: Worst credible

Table 8.2 Worst credible risk scores

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
1	Emergency Arch closure - arch No2 or 3	There may be an emergency requirement to close arch No2 or 3.	A	5	3	4	4
			B	5	3	4	4
			C	5	3	4	4

Table 8.2 Worst credible risk scores

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
			D	5	3	4	4
2	Planned arch closure - arch No2 or 3	There may be a requirement to close arch No2 or 3 for maintenance.	A	5	3	4	4
			B	5	3	4	4
			C	5	3	4	4
			D	N/A	N/A	N/A	N/A
3	Planned Arch closure - arch No1	During construction/use/deconstruction of the cofferdam it is proposed that arch No1 is closed to all navigation.	A	10	6	10	6
			B	10	6	10	6
			C	10	6	10	6
			D	N/A	N/A	N/A	N/A
4	Increase in flow	Changes to the hydrodynamics of the river may affect passing vessels, particularly through the arches of Charing Cross Rail Bridge.	A	12	9	9	12
			B	12	9	9	12
			C	12	9	9	12
			D	12	9	9	12
5	Contact - High Speed Passenger Vessel with worksite	A High Speed Passenger Vessel comes into contact with the project's temporary or permanent worksite at Victoria Embankment.	A	10	6	8	10
			B	10	6	8	10
			C	10	6	8	10
			D	10	6	8	10
6	Contact - Class V passenger vessel with worksite	A Class V passenger vessel comes into contact with the project's temporary or permanent worksite at Victoria Embankment.	A	10	6	8	10
			B	10	6	8	10
			C	10	6	8	10
			D	10	6	8	10
7	Contact - private leisure vessel with worksite	A private leisure vessel comes into contact with the project's temporary or permanent worksite at Victoria Embankment.	A	10	6	8	8
			B	10	6	8	8
			C	10	6	8	8
			D	10	6	8	8
8	Contact - commercial freight operator with worksite	A commercial freight operator comes into contact with the project's temporary or permanent worksite at Victoria Embankment.	A	8	6	8	6
			B	8	6	8	6
			C	8	6	8	6
			D	8	6	8	6
9	Contact - tug and	A tug and tow comes into	A	8	6	8	6

Table 8.2 Worst credible risk scores

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
	tow with worksite	contact with the project's temporary or permanent worksite at Victoria Embankment.	B	8	6	8	6
			C	8	6	8	6
			D	8	6	8	6
10	Grounding - All vessels due to 'Squat Effect'	At periods of low water, vessels may be affected by the 'Squat Effect', causing them to be closer to the river bed than expected.	A	8	4	8	8
			B	8	4	8	8
			C	8	4	8	8
			D	8	4	8	8
11	Mooring breakout	A vessel involved in project activities breaks free from moorings.	A	8	6	8	6
			B	8	6	8	6
			C	8	6	8	6
			D	N/A	N/A	N/A	N/A
12	Collision - High Speed Passenger Vessel (construction/deconstruction)	A vessel conducting project construction/deconstruction activities collides with a High Speed Passenger Vessel (eg, Thames Clipper) in the vicinity of Victoria Embankment	A	6	4	6	8
			B	N/A	N/A	N/A	N/A
			C	6	4	6	8
			D	N/A	N/A	N/A	N/A
13	Collision - Class V passenger vessel (construction/deconstruction)	A vessel conducting project construction/deconstruction activities collides with a Class V passenger vessel in the vicinity of Victoria Embankment.	A	6	4	6	8
			B	N/A	N/A	N/A	N/A
			C	8	4	6	8
			D	N/A	N/A	N/A	N/A
14	Collision - private leisure vessel (construction/deconstruction)	A vessel conducting project construction/deconstruction activities collides with a private leisure vessel in the vicinity of Victoria Embankment.	A	8	6	8	8
			B	N/A	N/A	N/A	N/A
			C	8	6	8	8
			D	N/A	N/A	N/A	N/A
15	Collision - commercial freight operator (construction/deconstruction)	A vessel conducting project construction/deconstruction activities collides with a commercial freight operator in the vicinity of Victoria Embankment.	A	9	12	9	9
			B	N/A	N/A	N/A	N/A
			C	9	12	6	6
			D	N/A	N/A	N/A	N/A
16	Collision - tug and tow	A vessel conducting project construction/deconstruction	A	9	12	9	9
			B	N/A	N/A	N/A	N/A

Table 8.2 Worst credible risk scores

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
	(construction/deconstruction)	activities collides with a tug and tow in the vicinity of Victoria Embankment.	C	9	12	9	9
			D	N/A	N/A	N/A	N/A
17	Contact with Charing Cross Rail Bridge (construction/deconstruction)	A vessel conducting project construction/deconstruction activities makes contact with Hungerford Bridge, including arches, abutments and any associated bridge superstructure.	A	9	6	9	9
			B	N/A	N/A	N/A	N/A
			C	9	6	9	9
			D	N/A	N/A	N/A	N/A
18	Collision - High Speed Passenger Vessel (delivery/material removal)	A vessel conducting project delivery/material removal activities collides with a High Speed Passenger Vessel (eg, Thames Clipper) in the vicinity of Victoria Embankment	A	N/A	N/A	N/A	N/A
			B	6	4	6	8
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
19	Collision - Class V passenger vessel (delivery/material removal)	A vessel conducting project delivery/material removal activities collides with a Class V passenger vessel in the vicinity of Victoria Embankment.	A	N/A	N/A	N/A	N/A
			B	6	4	6	8
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
20	Collision - private leisure vessel (delivery/material removal)	A vessel conducting project delivery/material removal activities collides with a private leisure vessel in the vicinity of Victoria Embankment.	A	N/A	N/A	N/A	N/A
			B	8	6	8	8
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
21	Collision - commercial freight operator (delivery/material removal)	A vessel conducting project delivery/material removal activities collides with a commercial freight operator in the vicinity of Victoria Embankment.	A	N/A	N/A	N/A	N/A
			B	9	12	9	9
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
22	Collision - tug and tow (delivery/material removal)	A vessel conducting project delivery/material removal activities collides with a tug and tow in the vicinity of Victoria Embankment.	A	N/A	N/A	N/A	N/A
			B	9	12	9	9
			C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A
23	Contact with Charing Cross	A vessel conducting project delivery/material removal	A	N/A	N/A	N/A	N/A
			B	9	6	9	9

Table 8.2 Worst credible risk scores

Hazard Id	Hazard title	Hazard description	Phase	Score			
				People	Environment	Operational	Media
	Rail Bridge (delivery/material removal)	activities makes contact with Hungerford Bridge, including arches, abutments and any associated bridge superstructure.	C	N/A	N/A	N/A	N/A
			D	N/A	N/A	N/A	N/A

9 Mitigation measures

9.1 Existing mitigation

9.1.1 Existing safeguards (measures that manage risk)in the form of control measures and relevant PLA guidance are set out in Table 9.1 together with any additional controls deemed desirable or necessary to reduce risk to a level that is ALARP. The risk is assessed taking account of the impact of these various safeguards and controls.

Table 9.1 Mitigation measures within the project's control

Boat Masters License	Vessel Master Experience
MCA - MGN 199 (M) Dangers of Interaction	Permanent/Temporary Notice to Mariners
Aids to Navigation	Passage Planning
Safe Systems of Work	Tug Operator Procedures
Contractors Risk Assessment	BML Local Knowledge Endorsement
River Bylaws	General Directions
VTS Qualification	VHF Communications
Bridge Special Signal Lights	Ship Towage Code of Practice
VTS Navigational Broadcast	Emergency Plans and Procedures
Thames AIS	Oil Spill Contingency Plan
PLA Bridge Guide	Maintenance/Inspection routines
Admiralty Charts	COLREGs
Tide Gauges	Qualified Crew
Tide Tables	Barge Operators daily check lists
Accurate Tidal Information	High Speed Craft Code

9.1.2 The above list is not exhaustive but was used to highlight the measures that are most relevant to project operations.

9.2 Proposed mitigation

9.2.1 The proposed risk reduction/mitigation measures were divided into three categories: design, physical and river operations. This is to provide the PLA with assurance that the measures proposed throughout this assessment , have regard to the project's responsibility to reduce risk rather than focussing on local authorities' and existing river users' responsibilities.

9.3 Design

9.3.1 The following measures are embedded in the designs and this assessment therefore only assesses the residual risk assuming the effective implementation of these measures:

a. The project minimised the footprint of the temporary works and the encroachment into the channel of the River Thames to avoid impacts on navigation through arches No2 and 3.

b. The permanent works would be set back from the existing line of the two permanently moored vessels: the Tattershall Castle and the Hispaniola, which could enable co-ordinated vessel movements through arch No1.

c. Constraints have been placed on the working areas within the river to minimise the duration and extent of obstructions into the river and to minimise the duration of a potential, short-term closure of arch No1 to through traffic.

d. Any planned closure of arch No.2 or 3 would not take place during the construction or removal of the temporary cofferdam (construction phases A and C);

    i General Inspection every two years (which would not require closure of the arch)

    ii Principal Inspection on every six years (which would be conducted immediately prior to commencing project works.

e. The proposed new location of the Tattershall Castle would be set back more than 15m from the northern boundary of the authorised channel and therefore would not adversely impact on navigational safety.

f. Grab chains and life-saving equipment would be provided on permanent and temporary structures

9.3.2 The following sections set out the proposed mitigation to address the residual risks.

9.4 Physical

a. Assess and understand operating procedures to ensure minimum disruption/interaction with existing users.

b. Meet with Cory, Thames Clippers, Bateaux London and RIBs to seek their views and input into interaction issues and possible working relationships.

c. Undertake a structural analysis of the mooring system used to secure the Tattershall Castle into its new position and its final position once works are complete (assumed to meet the requirements to secure a vessel of this size and weight in the tidal conditions expected on the River Thames.

d. Schedule barge movements/passage planning and publish planned operations.

e. Physical and computational modelling of in river structures and subsequent analysis of modelling results to determine likely increases/decreases in flow and vessel types most likely to be affected by changes.

f. Undertake a structural analysis of the mooring system used to secure the Tattershall Castle into its new position and into its final position once work is complete (assumed to meet the requirements to secure a vessel of this size and weight in the tidal conditions expected on the River Thames).

g. Undertake analysis of modelling results to determine likely increases/decreases in flow and vessel types most likely to be affected by changes.

9.5 River operations

a. Appoint Berthing Co-ordination Manager to: liaise and be in communication with all operators in the local area and be on hand to deal with potential areas of concern/conflict.

b. Issue Notices to Mariners informing operators and river users of planned operations in area, highlighting times when project barges would likely be servicing the site.

c. Restrict the types of vessels able to use arch No1 during construction activities and at certain stages of the tide, for example:

   i Limit the use of arch No1 to Thames Clippers only.

   ii Reduce speed through arch No1.

d. The project would remove plant and equipment from the river to enable navigation through arch No2 or 3 in the event of an unplanned closure.

e. Safety boats would maintain a continuous VHF watch on Channel 14 in the event of arch No3 closure.

Table 9.2 Mitigation measures within the project's control

Procedural	Informational	Qualifications/ Personnel	Guidance/ Publications	Site-Specific
Safe systems of work	Sound warnings	Berth master (term to be defined)	Temporary Notice to Mariners	Grab chains
Contractors risk assessment	Light warnings	Qualifications/ Competence of on site personnel	Permanent Notice to Mariners	Fendering
Site working practises	Anemometer at site			Impact protection - temporary works
Scheduling of barge movements to assist with existing river events				Impact protection - permanent works
				New tide gauges/markers

10 Conclusion

10.1 Assessment

10.1.1 This *Navigation Issues and Preliminary Risk Assessment* assessed the potential impact of the proposed project works at Victoria Embankment Foreshore on existing river users.

10.1.2 The project's approach to this assessment comprised stakeholder engagement, analysis of AIS data, observation of current river operations including a desktop review of hazards, and development of potential mitigation measures.

10.1.3 The risk assessment criteria, assessment matrix, terminology and risk classification were provided by the PLA. The assessment also follows the Formal Safety Assessment (FSA) methodology including:

a. stakeholder consultation

b. identification of hazards

c. hazard analysis.

10.1.4 The permanent structure would be set back from the authorised channel, behind the current line of the Tattershall Castle and the Hispaniola. Therefore it was determined that the structure would not present an additional navigational hazard.

10.1.5 During construction of the cofferdam there would be a requirement to place construction plant within 5m of the authorised channel, which may introduce navigational hazards that would require mitigation.

10.2 Stakeholder engagement

10.2.1 A number of issues were identified throughout the risk assessment process, including:

a. interaction with existing river users

b. interaction with users of Embankment Pier

c. intrusion into the River Thames(proximity to the authorised channel)

d. relocation of the Tattershall Castle

e. changes in river flow.

10.3 Risk analysis

10.3.1 Hazards at various stages of the project were assessed and scored using the risk matrix and scorecard provided by the PLA and in terms of 'Most Likely' and 'Worst Credible' scenarios.

10.3.2 The annexes provide full detail of the hazards identified and their overall scores. The analysis is summarised below in Table 10.1 and Table 10.2.

Table 10.1 Most Likely analysis

Most Likely	Phase A	Phase B	Phase C	Phase D
Extreme: Intolerable risk. Job is not authorised	0	0	0	0
High: Efforts should be made to reduce risk to ALARP level. Job can only be performed after authorisation from Harbour Master and after further additional controls required under the circumstances.	2	2	2	3
Moderate: Efforts should be made to reduce risk to ALARP level. Job can be performed under direct supervision of Senior Officer.	54	53	53	25
Minor: No additional controls are required, monitoring is required to ensure no changes in circumstances.	11	12	12	3
Slight: No action is required.	1	1	1	1

Table 10.2 Worst Credible analysis

Worst Credible	Phase A	Phase B	Phase C	Phase D
Extreme: Intolerable risk. Job is not authorised	0	0	0	0
High: Efforts should be made to reduce risk to ALARP level. Job can only be performed after authorisation from Harbour Master and after further additional controls required under the circumstances.	11	11	11	7
Moderate: Efforts should be made to reduce risk to ALARP level. Job can be performed under direct supervision of Senior Officer.	48	48	48	21
Minor: No additional controls are required, monitoring is required to ensure no changes in circumstances.	9	9	9	4
Slight: No action is required.	0	0	0	0

10.3.3 Most of the hazards (within the Most Likely assessment) fell within the 'moderate risk' category, requiring efforts to be made to reduce the risk to ALARP level.

10.3.4 For 'Worst Credible' scenarios, the majority of hazards fell within the 'moderate risk' category, and a number fell within the 'high risk' category, indicating that the work could only be performed after authorisation from the Harbour Master.

10.4 Overall

10.4.1 It is widely acknowledged that the Central London section of the River Thames is one of the busiest sections and a diverse range of vessels currently operates through it. The PLA is particularly concerned about navigational safety in this area and considers it one of the most hazardous within its area of responsibility.

10.4.2 The proposed project works would introduce additional freight movements and in-river infrastructure to a location in close proximity to a major bridge, a frequently-used passenger pier and two permanently moored vessels.

10.4.3 The navigational issues were summarised as follows:

a. interaction with existing river users

b. interaction with users of Embankment Pier

c. intrusion into river (proximity to the authorised channel)

d. relocation of the Tattershall Castle

e. changes in river flow.

10.4.4 This report sought to provide an independent, evidence-based assessment of current river operations and the likely impact that project operations would have on existing river users.

The overall responsibility for safety on the River Thames lies with the Port of London Authority, which needs to determine whether the issues and hazards set out in this report present a ‘tolerable’ navigational risk.

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11 Recommendations

11.1 General

11.1.1 The project recommends implementing the mitigation measures set out in Section 7. Additionally, the below should be given consideration:

11.1.2 **Construction methodology**: It was determined that the period during which plant and equipment, such as jack-up barges, would be in close proximity to the authorised channel would present the greatest hazard, both to construction workers and other river users.

11.1.3 **Marine Logistics Manager:** Network Rail's major works at Blackfriars Bridge were highlighted as an example of how the river can be used for large scale civil engineering projects over an extended time period. Dedicated marine logistic managers and experienced marine staff are employed on this project to ensure that project and navigational safety requirements are met. The project recommends taking lessons learnt and best working practices from similar projects and implementing them for this project.

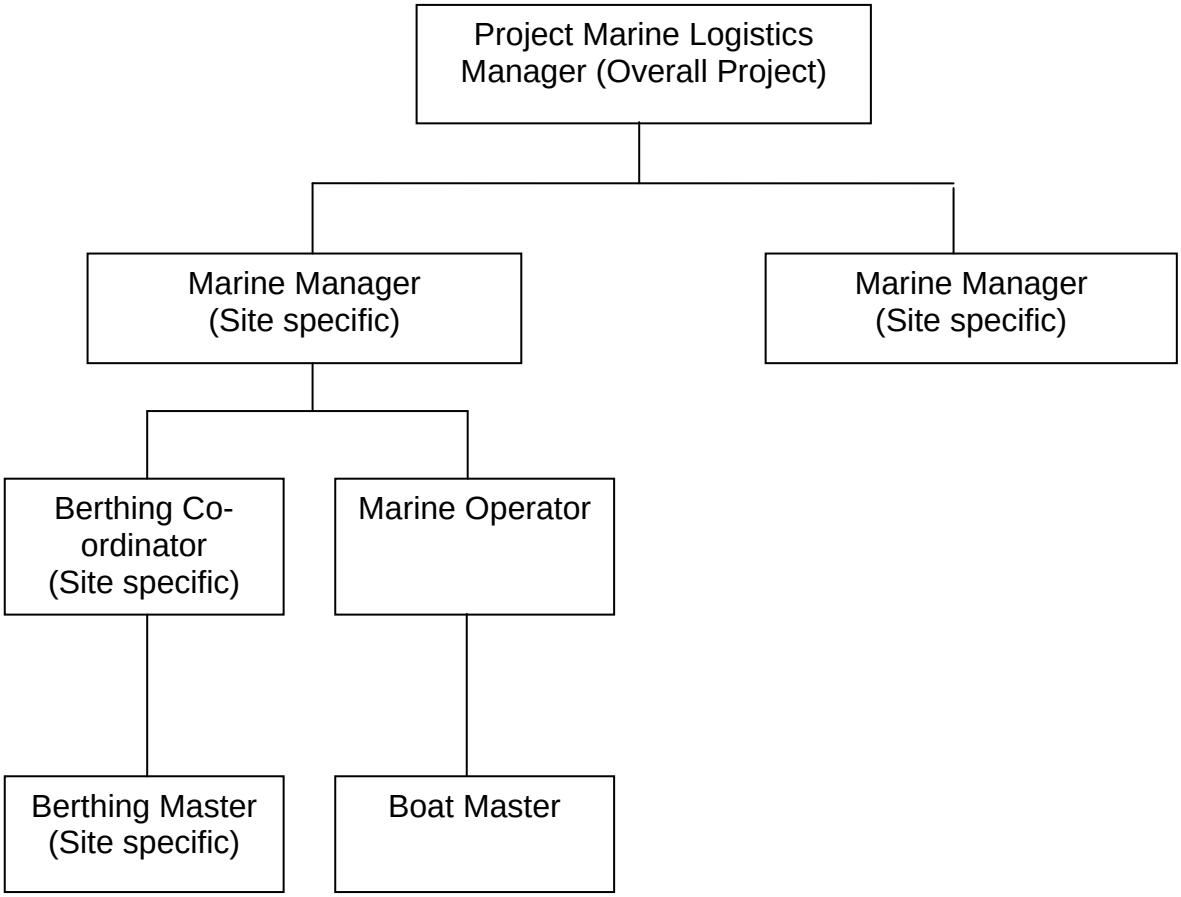
11.1.4 **Berthing Co-ordinator:** The project recommends appointing a Berthing Co-ordinator to communicate with all commercial operators in order to facilitate safe berthing and departures from berths in close proximity to project operations. The co-ordinator would co-ordinate departures so that all freight operators, including project barges, could depart on time without adversely impacting on navigation on the tidal Thames.

11.1.5 The project recommends considering the designated Berthing Co-ordinator's authority and responsibilities. One responsibility of the Berth Co-ordinator would be to liaise regularly with the PLA and local stakeholders. Clear lines of delegation and responsibilities would need to be established prior to commencing project works to ensure that potential conflict of interest issues would be managed and to prevent confusion to mariners and authorities regarding various traffic control systems.

11.1.6 Overall safety on the river is the PLA's responsibility; the Thames Barrier Navigation Centre assists the PLA by managing and directing traffic from Crayfordness to Teddington Lock.

11.1.7 **Further consultation**: The project recommends undertaking further consultation with the owners and operators of Embankment Millennium Pier, Thames Clippers, Bateaux London and Thames RIB Experience.

Figure 11.1 Potential marine logistics hierarchy



Abbreviations

AIS	Automatic Identification System
ALARP	As low as reasonably practicable
CSO	Combined sewer overflow
LLAU	Limits of land to be acquired or used
NtM	Notice to Mariners
PLA	Port of London Authority

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Appendices

List of appendices in order

Appendix A: Project drawings

Appendix B: HR Wallingford analysis

Appendix C: Freight tracks and AIS analysis

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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Navigational Issues and Preliminary Risk Assessment

Doc Ref: **7.20.09**

Victoria Embankment Foreshore

Appendix A

APFP Regulations 2009: Regulation **5(2)(q)**

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January 2013

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Appendix A: Project drawings

Drawing title	Phase
Construction phases - Site set-up	Phase A
Construction phases - Shaft construction and tunnelling	Phase B
Construction phases - Construction of other structures	Phase B
Construction phases - Site demobilisation	Phase C
Permanent works layout	Phase D
River foreshore zones of working	

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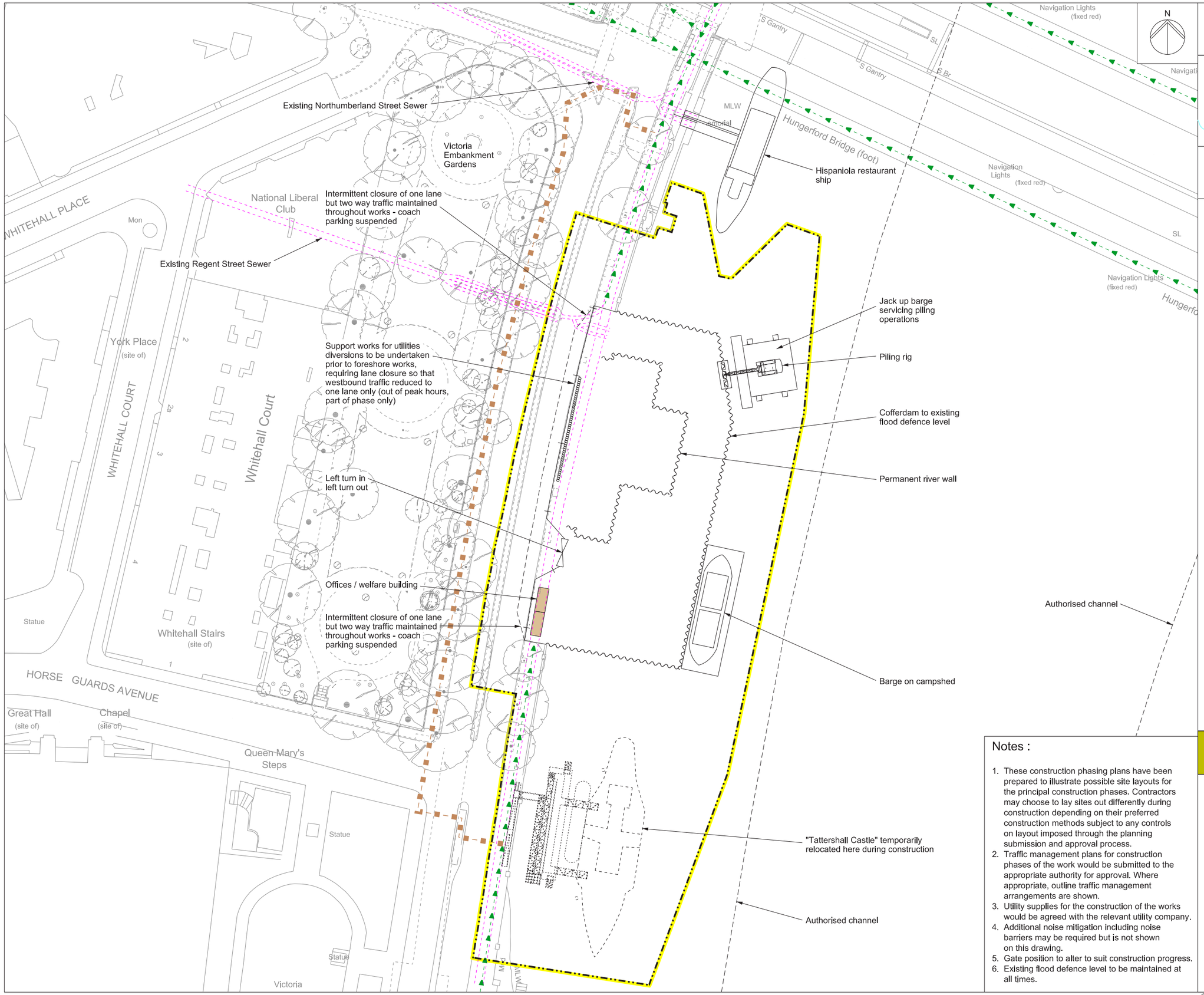

Keyplan:
This drawing

Coordinates are to be Ordance Survey Datum OSGB36. All levels are in metres and relate to the Tunnel Datum which is 100 metres below Ordnance Datum Newlyn.

Key:

- Limits of land to be acquired or used (LLAU)
- Hoarding
- Maximum extent of working area
- Existing public right of way
- Route of temporary diversion of right of way
- Site access
- Existing sewers
- Sheet piles
- Secant piles installed

10m 0 40m

Scale 1:500 at A1
1:1000 if reproduced at A3

Notes :

1. These construction phasing plans have been prepared to illustrate possible site layouts for the principal construction phases. Contractors may choose to lay sites out differently during construction depending on their preferred construction methods subject to any controls on layout imposed through the planning submission and approval process.
2. Traffic management plans for construction phases of the work would be submitted to the appropriate authority for approval. Where appropriate, outline traffic management arrangements are shown.
3. Utility supplies for the construction of the works would be agreed with the relevant utility company.
4. Additional noise mitigation including noise barriers may be required but is not shown on this drawing.
5. Gate position to alter to suit construction progress.
6. Existing flood defence level to be maintained at all times.

ILLUSTRATIVE

Location
VIctorla Embankment Foreshore
City of Westminster

Document Information
Application for Development Consent

Construction phases - phase 1
Site setup
Book of plans - section 18

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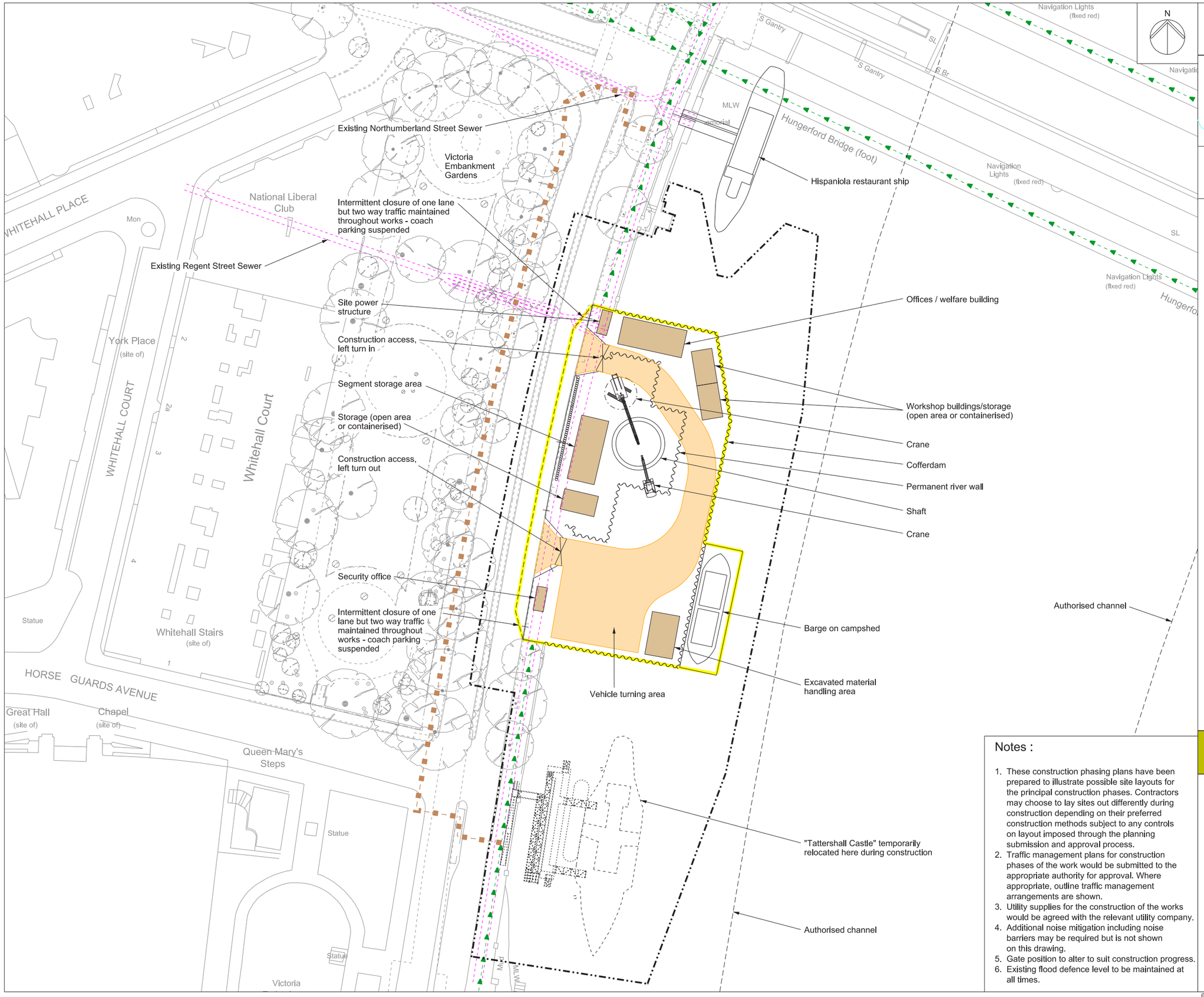
Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Thames Water



Keyplan:
This drawing

Coordinates are to be Ordance Survey Datum OSGB36. All levels are in metres and relate to the Tunnel Datum which is 100 metres below Ordnance Datum Newlyn.

Key:

- Limits of land to be acquired or used (LLAU)
- Hoarding
- Maximum extent of working area
- Existing public right of way
- Route of temporary diversion of right of way
- Site access
- Access / haul route
- Existing sewers
- Sheet piles
- Secant piles installed

Notes :

1. These construction phasing plans have been prepared to illustrate possible site layouts for the principal construction phases. Contractors may choose to lay sites out differently during construction depending on their preferred construction methods subject to any controls on layout imposed through the planning submission and approval process.
2. Traffic management plans for construction phases of the work would be submitted to the appropriate authority for approval. Where appropriate, outline traffic management arrangements are shown.
3. Utility supplies for the construction of the works would be agreed with the relevant utility company.
4. Additional noise mitigation including noise barriers may be required but is not shown on this drawing.
5. Gate position to alter to suit construction progress.
6. Existing flood defence level to be maintained at all times.

ILLUSTRATIVE

Location
VIctorla Embankment Foreshore
City of Westminster

Document Information
Application for Development Consent

Construction phases - phase 2
Shaft construction and tunnelling
Book of plans - section 18

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January 2013

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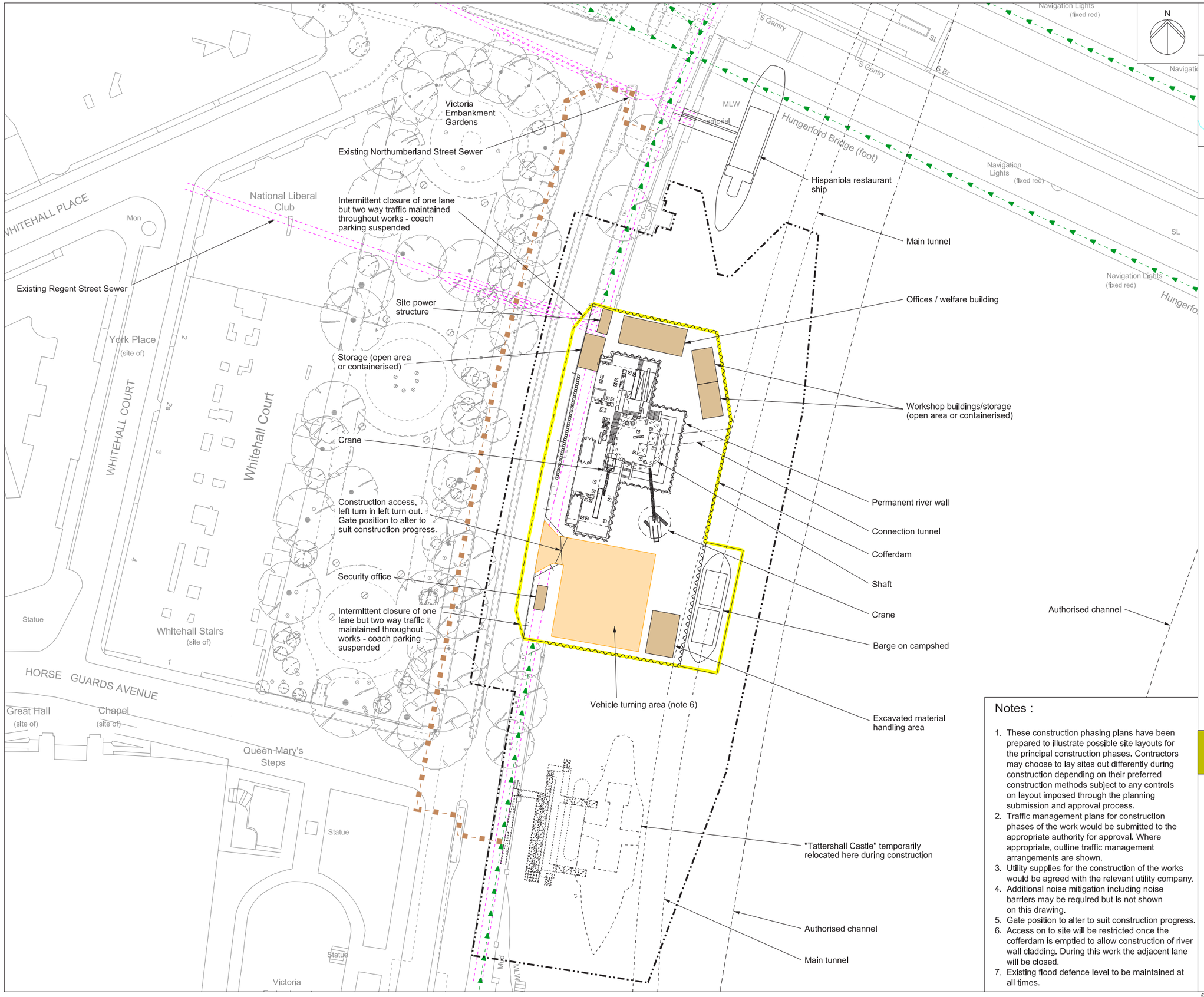
Thames Water



N

Keyplan:
This drawing

Coordinates are to be Ordance Survey Datum OSGB36. All levels are in metres and relate to the Tunnel Datum which is 100 metres below Ordnance Datum Newlyn.

Key:

- Limits of land to be acquired or used (LLAU)
- Hoarding
- Maximum extent of working area
- Existing public right of way
- Route of temporary diversion of right of way
- Site access
- Access / haul route
- Existing sewers
- Sheet piles
- Secant piles installed

10m 0 40m

Scale 1:500 at A1
1:1000 if reproduced at A3

Notes :

1. These construction phasing plans have been prepared to illustrate possible site layouts for the principal construction phases. Contractors may choose to lay sites out differently during construction depending on their preferred construction methods subject to any controls on layout imposed through the planning submission and approval process.
2. Traffic management plans for construction phases of the work would be submitted to the appropriate authority for approval. Where appropriate, outline traffic management arrangements are shown.
3. Utility supplies for the construction of the works would be agreed with the relevant utility company.
4. Additional noise mitigation including noise barriers may be required but is not shown on this drawing.
5. Gate position to alter to suit construction progress.
6. Access on to site will be restricted once the cofferdam is emptied to allow construction of river wall cladding. During this work the adjacent lane will be closed.
7. Existing flood defence level to be maintained at all times.

ILLUSTRATIVE

Location
Victoria Embankment Foreshore
City of Westminster

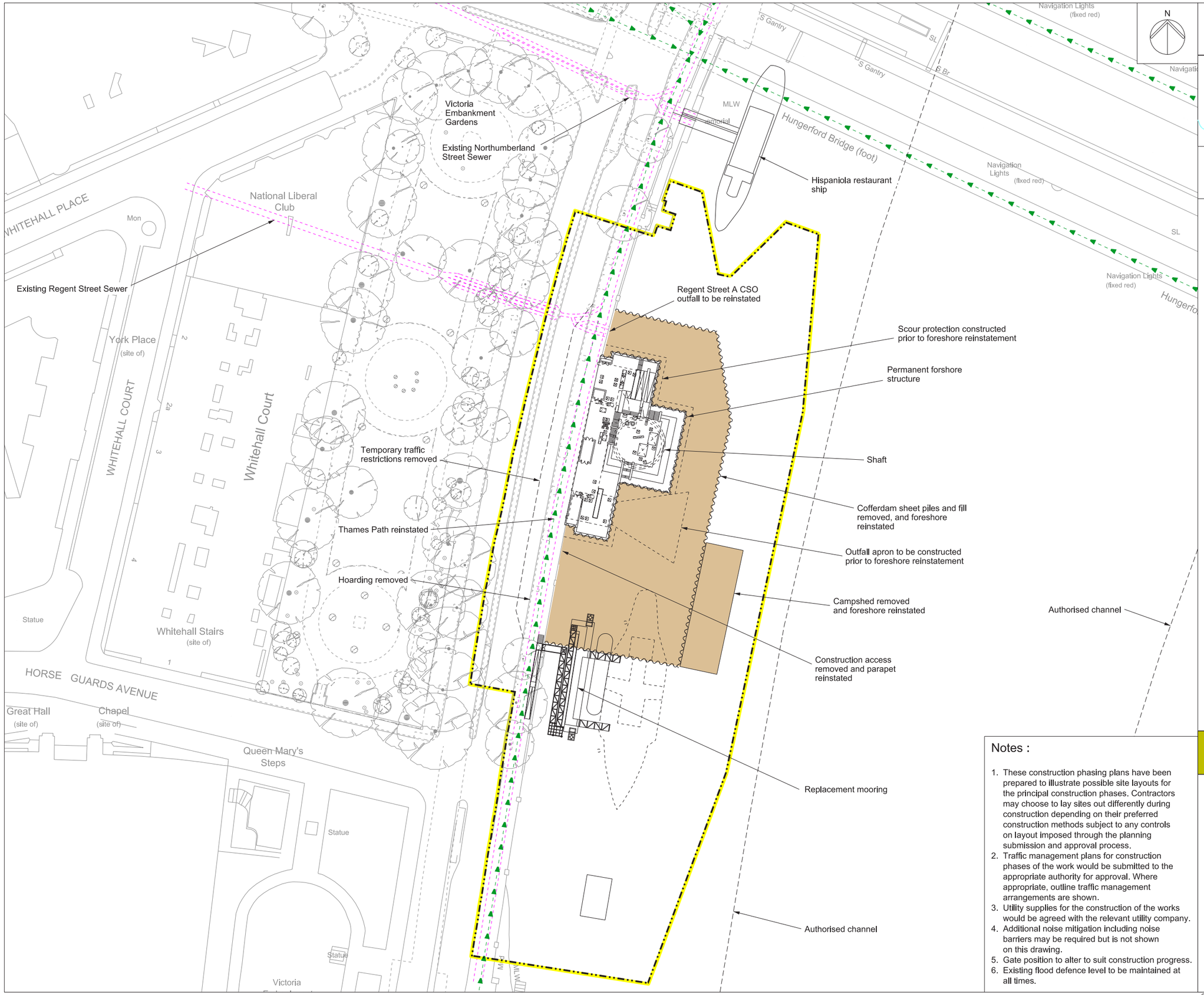
Document Information
Application for Development Consent

Construction phases - phase 3
Construction of other structures
Book of plans - section 18

DCO-PP-16X-VCTEF-180030
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Thames Water



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Keyplan:
This drawing

Coordinates are to be Ordance Survey Datum OSGB36. All levels are in metres and relate to the Tunnel Datum which is 100 metres below Ordnance Datum Newlyn.

Key:

- Limits of land to be acquired or used (LLAU)
- Maximum extent of working area
- Existing public right of way
- Existing sewers
- Sheet piles

10m 0 40m

Scale 1:500 at A1
1:1000 if reproduced at A3

Notes :

1. These construction phasing plans have been prepared to illustrate possible site layouts for the principal construction phases. Contractors may choose to lay sites out differently during construction depending on their preferred construction methods subject to any controls on layout imposed through the planning submission and approval process.
2. Traffic management plans for construction phases of the work would be submitted to the appropriate authority for approval. Where appropriate, outline traffic management arrangements are shown.
3. Utility supplies for the construction of the works would be agreed with the relevant utility company.
4. Additional noise mitigation including noise barriers may be required but is not shown on this drawing.
5. Gate position to alter to suit construction progress.
6. Existing flood defence level to be maintained at all times.

ILLUSTRATIVE

Location
VIctorla Embankment Foreshore
City of Westminster

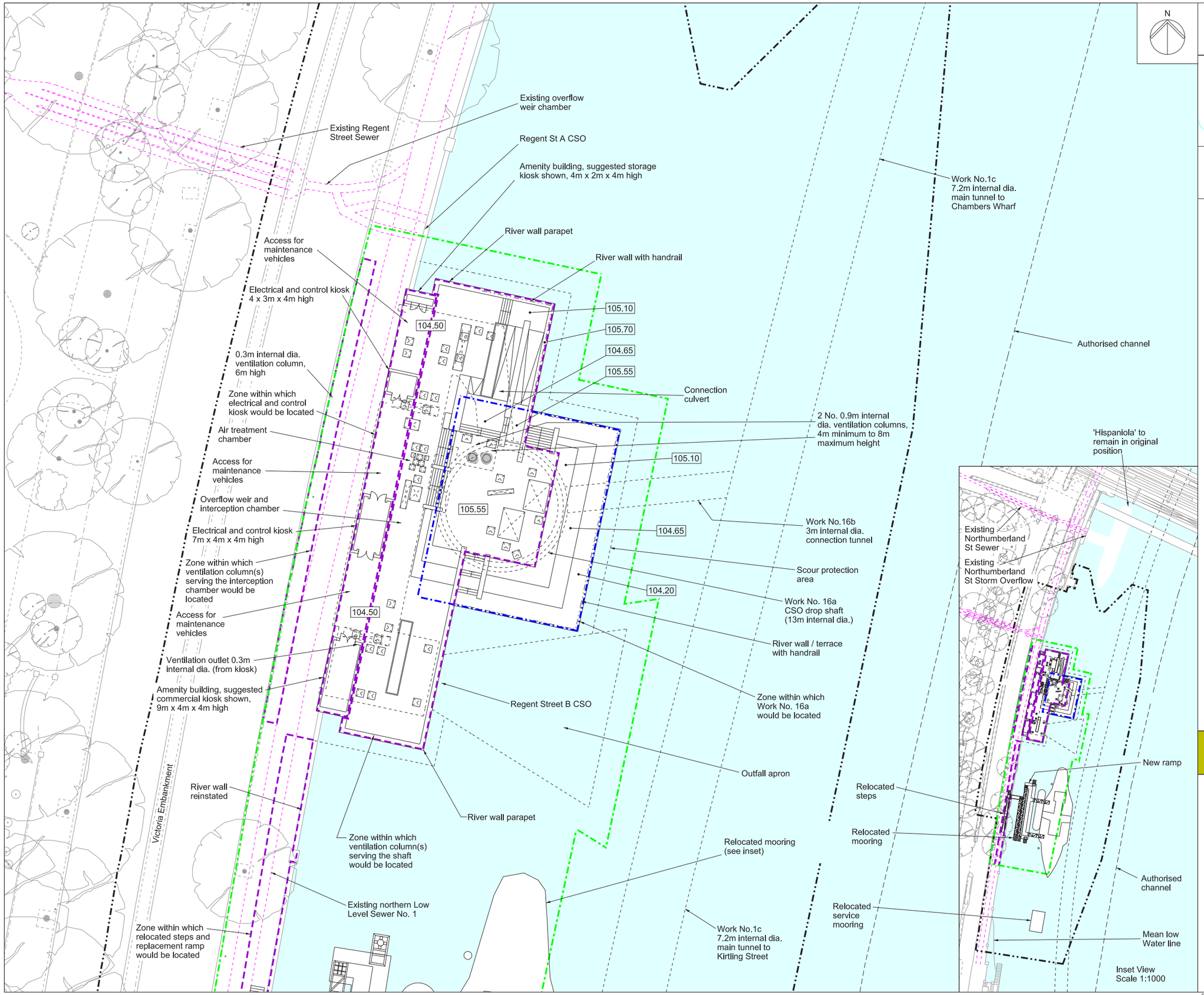
Document Information
Application for Development Consent

Construction phases - phase 4
Site demobilisation
Book of plans - section 18

DCO-PP-16X-VCTEF-180031
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Thames Water



Keyplan:

Coordinates are to be Ordance Survey Datum OSGB36. All levels are in metres and relate to the Tunnel Datum which is 100 metres below Ordnance Datum Newlyn.

Key:

- Limits of land to be acquired or used (LLAU)
- Existing sewers
- Proposed access cover
- 104.50 — Proposed level (shown in metres above tunnel datum)
- Zone within which all permanent site structures would be located
- Zone within which the shaft would be located
- Zone within which permanent above ground structures would be located

Notes:

1. All dimensions and levels are approximate.
2. Any discrepancy between the location of structures and the parameters marked on the drawings are due to differences between the Ordnance Survey base and topographical survey base, both of which have been used in the preparation of this drawing.
3. This drawing shows permanent site structures only. Landscaping hard works and soft works are shown on the Proposed landscape plan and/or Proposed site features plan.
4. Access for external inspection of tidal flap gates in foreshore to be by boat.

10m 0 10m

Scale 1:200 at A1
1:400 if reproduced at A3

ILLUSTRATIVE

Location

Victoria Embankment Foreshore
City of Westminster

Document Information

Application for Development Consent

Permanent works layout

Book of plans - section 18

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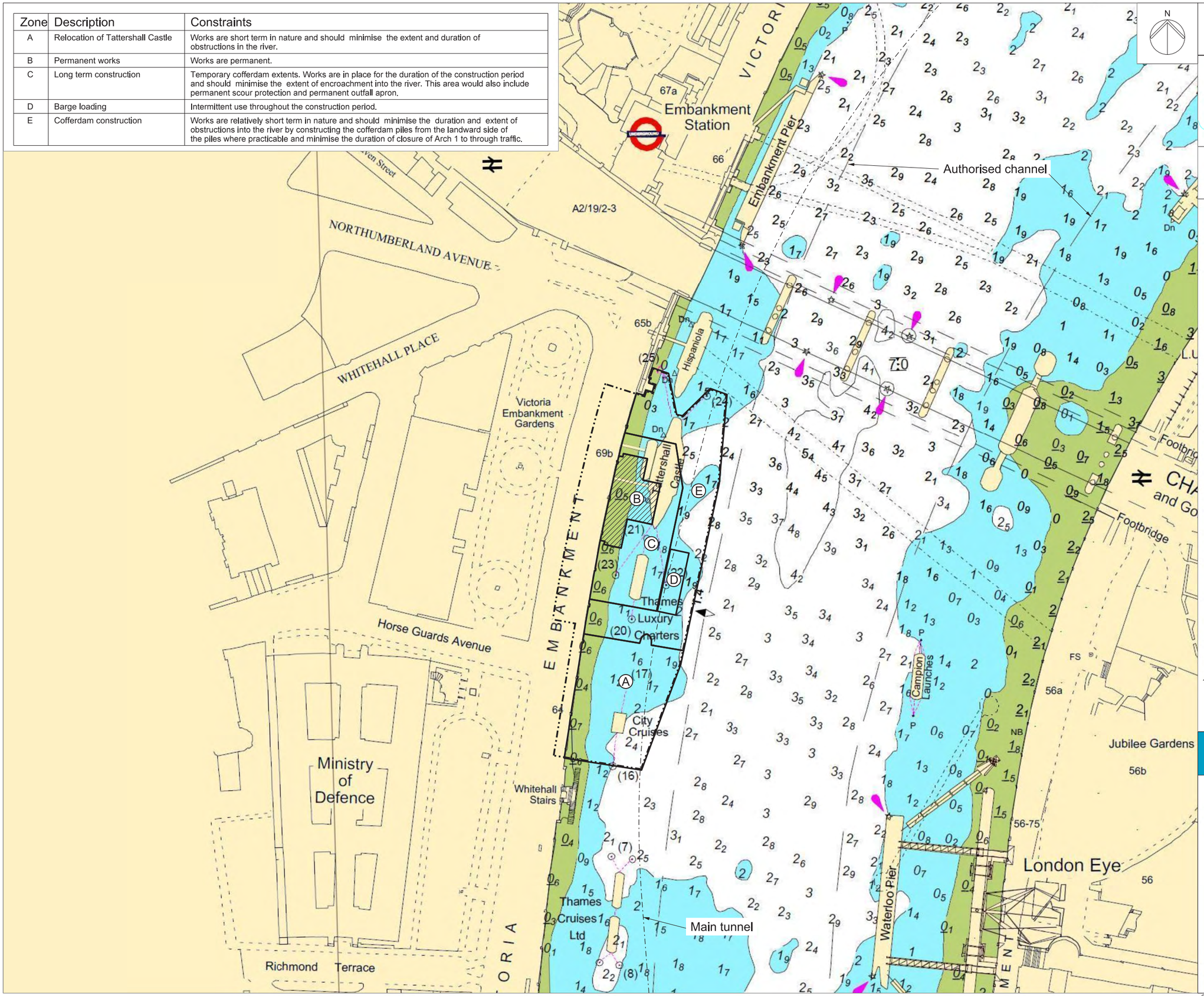
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Thames Water

Zone	Description	Constraints
A	Relocation of Tattershall Castle	Works are short term in nature and should minimise the extent and duration of obstructions in the river.
B	Permanent works	Works are permanent.
C	Long term construction	Temporary cofferdam extents. Works are in place for the duration of the construction period and should minimise the extent of encroachment into the river. This area would also include permanent scour protection and permanent outfall apron.
D	Barge loading	Intermittent use throughout the construction period.
E	Cofferdam construction	Works are relatively short term in nature and should minimise the duration and extent of obstructions into the river by constructing the cofferdam piles from the landward side of the piles where practicable and minimise the duration of closure of Arch 1 to through traffic.



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Keyplan:
This drawing

Coordinates are to be Ordance Survey Datum OSGB36. All levels are in metres and relate to the Tunnel Datum which is 100 metres below Ordnance Datum Newlyn.

Key:

Limits of land to be acquired or used (LLAU)

Notes:

1. All levels are in metres and relate to chart datum.
2. Background information shown on this drawing is taken from:

   River Thames - Lambeth Reach

   Port of London Authority Hydrographic Service

   H.O. Ref. No....113-316-157....Date....29/12/2010

Scale 1:1000 at A1
1:2000 if reproduced at A3

FOR INFORMATION

Location
Victoria Embankment Foreshore
City of Westminster

Document Information
Application for Development Consent
River foreshore zones of working

DCO-PP-16X-VCTEF-180034
January 2013

Thames Tideway Tunnel
Creating a cleaner, healthier River Thames

Thames Water

Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Navigational Issues and Preliminary Risk Assessment

Doc Ref: **7.20.09**

Victoria Embankment Foreshore

Appendix B

APFP Regulations 2009: Regulation **5(2)(q)**

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Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Appendix B: HR Wallingford analysis

B.1 Introduction

HR Wallingford Studies

B.1.1 In January 2009 HR Wallingford were commissioned by the Thames Tideway Tunnel Delivery Team to undertake detailed fluvial modelling and simulations of conditions at proposed sites for the interception of selected Combined Sewer Overflows (CSOs) in the proposed Thames Tideway Tunnel project.

B.1.2 As part of a Navigational Risk Assessment for the Victoria Embankment Foreshore Site the results of HR Wallingford's modelling and simulations were analysed. This was conducted to provide an evidence based approach on the potential impact that proposed in river structures may have on the flow of the river and subsequently on vessels in transit past the site.

B.1.3 The following flow scenarios were modelled by HR Wallingford:

a. Large Flood Tide - a typical spring tide range with 65m^3/s flow at Teddington (65m^3/s being the annual mean freshwater flow)

b. Extreme Ebb Tide - a typical spring tide range with 800m^3/s flow at Teddington (800m^3/s was measured in the winter of 1894 and is considered to represent an approximately 1 in 100 year flow)

c. Spring tide range enhanced by passage of surge and 65m^3/s flow at Teddington.

B.1.4 Typical tidal conditions used comprised a series of spring tides of ranging from 5.06m to 5.86m at Southend-on-Sea.

B.1.5 HR Wallingford's study simulations of high current conditions were required for combinations of extreme tides and fluvial flows for which the Thames Barrier would **NOT** be closed.

B.2 Results

HR Wallingford Analysis

B.2.1 By adding a pair of lines crossing the river (one in line with the development and one under Charing Cross Railway Bridge) it was possible to analyse the changes in flow rate across the gates. Images were produced to represent each of the current flow diagrams for the Wallingford report and these have been included in the sections below.

B.2.2 Current patterns would beaffected by the proposed structures, however analysis shows that significant changes to current patterns would typically be in close proximity (within a few meters) to either the bridge arches or the new structure itself.

B.2.3 In areas further from the arches or the structure, changes to the flow would typically be a slight increase, with very little to no change to direction of flow.

B.2.4 Considering the change in maximum flow, for the temporary works, the greatest change in maximum flow under the bridge (across a given cross section) would beapproximately 0.4 knots. This would beassociated with a peak ebb spring tide with river flow of 65m^3/s.

B.2.5 Considering the change in maximum flow, for the permanent works, the greatest change in maximum flow under the bridge (across a given cross section) would beapproximately 0.2 knots, this would beassociated with a peak ebb spring tide with 65m^3/s river flow. In line with the widest part of the structure, this increase would remain at approximately 0.2 knots.

B.2.6 The change in maximum flow under the bridge would beless than 0.4 knots for both the temporary and permanent works. Although the changes in flow could be considered small, it is recommended that notices to mariners should be issued warning of these changes.

B.2.7 The changes in maximum flows are tabulated below for the temporary works.

Table B.1 Temporary Works

Reference	Flow Conditions	Change in maximum flow in line with development	Change in maximum flow in line with Rail Bridge
Fig B.1	Peak Ebb currents - Spring tide, 65m^3/s river flow	0 knots	0.4 knots
Fig B.2	Peak Flood currents - spring tide, 65 m^3/s river flow	0.4 knots	0 knots
Fig B.3	Peak Ebb currents - spring tide, 800 m^3/s river flow	0.4 knots	0.3 knots
Fig B.4	Peak Flood currents - spring tide, 800 m^3/s river flow	0.2 knots	0 knots
Fig B.5	Peak Ebb currents - large flood tide rise with 65m^3/s river flow	0.2 knots	0.2 knots
Fig B.6	Peak Flood currents - large flood tide rise with 65m^3/s river flow	0 knots	0.2 knots

Table B.2 Permanent Works

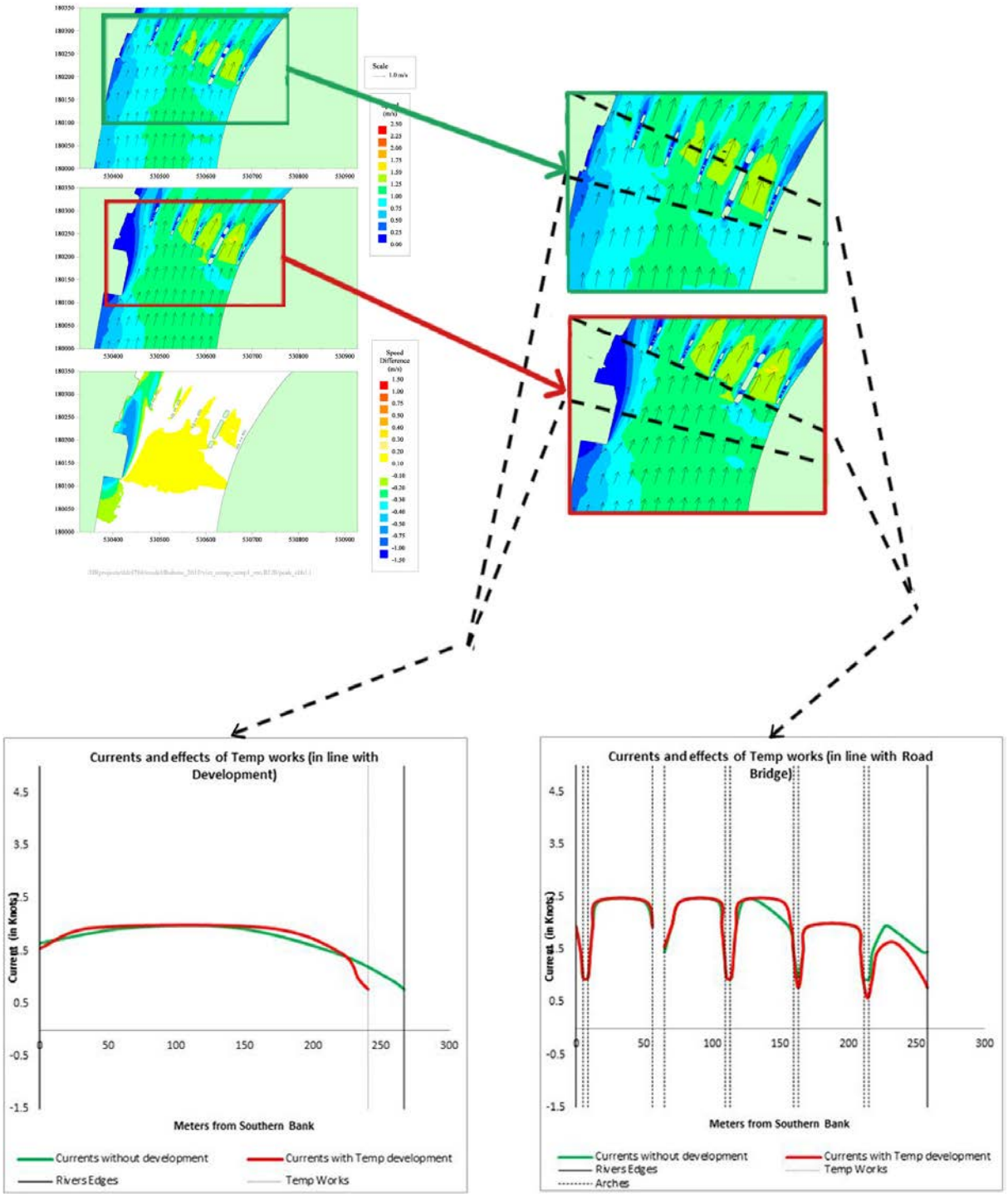
Reference	Flow Conditions	Change in maximum flow in line with development	Change in maximum flow in line with Rail Bridge
Fig B.7	Peak Ebb currents - Spring tide, 65m^3/s river flow	0.2 knots	0.2 knots
Fig B.8	Peak Flood currents - spring tide, 65 m^3/s river flow	0 knots	0.1 knots
Fig B.9	Peak Ebb currents - spring tide, 800 m^3/s river flow	0.2 knots	0.1 knots
Fig B.10	Peak Flood currents - spring tide, 800 m^3/s river flow	0 knots	0 knots
Fig B.11	Peak Ebb currents - large flood tide rise with 65m^3/s river flow	0.2 knots	0.1 knots
Fig B.12	Peak Flood currents - large flood tide rise with 65m^3/s river flow	0.2 knots	0 knots

B.2.8 Temporary Works - Peak Ebb currents - Spring tide, 65m^3/s river flow:

a. The average increase in flow (in line with structure) would beapproximately 0.1 knots. There would be no increase in maximum flow.

b. There would be no increase in average flow (in line with Road Bridge). The increase in maximum flow would be 0.4 knots.

Figure B.1 Temporary Works - Peak Ebb currents - Spring tide, 65m^3/s river flow

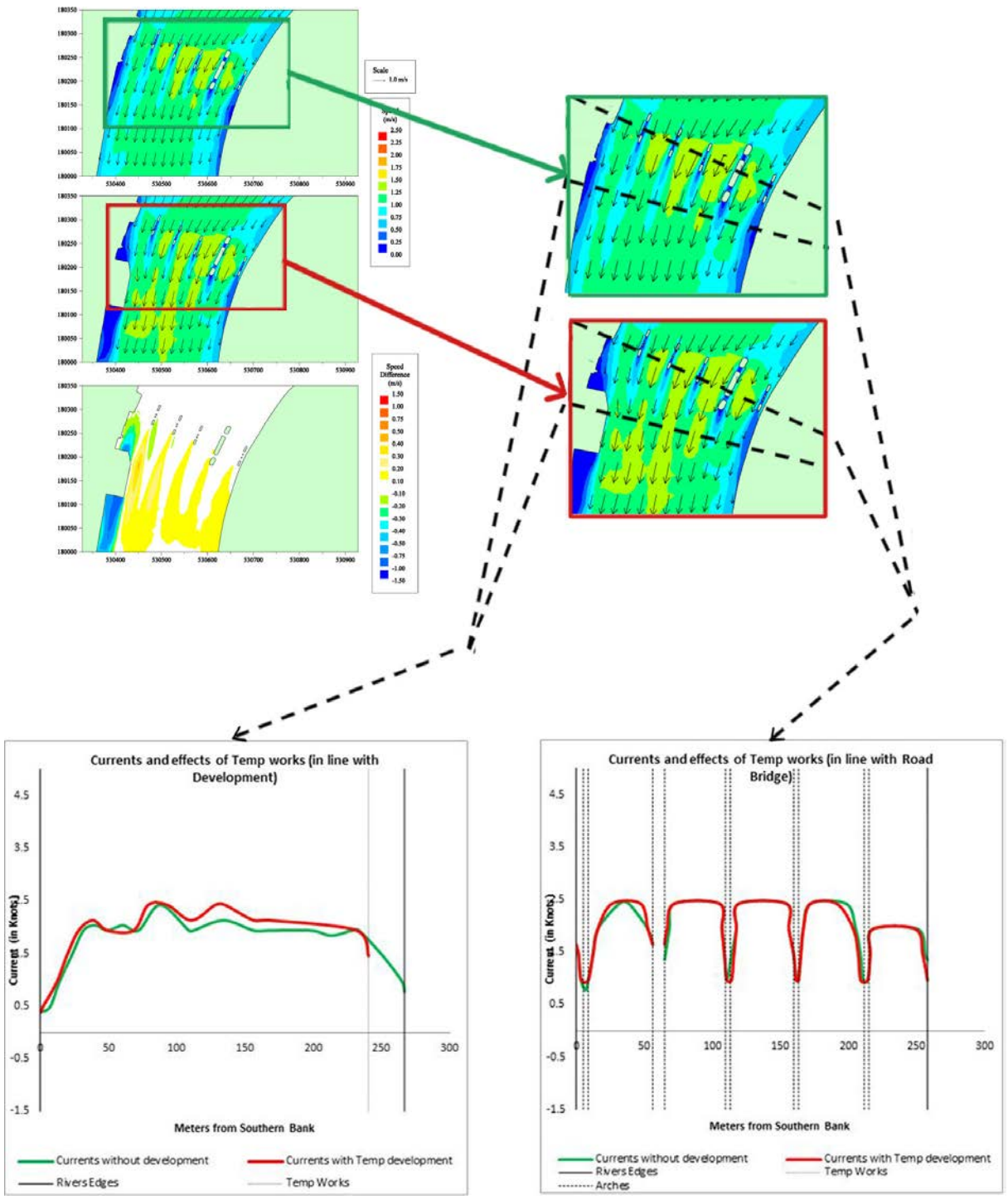


B.2.9 Temporary Works - Peak Flood currents - spring tide, 65 m^3/s river flow:

a. The average increase in flow (in line with structure) would be approximately 0.2 knots. The increase in maximum flow would be 0.4 knots.

b. There would be no increase in average or maximum flow (in line with Road Bridge)..

Figure B.2 Temporary Works - Peak Flood currents - spring tide, 65 m^3/s river flow

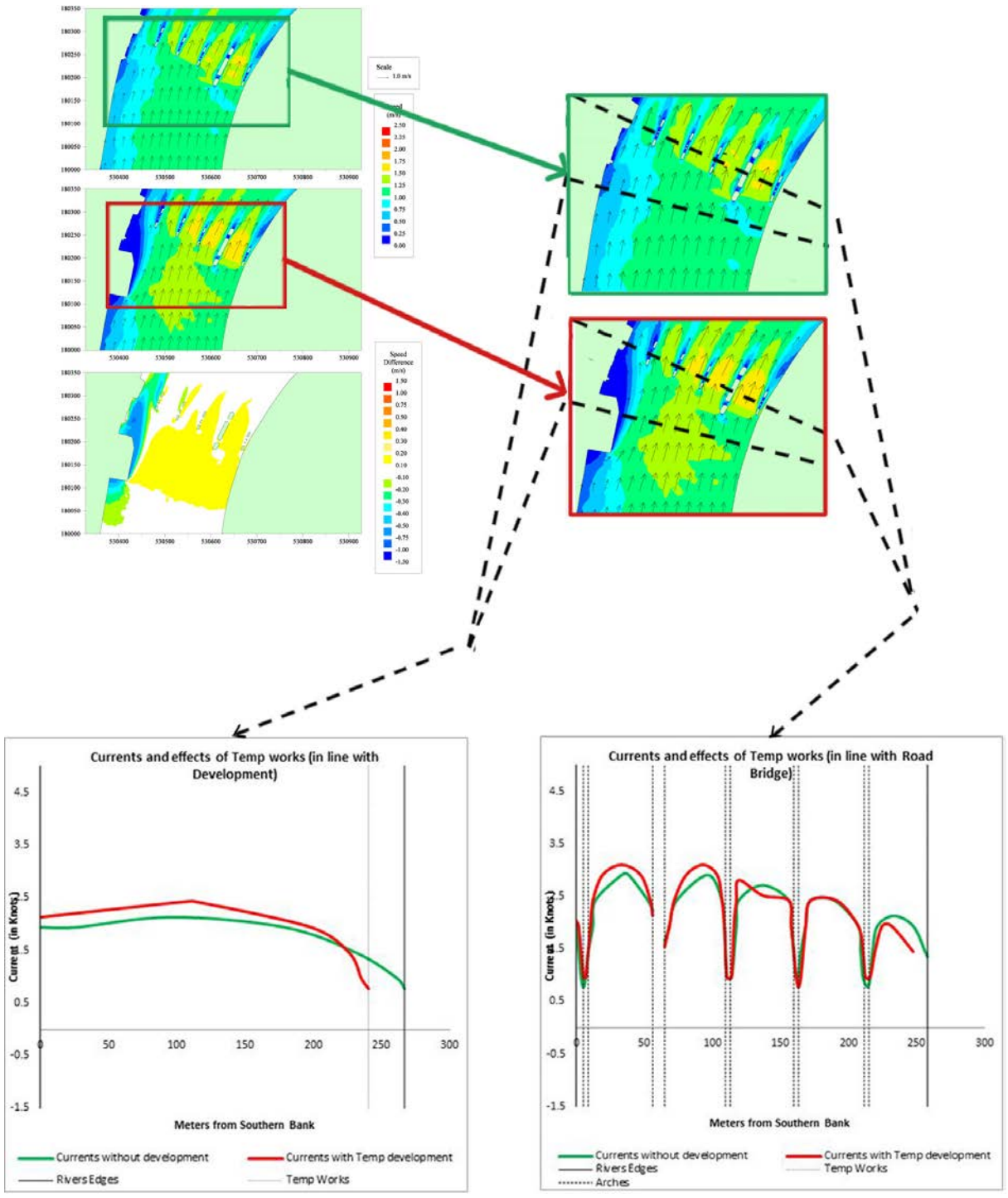


B.2.10 Temporary Works - Peak Ebb currents - spring tide, 800 m^3/s river flow:

a. The average increase in flow (in line with structure) would be approximately 0.3 knots. The increase in maximum flow would be 0.4 knots.

b. There would be no increase in average flow (in line with Road Bridge). The increase in maximum flow would be 0.3 knots.

Figure B.3 Temporary Works - Peak Ebb currents - spring tide, 800 m^3/s river flow.

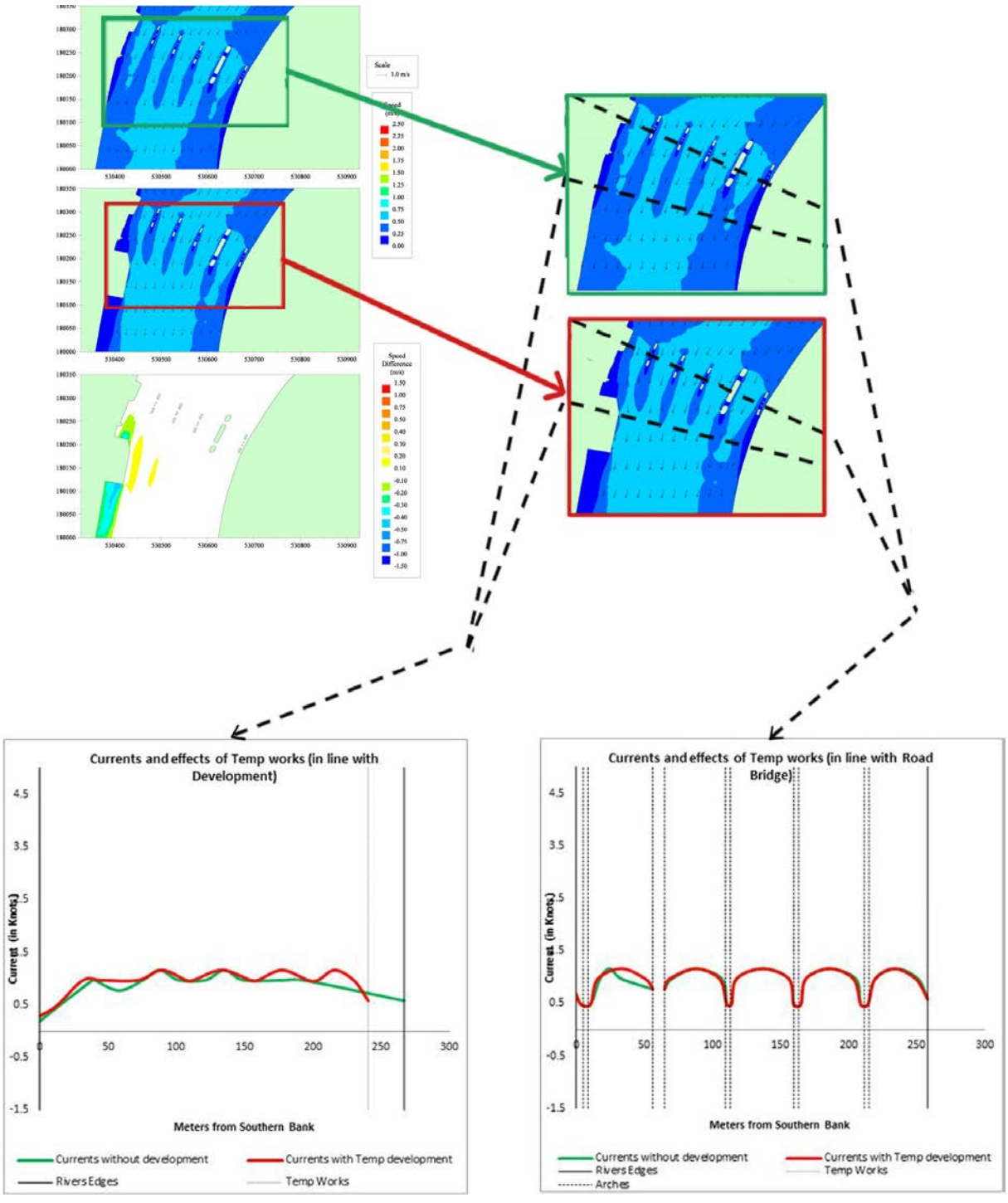


B.2.11 Temporary Works - Peak Flood currents - spring tide, 800 m^3/s river flow:

a. The average increase in flow (in line with structure) would be approximately 0.4 knots. The increase in maximum flow would be 0.2 knots.

b. There would be no increase in average or maximum flow (in line with Road Bridge).

Figure B.4 Temporary Works - Peak Flood currents - spring tide, 800 m^3/s river flow.

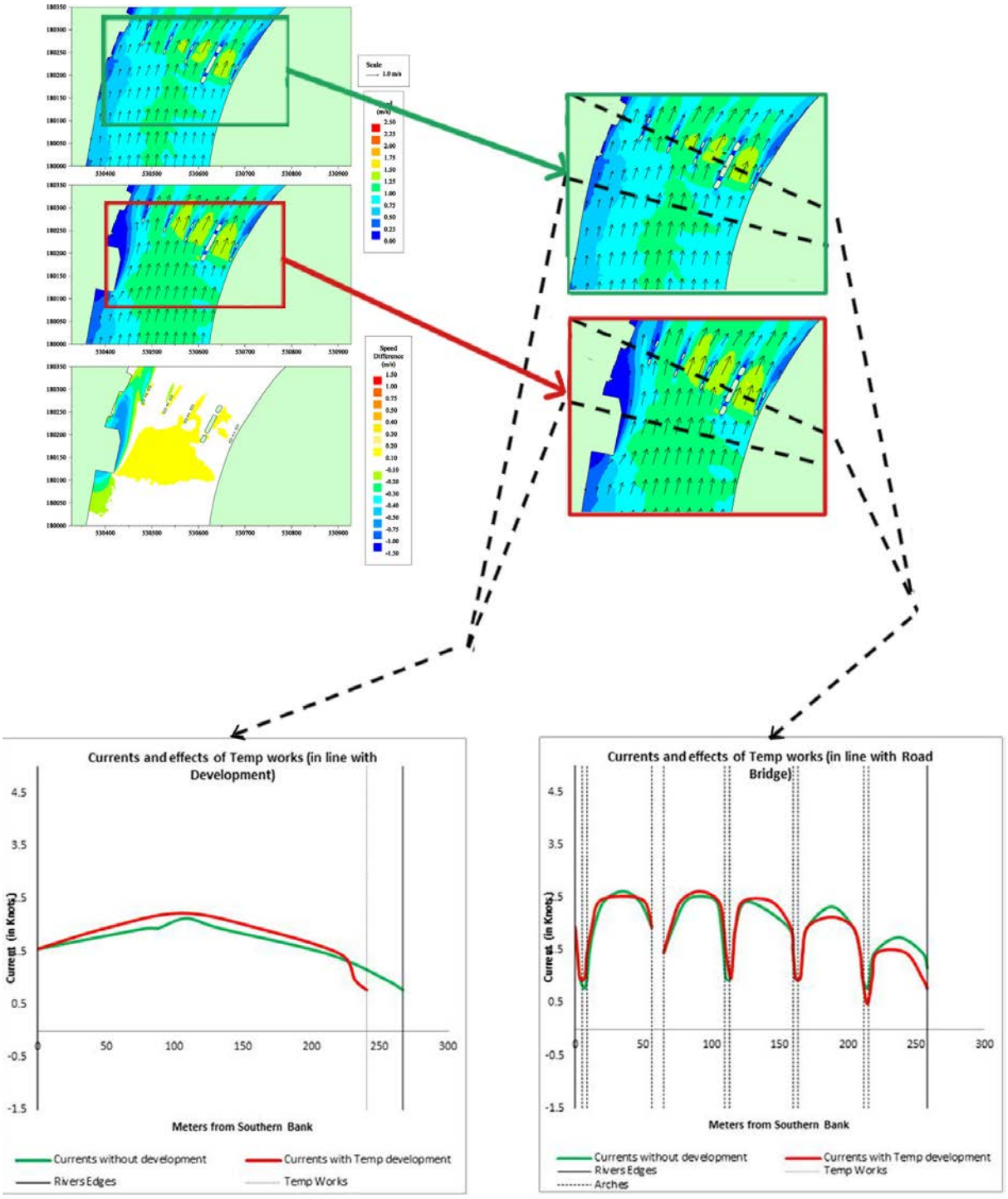


B.2.12 Temporary Works - Peak Ebb currents - large flood tide rise with 65m^3/s river flow:

a. The average increase in flow (in line with structure) would be approximately 0.2 knots. The increase in maximum flow would be 0.2 knots.

b. There would be no increase in average flow (in line with Road Bridge). The increase in maximum flow would be 0.2 knots.

Figure B.5 Temporary Works - Peak Ebb currents - large flood tide rise with 65m^3/s river flow.

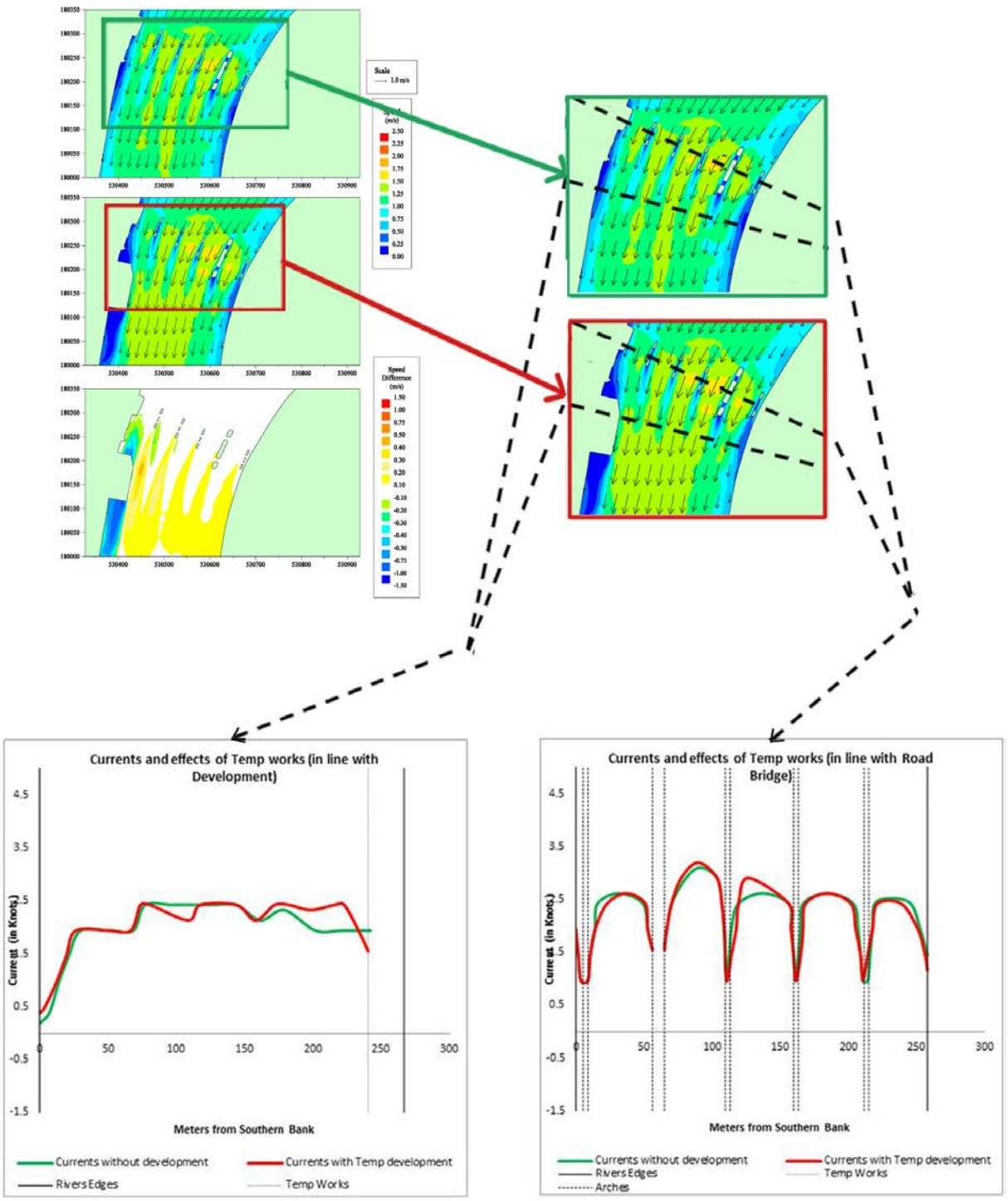


B.2.13 Temporary Works - Peak Flood currents - large flood tide rise with 65m^3/s river flow:

a. The average increase in flow (in line with structure) would be approximately 0.3 knots. There would be no increase in maximum flow.

b. There would be no increase in average flow (in line with Road Bridge). The increase in maximum flow would be 0.2 knots.

Figure B.6 Temporary Works - Peak Flood currents - large flood tide rise with 65m^3/s river flow.

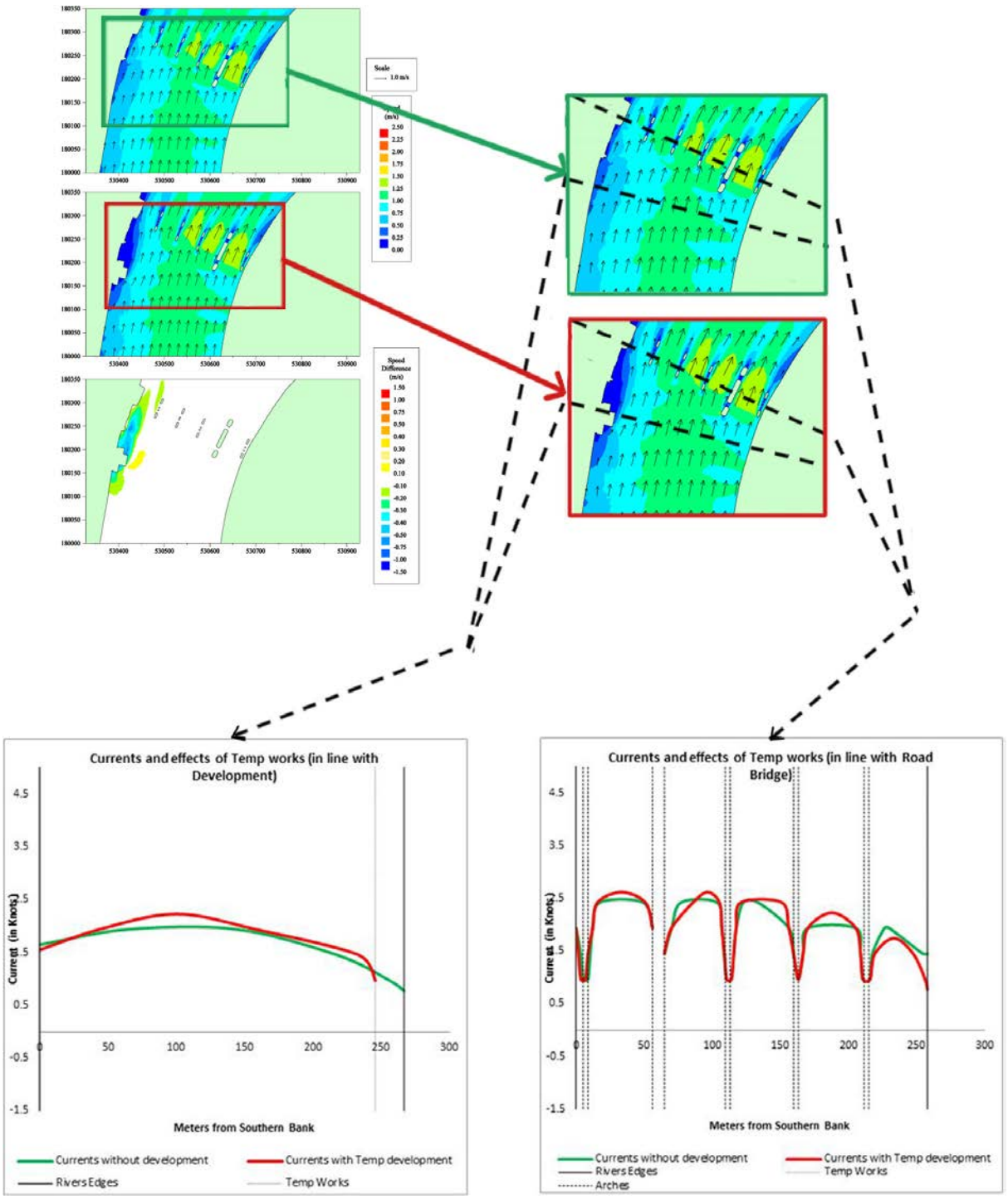


B.2.14 Permanent Works - Peak Ebb currents - Spring tide, 65m^3/s river flow:

a. The average increase in flow (in line with structure) would be approximately 0.2 knots. The increase in maximum flow would be 0.2 knots.

b. There would be no increase in average flow (in line with Road Bridge). The increase in maximum flow would be 0.2 knots.

Figure B.7 Permanent Works - Peak Ebb currents - Spring tide, 65m^3/s river flow.

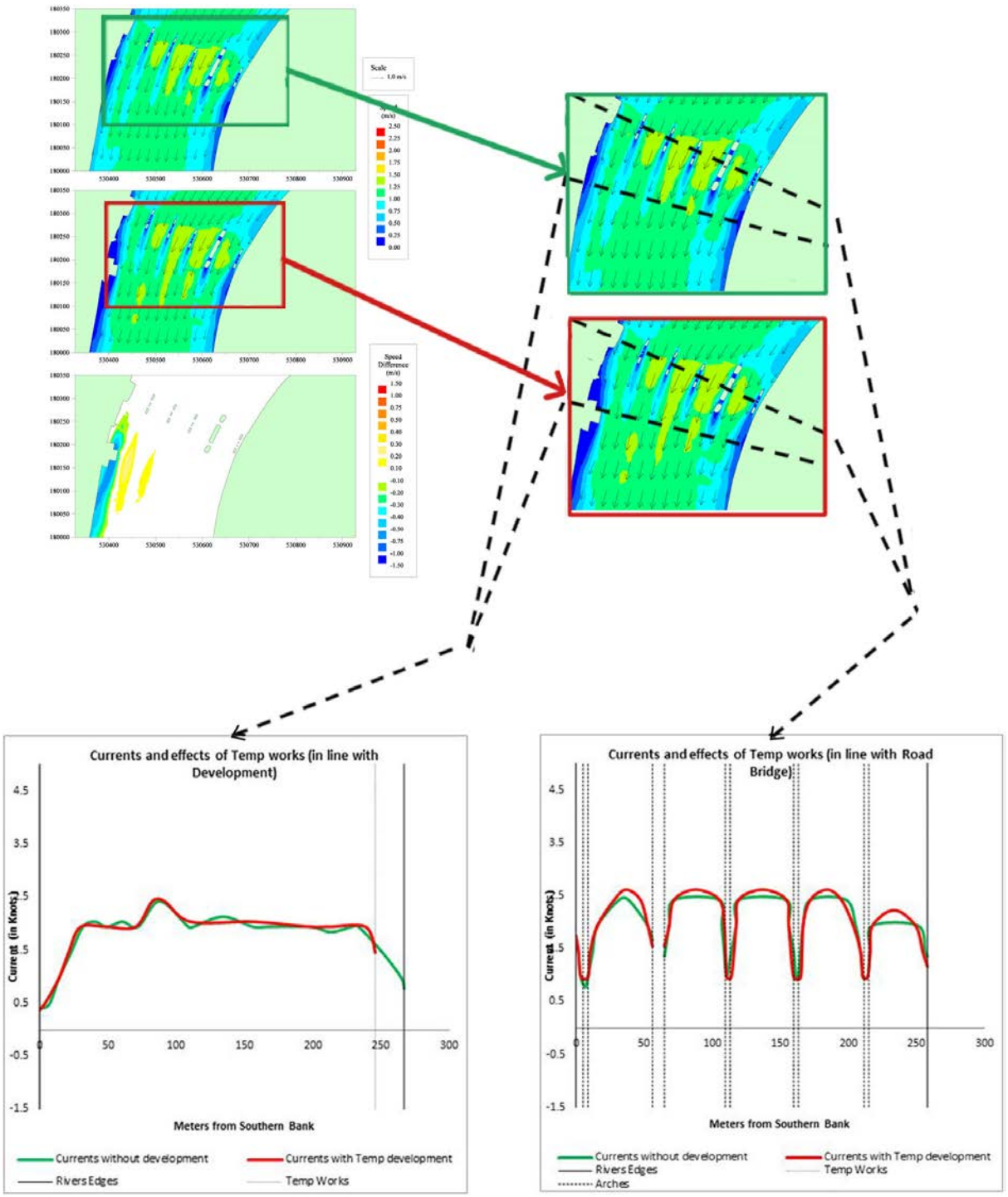


B.2.15 Permanent Works - Peak Flood currents - spring tide, 65 m^3/s river flow:

a. The average increase in flow (in line with structure) would be approximately 0.1 knots. There would be no increase in maximum flow.

b. The average increase in flow (in line with Road Bridge) would be approximately 0.1 knots. The increase in maximum flow would be 0.1 knots.

Figure B.8 Permanent Works - Peak Flood currents - spring tide, 65 m^3/s river flow.

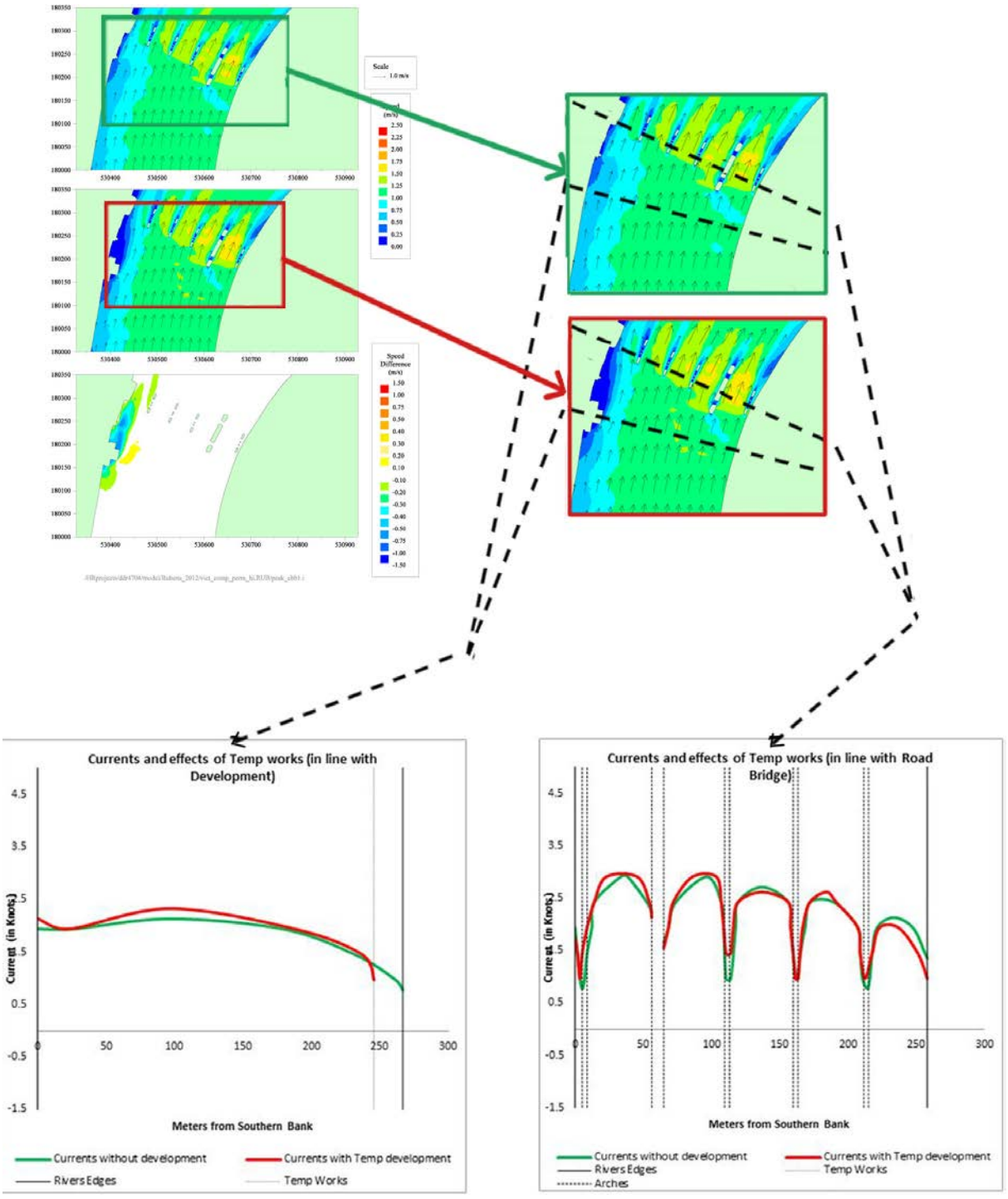


B.2.16 Permanent Works - Peak Ebb currents - spring tide, 800 m^3/s river flow:

a. The average increase in flow (in line with structure) would be approximately 0.2 knots. The increase in maximum flow would be 0.2 knots.

b. The average increase in flow (in line with Road Bridge) would be approximately 0.1 knots. The increase in maximum flow would be 0.1 knots.

Figure B.9 Permanent Works - Peak Ebb currents - spring tide, 800 m^3/s river flow.

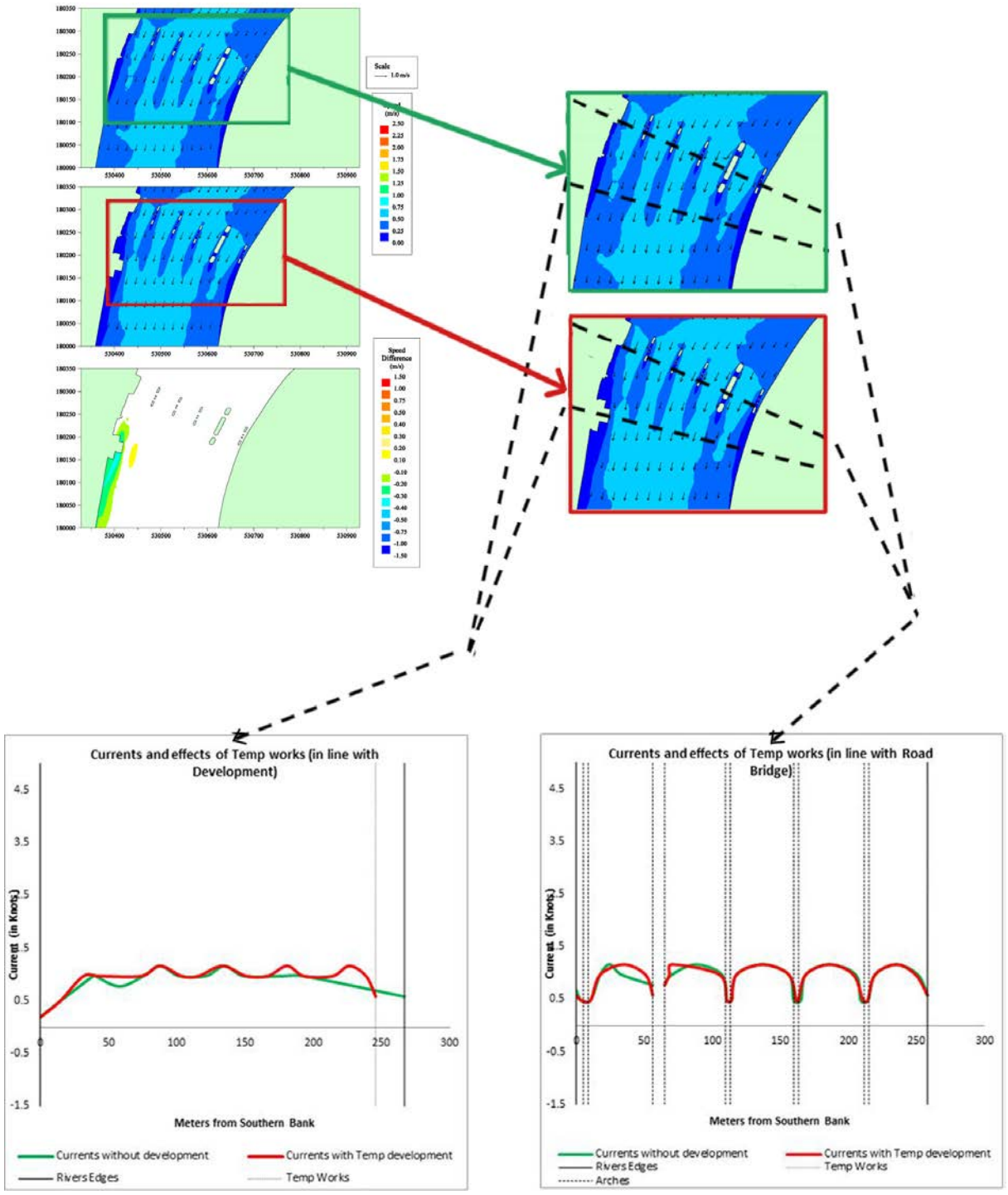


B.2.17 Permanent Works - Peak Flood currents - spring tide, 800 m^3/s river flow:

a. The average increase in flow (in line with structure) would be approximately 0.1 knots. There would be no increase in maximum flow.

b. There would be no increase in average or maximum flow (in line with Road Bridge).

Figure B.10 Permanent Works - Peak Flood currents - spring tide, 800 m^3/s river flow.

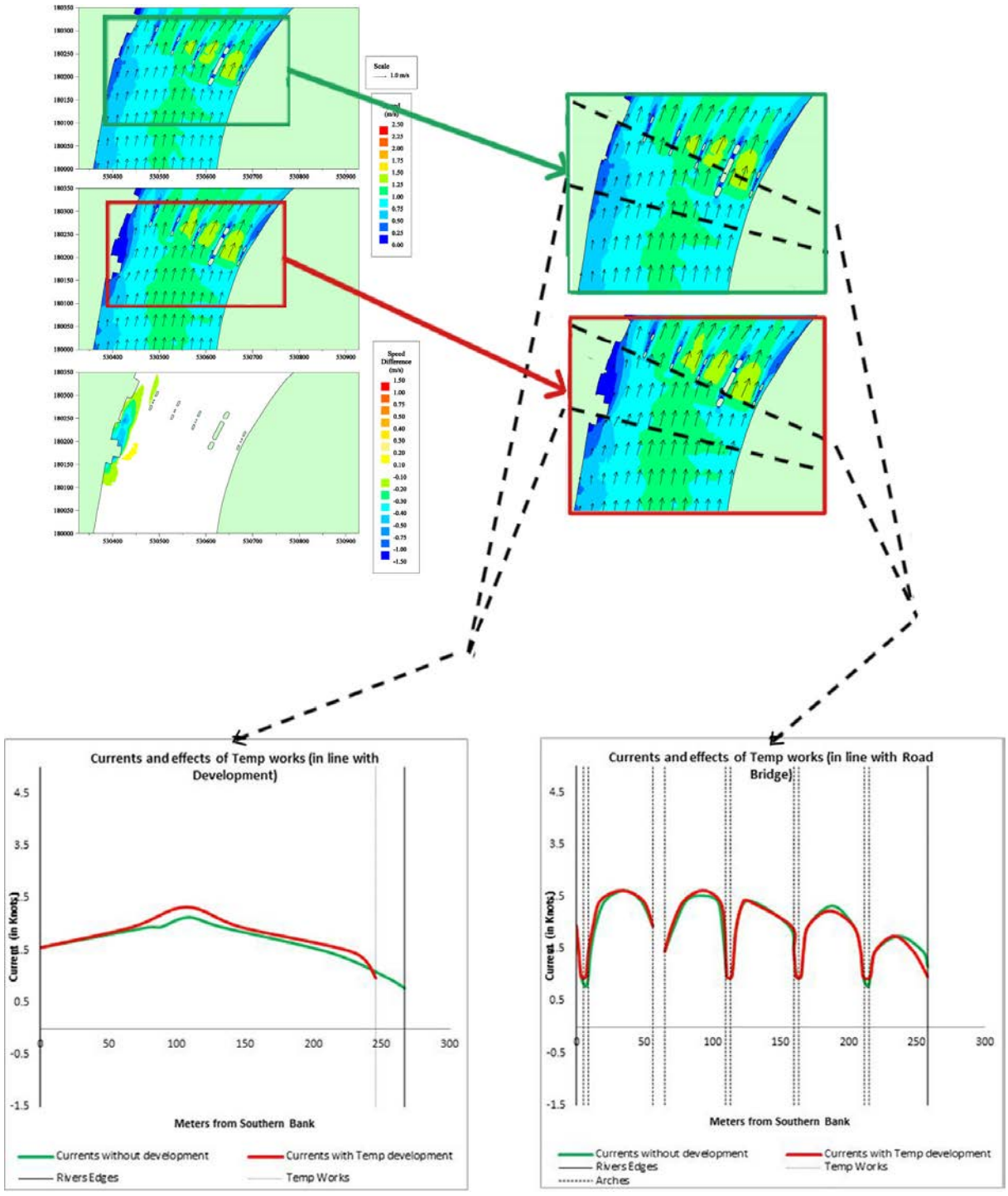


B.2.18 Permanent Works - Peak Ebb currents - large flood tide rise with 65m^3/s river flow:

a. The average increase in flow (in line with structure) would be approximately 0.2 knots. The increase in maximum flow would be 0.2 knots.

b. There would be no increase in average flow (in line with Road Bridge). The increase in maximum flow would be 0.1 knots.

Figure B.11 Permanent Works - Peak Ebb currents - large flood tide rise with 65m^3/s river flow.

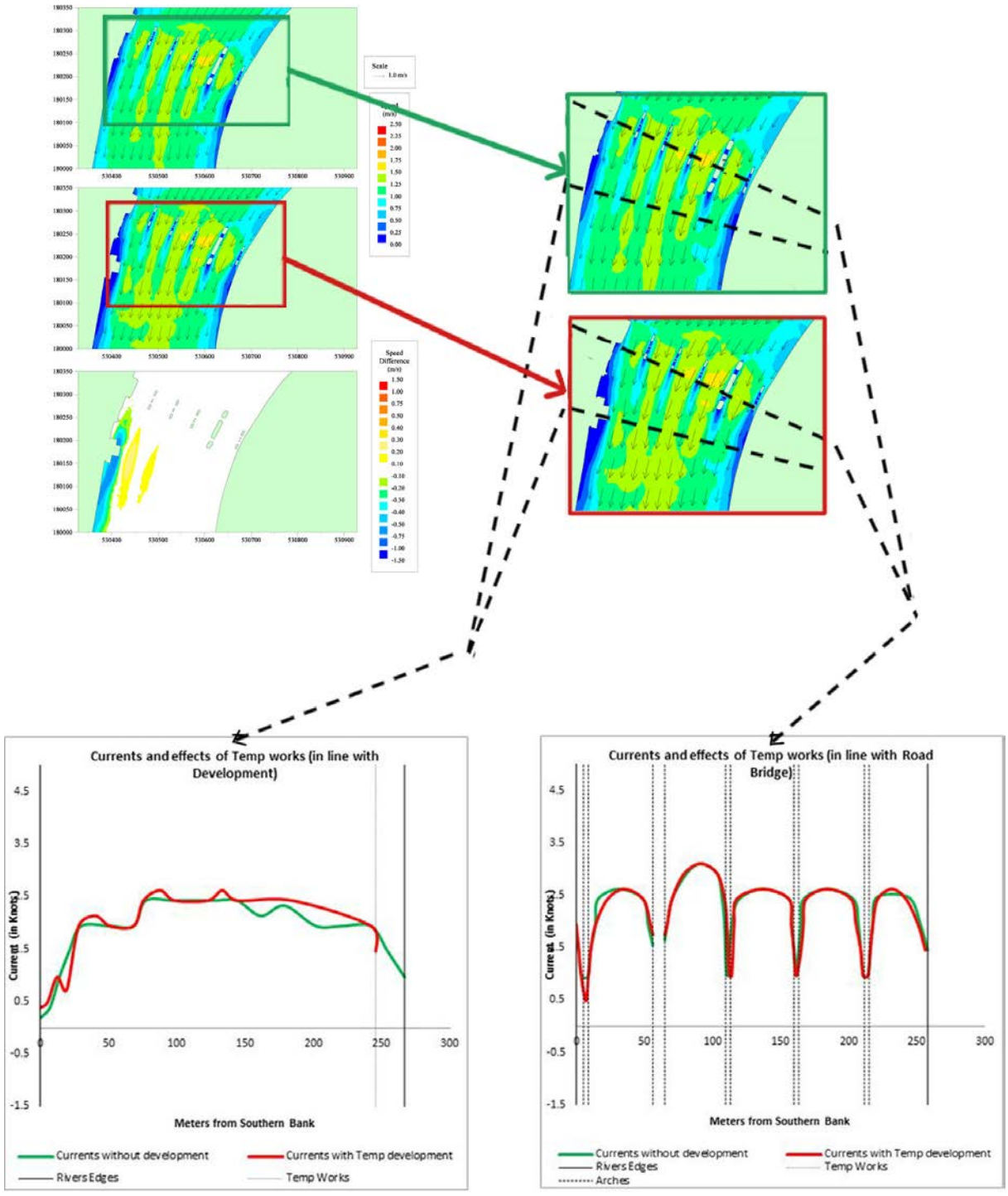


B.2.19 Permanent Works - Peak Flood currents - large flood tide rise with 65m^3/s river flow:

a. The average increase in flow (in line with structure) would be approximately 0.1 knots. The increase in maximum flow would be 0.2 knots.

b. There would be no increase in average or maximum flow (in line with Road Bridge).

Figure B.12 Permanent Works - Peak Flood currents - large flood tide rise with 65m^3/s river flow.



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Thames Tideway Tunnel
Thames Water Utilities Limited

Application for Development Consent

Application Reference Number: WWO10001

Navigational Issues and Preliminary Risk Assessment

Doc Ref: **7.20.09**

Victoria Embankment Foreshore

Appendix C

APFP Regulations 2009: Regulation **5(2)(q)**

Hard copy available in

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January 2013

Thames Tideway Tunnel

Creating a cleaner, healthier River Thames

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Appendix C: Freight tracks & AIS analysis

C.1 Introduction & summary

C.1.1 The project proposes to use the foreshore of the River Thames, east of Victoria Embankment (A3211), for construction and accommodation of permanent structures required to operate the main tunnel. The site would be used to intercept the existing local CSO, known as the Regent Street CSO, by connecting the northern Low Level Sewer No.1 to the main tunnel.

C.1.2 Victoria Embankment Gardens and Victoria Embankment Foreshore were presented as possible sites during phase one public consultation with the Foreshore site being identified as the preferred option.

C.1.3 The permanent structure would extend from the foreshore into the river approximately 30m at the site currently occupied by the Tattershall Castle.

C.1.4 The permanent in-river structure would protrude into the river to approximately the same distance as the Tattershall Castle structure, and could have an impact on vessels passing through arch No 1.

C.1.5 A review of AIS track information of inbound freight movements passing through this section of the river was undertaken. The track data was captured in November 2011 and provided by Cory Environmental Ltd. An AIS transponder was sited on the starboard rear quarter of the rearmost rank of barges, enabling analysis of vessel track data for the entire duration of the journey.

C.1.6 Arch No3 of Charing Cross Railway Bridge has the Special Signal Light situated above it and is generally used by all larger, Reporting Vessels, proceeding up stream and down stream. Observations and AIS track analysis at this site confirms this.

C.2 Vessel routing

Inbound traffic

C.2.1 Vessels transiting through the bridge at Victoria, heading up river, currently have two options to take, passing through either arch No 2 or arch No 3.

Outbound traffic

C.2.2 Vessels on an outbound transit have the option to pass through arches No3 & 4. All construction is based on the north bank and would have no direct impact on downstream traffic.

Other main river users

C.2.3 Thames Clippers represent the heaviest user of Embankment Pier, and Cory Environmental represent one of the most significant freight operators passing through the Victoria Embankment Foreshore area.

C.2.4 To reflect the high percentage of traffic volume that these two operators contribute within the study area, separate analyses were conducted. The results of these are contained within this Appendix.

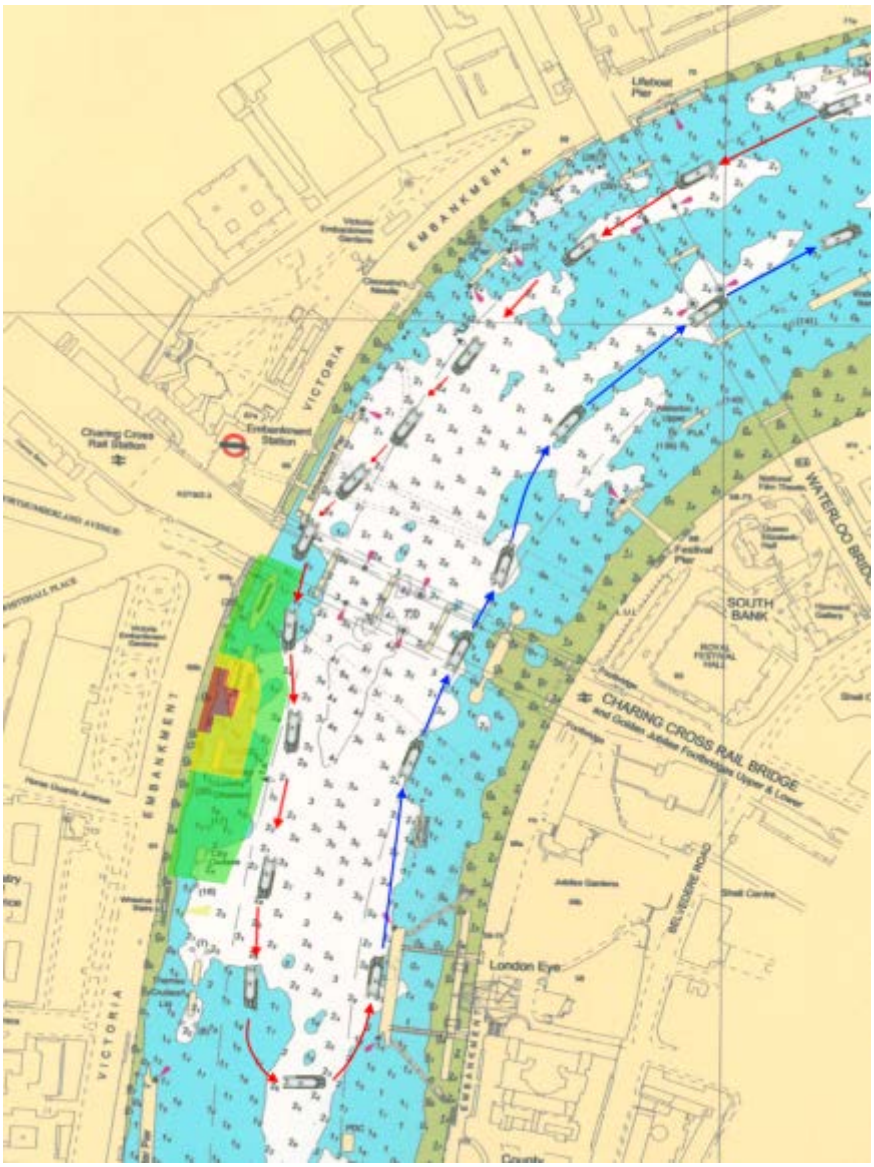
C.2.5 The Thames Clipper tracks are for access to the existing pier.

C.3 Images

Thames Clippers

C.3.1 The figure below (Figure C.1) displays the routes taken by Thames Clippers in the Victoria Embankment Foreshore area. Currently, when leaving Embankment Pier for London Eye Pier, Thames Clippers proceed through arch No1. It is not envisaged that Thames Tunnel operations would adversely impact on Thames Clippers downstream service.

Figure C.1 Thames Clipper routing



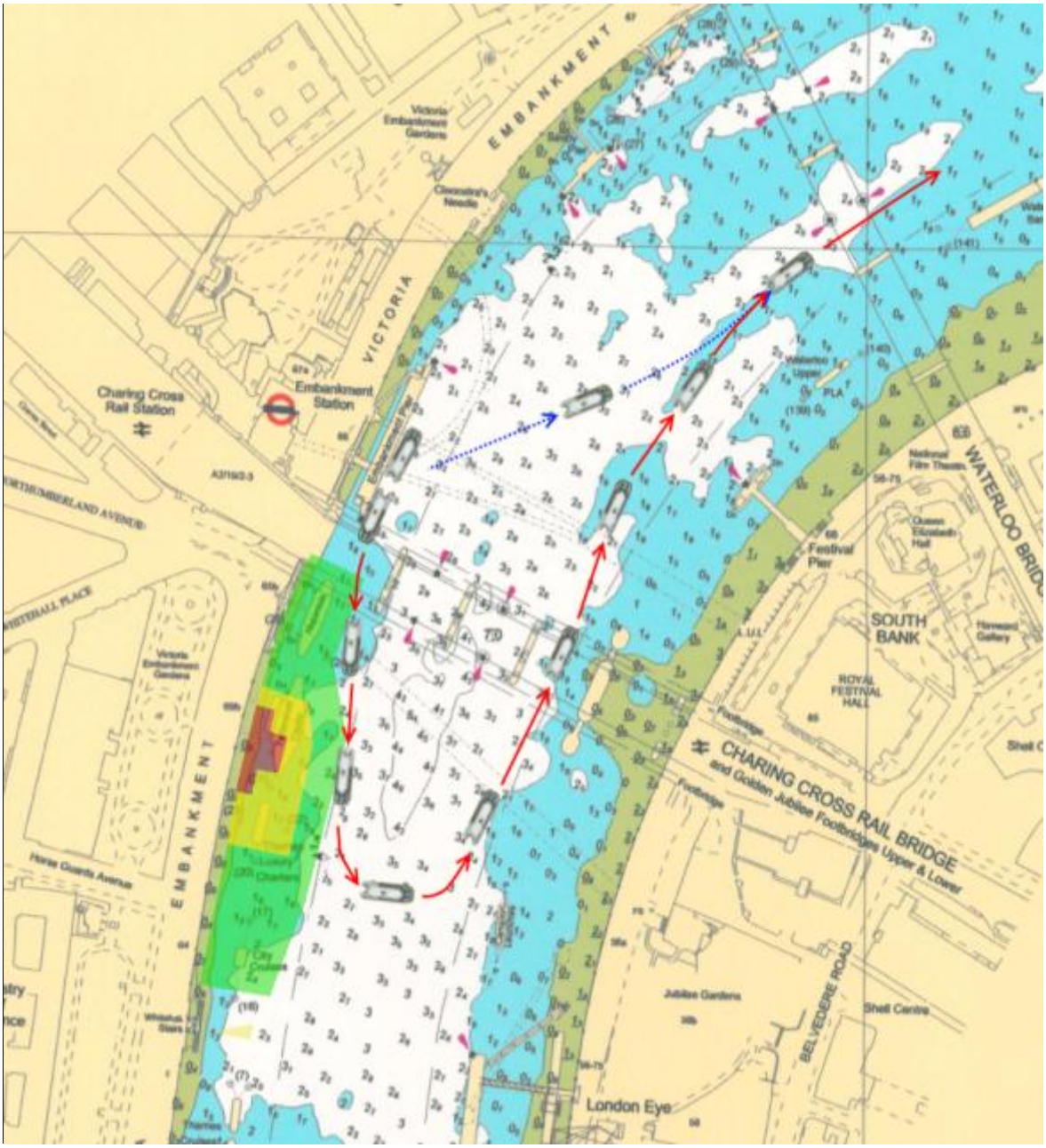
Tate to Tate

C.3.2 Eastbound Embankment Pier Departures:

a. Head Up departure (Red arrows) - depart through arch No 1 then work up the starboard side of the fairway, when safe to do so, round head down, taking either arches No 3 or 4 of Charing Cross Rail Bridge, continue on the starboard side of the fairway, taking the centre arch of Waterloo Road Bridge.

b. Head Down departure (Blue arrows) - Cross to the starboard side of the fairway, when safe to do so, taking the centre arch of Waterloo Road Bridge, continue on the starboard side of the fairway down to Blackfriars Road and Rail Bridges, taking arches No 3 or 4.

Figure C.2 Tate to Tate routes

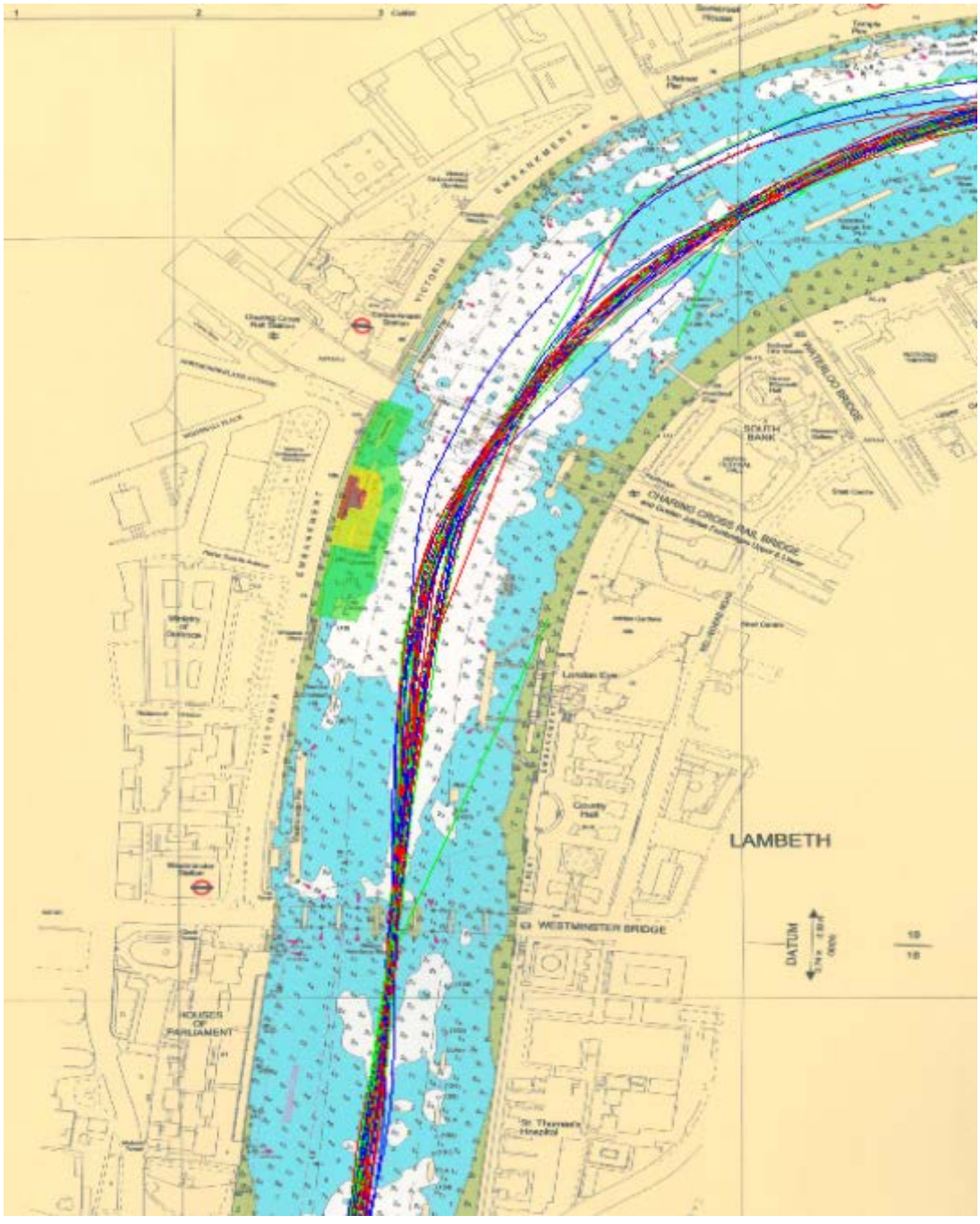


C.4 Cory Environmental

Cory tug & tow upstream GPS tracks

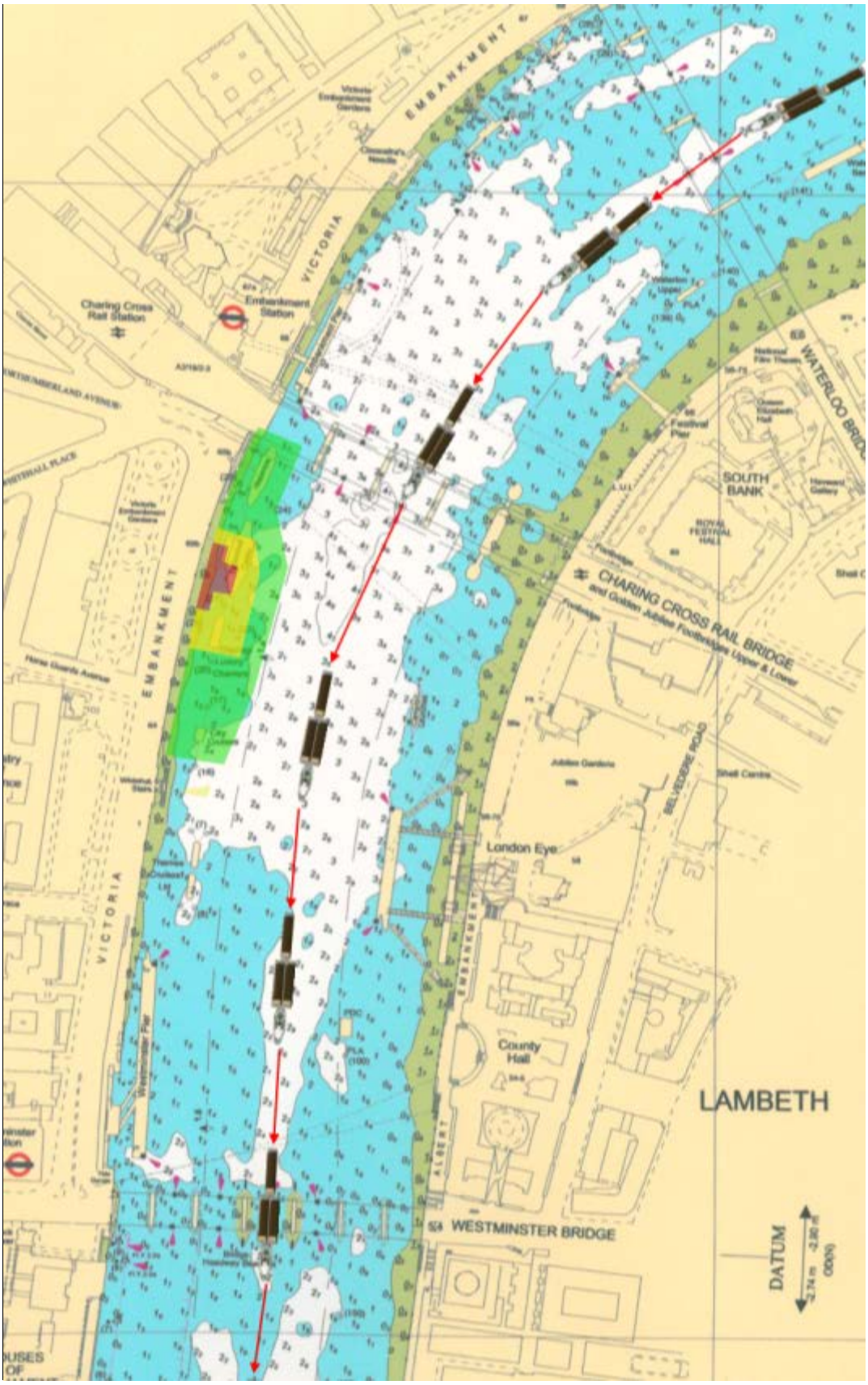
C.4.1 Cory environmental supplied the project with a set of GPS data showing the movements of their tugs and barges. The data covered 14 days in November 2011, a total of 35 tug movements. This data was analysed and visualised to inform various sections of this report. Included below in Figure C.1 is a GIS output of all tracks overlaid over a chart of the Victoria Embankment Foreshore area.

Figure C.3 GPS Tracks of Cory tugs and barges



Sample tug & tow route

Figure C.4 Barge movements (typical path)



C.4.2 By individually investigating each of the tracks supplied it has been possible to speculate on the potential impacts of the various phases of development.

C.4.3 For each track supplied, an image was created displaying a wide ‘bar’ type line. This line represented the path taken by the tug in question, with the width being representative of the width a tug towing at least two barges (side by side). However due to the similarities between the vast majority of these lines, only five have been included in this report. These five (highlighted yellow in Table C.1) represent a good cross section of possible routes taken by Cory Environmental.

Cory GPS summary

C.4.4 Table C.1 has the following headings:

c. Date – Date the GPS data was collected

d. Colour – colour system assigned by Cory tugs to enable identification of individual tugs

e. Tug – The name of the tug in question

f. Head Rank Port – The name of the barge being towed in the port position

g. Head Rank stb’d - the name of the barge being towed in the starboard position

h. Second rank – the name of the barge being towed in the rear position (where applicable)

i. Wind Direction - Approximate Wind Direction

j. Wind Speed - Wind speed in m/s

k. High tide – time at which high tide was (taken from the PLA 2011 tide times booklet)

l. Tidal height – projected height of tide at Tower Bridge (taken from the PLA 2011 tide times booklet)

m. Notes/Comments – any pertinent notes or comments on this specific track data

n. Path Figure – reference in this document for the image of the GPS tracks.

Table C.1 Cory AIS Data

Date	Colour	Tug	Head rank port	Head rank stb'd	Second rank	Wind direction	Wind Speed (m/s)	High tide at	Tidal height (m)	Notes / Comments	Path Figure
07/11/11	Red	Resource	Cringle	Cringle		NE	3	11:21	6.2		
07/11/11	Blue	Reclaim	Cringle	Cringle	Walbrook	NE	3	11:21	6.2	No data in this area	
07/11/11	Green	Recovery	Cringle	Wangas		NE	3	11:21	6.2	Data incomplete in this area	
08/11/11	Red	Reclaim	Cringle	Cringle	Cringle	SE	9	12:10	6.5		
08/11/11	Blue	Regain	Cringle	Cringle		SE	8	12:10	6.5		
08/11/11	Green	Resource	Cringle	Cringle	Wangas	SE	8	12:10	6.5		
09/11/11	Red	Resource	Cringle	Walbrook		SE	3	12:51	6.7		Figure C.5
09/11/11	Blue	Recovery	Cringle	Wangas	Wangas	SE	3	12:51	6.7		
09/11/11	Green	Redoubt	Cringle	Cringle	Wangas	SE	5	12:51	6.7		
10/11/11	Red	Resource	Cringle	Cringle	Wangas	E	3	13:27	6.8		
10/11/11	Blue	Regain	Cringle	Cringle	Wangas	E	4	13:27	6.8		Figure C.6
11/11/11	Red	Reclaim	Cringle	Cringle	Wangas	E	4	14:00	6.9		
11/11/11	Blue	Recovery	Walbrook	Cringle		SE	4	14:00	6.9		
11/11/11	Green	Resource	Cringle	Cringle	Wangas	SE	4	14:00	6.9		
14/11/11	Red	Resource	Wangas	Cringle		E	4	15:39	6.9		
14/11/11	Blue	Recovery	Walbrook	Cringle		E	4	15:39	6.9		Figure C.7
14/11/11	Green	Regain	Wangas	Cringle		E	4	15:39	6.9		

Date	Colour	Tug	Head rank port	Head rank stb'd	Second rank	Wind direction	Wind Speed (m/s)	High tide at	Tidal height (m)	Notes / Comments	Path Figure
15/11/11	Green	Reclaim	Cringle	Cringle		NE	4	16:16	6.8	Incomplete data	
16/11/11	Red	Redoubt	Walbrook	Cringle		SE	3	16:55	6.7		
16/11/11	Blue	Reclaim	Cringle	Cringle	Cringle	E	3	16:55	6.7		
16/11/11	Green	Recovery	Cringle	Wangas	Cringle	E	3	16:55	6.7	Incomplete data	
17/11/11	Red	Redoubt	Cringle	Cringle	Cringle	SW	5	17:40	6.6		
17/11/11	Blue	Reclaim	Wangas	Wangas		SW	5	17:40	6.6		
18/11/11	Red	Regain	Cringle	Wangas	Cringle	S	5	18:33	6.4		
18/11/11	Blue	Recovery	Cringle	Cringle		S	4	18:33	6.4		
22/11/11	Red	Regain	Wangas	Wangas		E	2	10:34	6.5		
22/11/11	Blue	Recovery	Cringle	Cringle	Cringle	E	2	10:34	6.5		
22/11/11	Green	Reclaim	Cringle	Cringle		E	2	10:34	6.5		
23/11/11	Red	Reclaim	Wangas	Wangas		SW	2	11:35	6.8		
23/11/11	Blue	Redoubt	Cringle	Walbrook		SW	2	11:35	6.8	No data in this area	
23/11/11	Green	Regain	Transponder on tug			SW	2	11:35	6.8		Figure C.8
24/11/11	Red	Resource	Wangas	Wangas		SW	4	12:31	7.1		
24/11/11	Blue	Reclaim	Cringle	Cringle	Cringle	SW	4	12:31	7.1		
24/11/11	Green	Recovery	Cringle	Cringle	Cringle	SW	4	12:31	7.1		
25/11/11	Red	Resource	Walbrook	Cringle		W	10	13:22	7.2		Figure C.9
25/11/11	Blue	Recovery	Wangas	Wangas		W	10	13:22	7.2		

Date	Colour	Tug	Head rank port	Head rank stb'd	Second rank	Wind direction	Wind Speed (m/s)	High tide at	Tidal height (m)	Notes / Comments	Path Figure
25/11/11	Green	Redoubt	Cringle	Cringle	Cringle	W	10	13:22	7.2		

Figure C.5 Cory Individual Track - 9/11/2011 - Red Track image

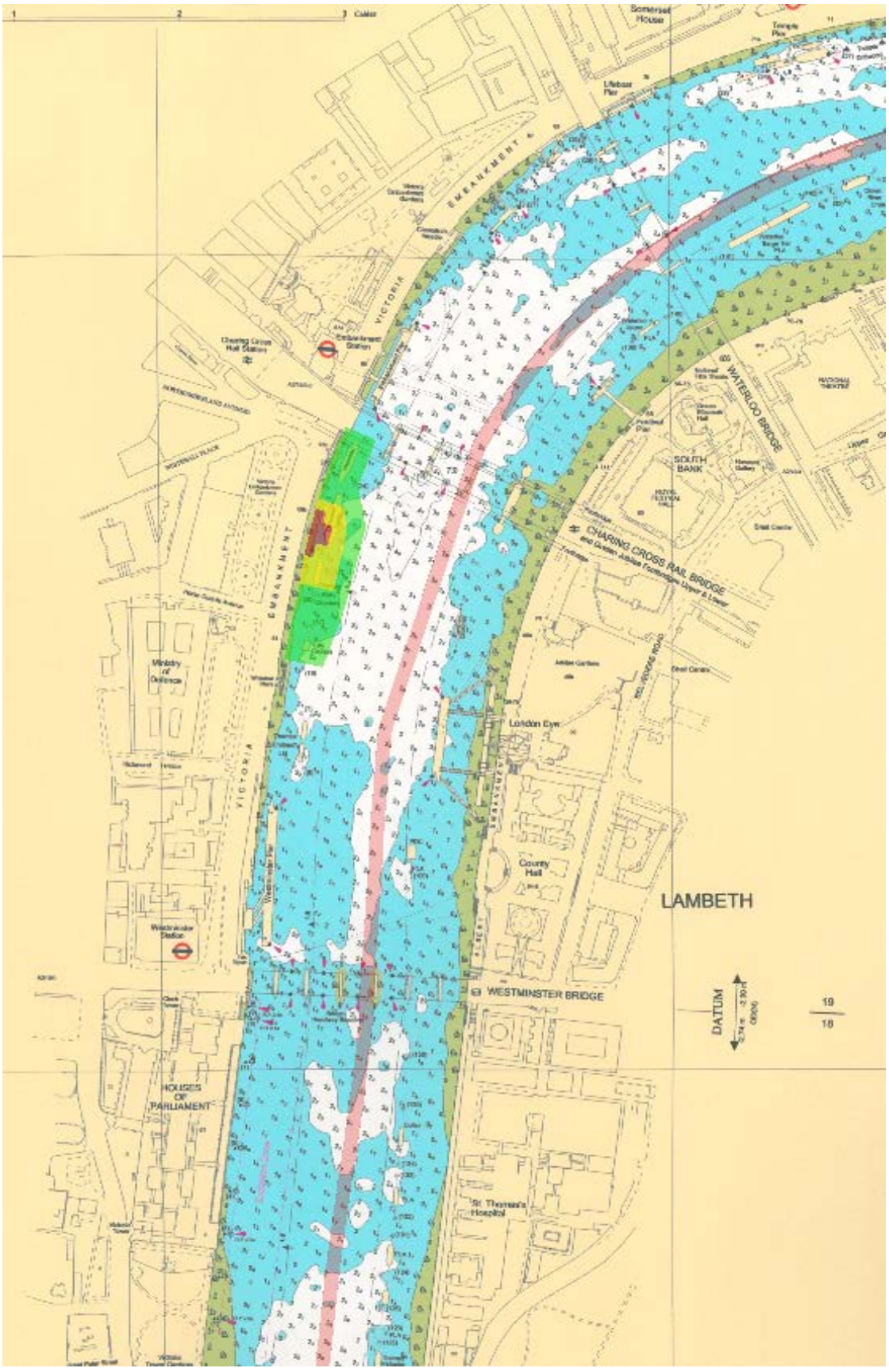


Figure C.6 Cory Individual Track - 10/11/2011 - Blue Track image

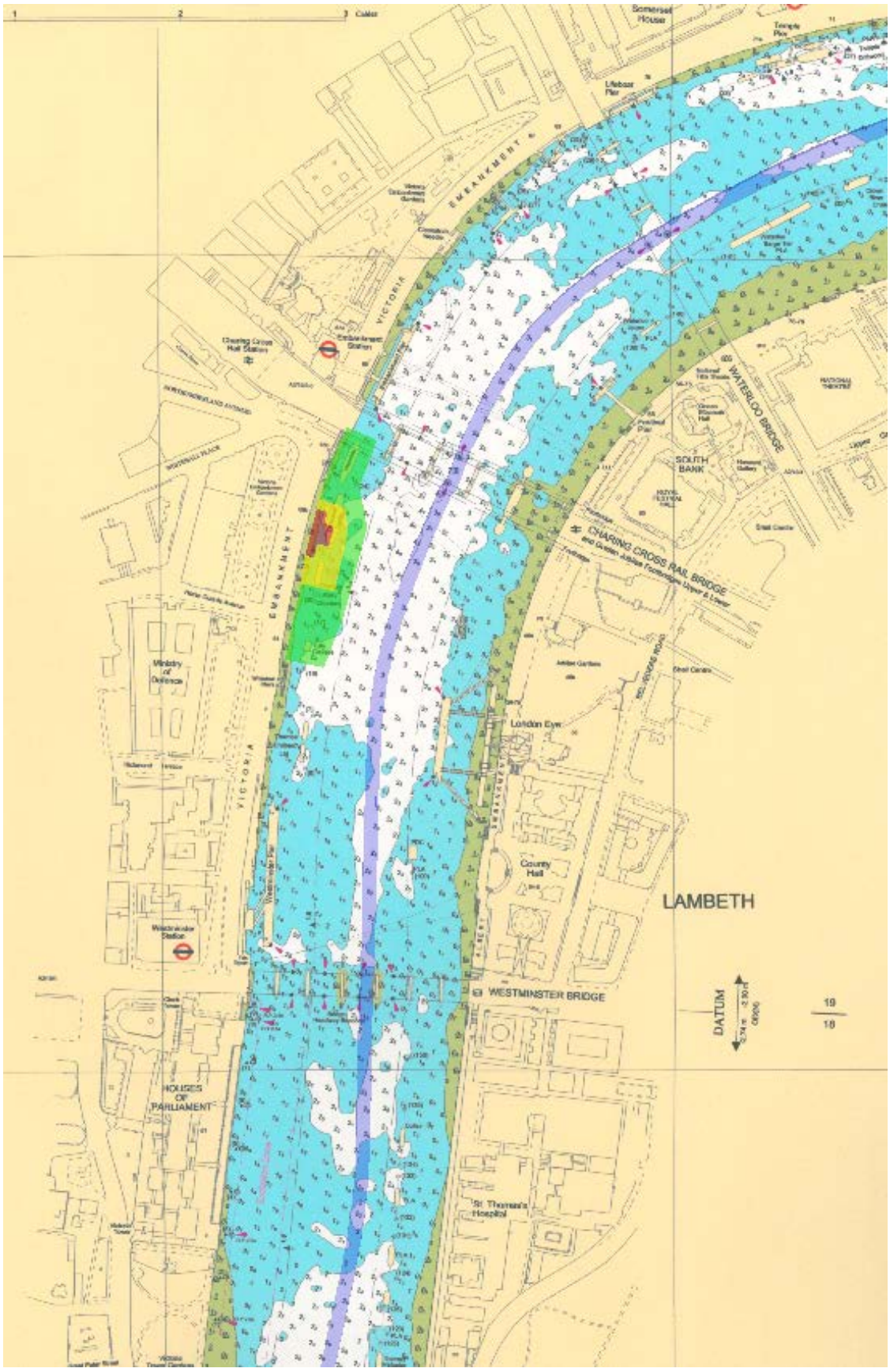


Figure C.7 Cory Individual Track - 14/11/2011 - Blue Track image

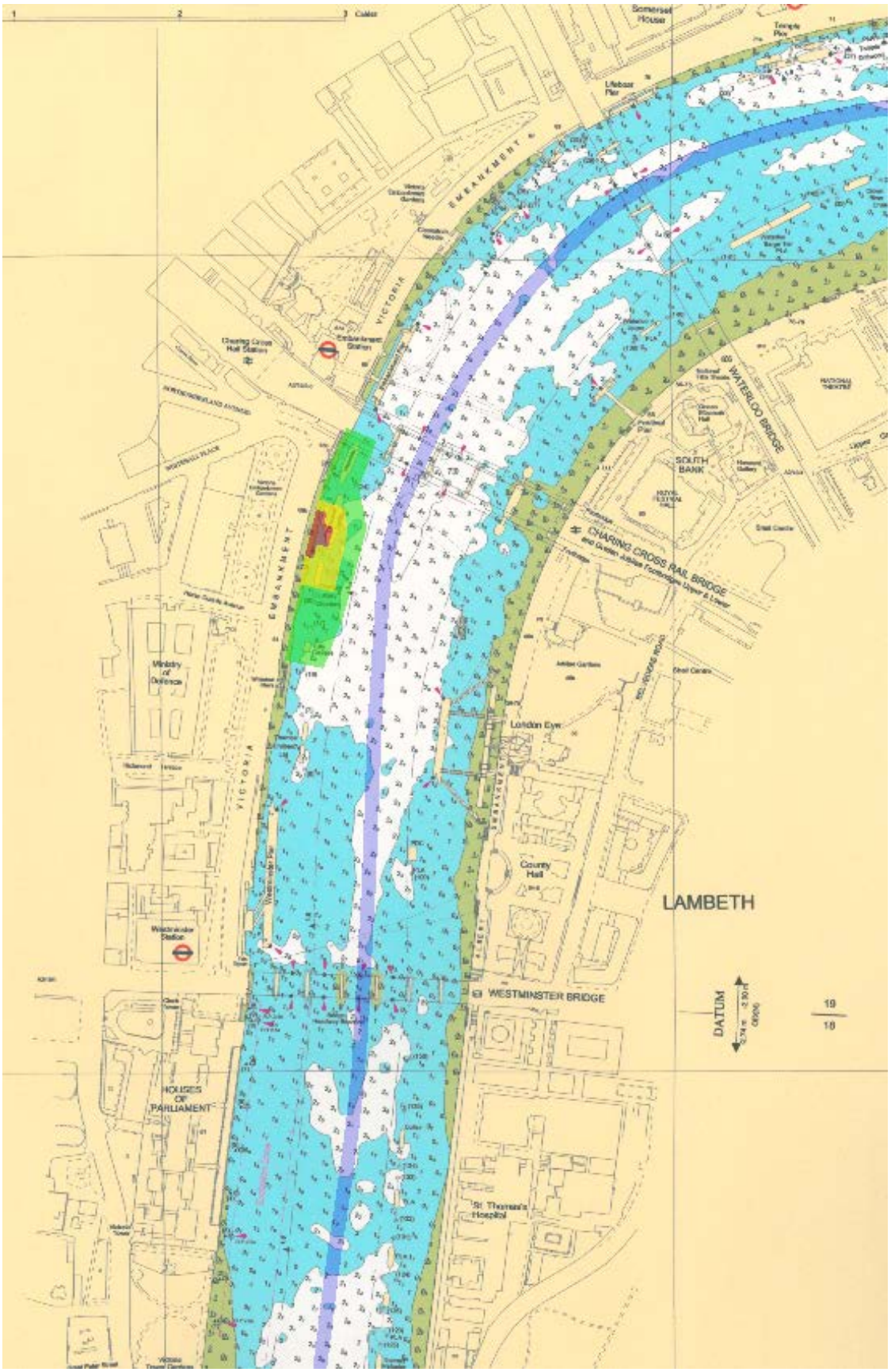


Figure C.8 Cory Individual Track - 23/11/2011 - Green Track image

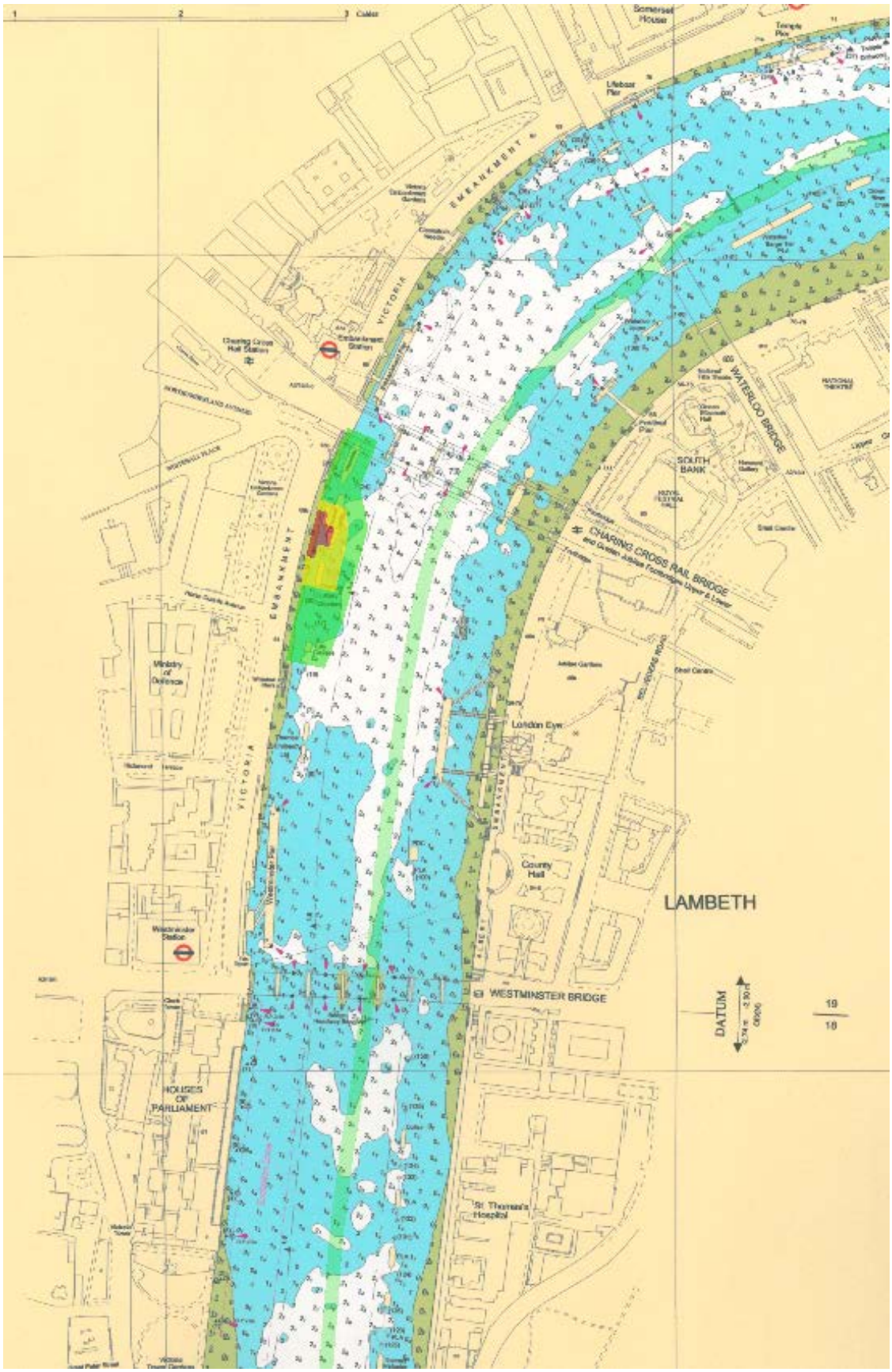
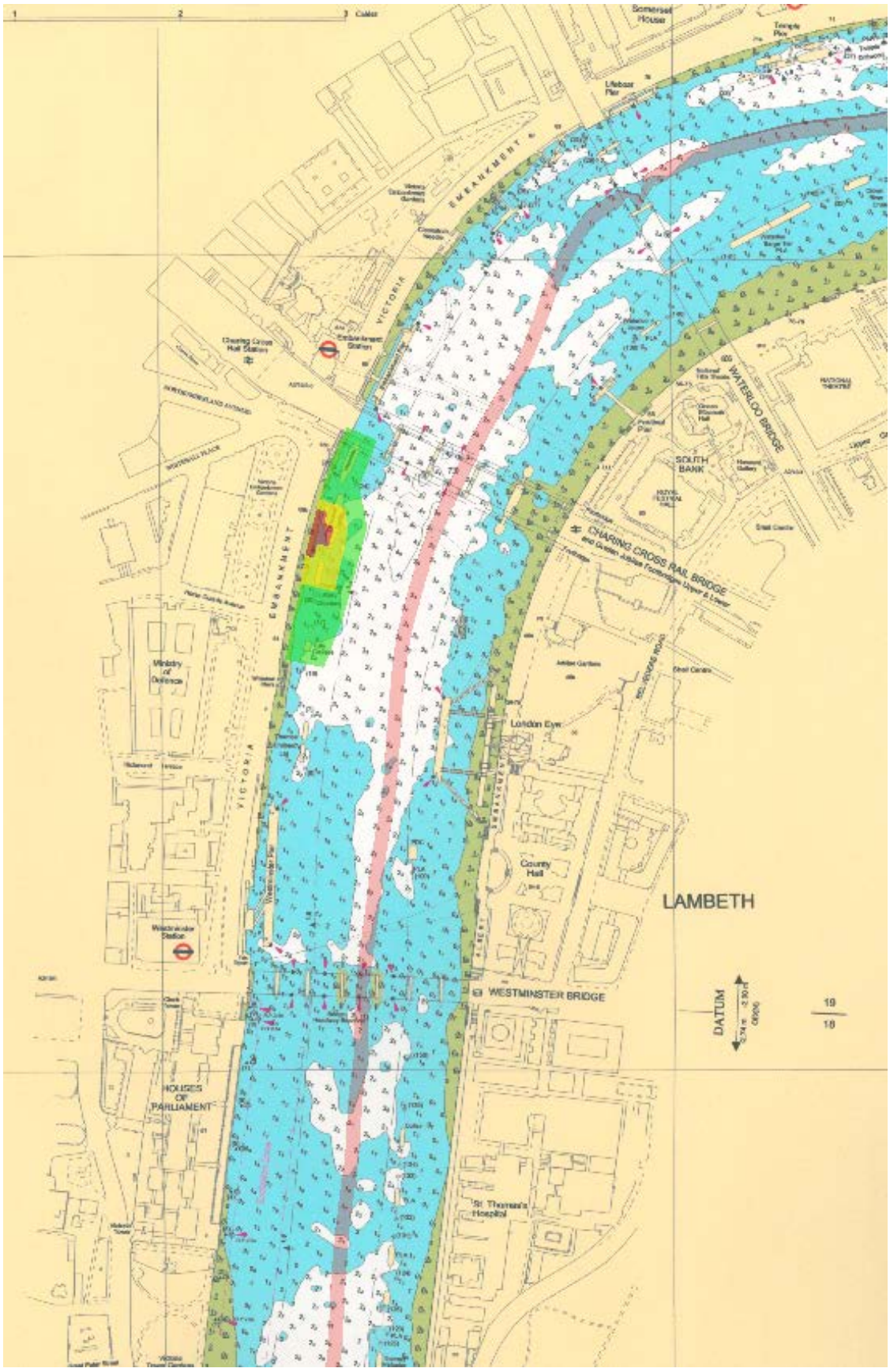


Figure C.9 Cory Individual Track - 25/11/2011 - Red Track image



Thames Water Utilities Limited
Clearwater Court, Vastern Road, Reading RG1 8DB

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