Jacobs

CSO Discharge Designers Risk Assessment Permanent Case – Blackfriars Bridge Foreshore

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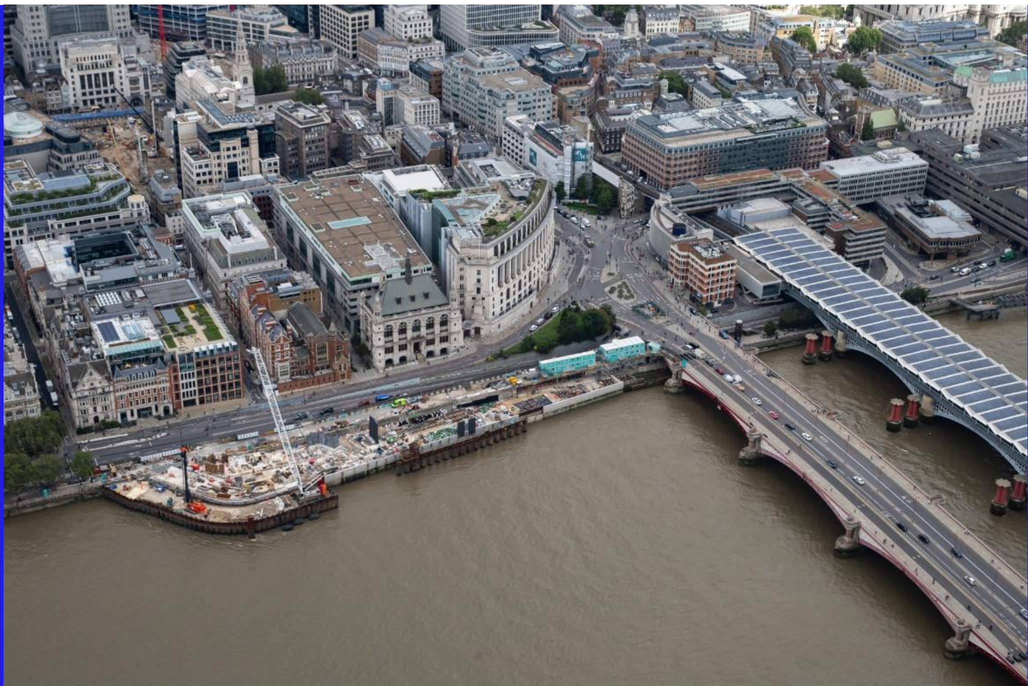
Bazalgette Tunnel Limited

Tideway
20 November 2024



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Required Approvals

	Name	Role	Signature	Date
Checked by	Phil Reed	Lead Marine Civil Engineer	*Philip Reed*	03/10/2024
Reviewed by	Ed Davies	CDM Advisor (Ports and Maritime)	*Ed Davies*	03/10/2024
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Executive summary

1.1 This designers risk assessment has been produced to assess the hazards of swamping, capsizing, grounding and collision created by the physical impact of the Fleet CSO discharge flows to vessels on the Thames at the Blackfriars Foreshore site (BLABF)

1.2 It has been undertaken for the permanent phase when the existing CSO is diverted into the new CSO that is situated further into the river Thames in the new BLABF structure.

1.3 This designers risk assessment has assessed the risk to all types of vessels that passage past the location and the impact to the vessels in Arches 2, 3 and 4, concluding that there are only impacts in Arches 2 and 3.

1.4 A most probable worst-case scenario of a 1 in 15-year event at MLWS with an instantaneous peak discharge modelled +/- 50 minutes from slack water has been analysed to assess the impacts to vessels in the bridge Arches.

1.5 All discharges should be considered as the most probable worst case where it is not possible to establish the magnitude of the discharge at the time of discharge. Consideration should be made to the magnitude of the discharge rate and the minimum period of 2 minutes and 30 seconds from the start of the discharge to a significant rate of discharge.

1.6 The Fleet CSO discharge also creates a cyclonic state around low water slack periods causing a variation of effects to passing vessels, the addition of this effect combined with the vertical component of the CSO discharge increases the risk to all vessels, with the greatest risk to un-powered vessels.

1.7 With the tunnel in permanent operation the discharges are likely to occur approximately 4 to 5 times per year reducing from the current predictions of 20 times per year when the tunnel is not in operation.

1.8 It has been concluded that the impact of the discharge occurs for 60 minutes, starting 15 minutes before MLWS and concluding 45 minutes after, this period of impact should be applied for all low tides.

1.9 The HR Wallingford simulations have demonstrated that there is some impact at high water neap slacks, this period should be considered for all high-water slack states of tide and all states of tide within 30m of the CSO outfall.

1.10 The assessment has concluded that the discharges cannot be predicted within 30m of the CSO outfall and all vessels should avoid that close proximity to the discharge at any state of the tide.

1.11 It is assumed that the same effects from the CSO discharges would be present when a Thames barrier closure is in operation and the river is in a permanent state of slack water.

1.12 Due to the limitations of the HRW modelling of the discharges, a more conservative approach to assessing the most probable worst case tidal windows could be to make an allowance for the variabilities potentially caused by environmental and climatic conditions, the tidal windows are listed below:

(a) Tidal windows across low water to be considered LW Slack +/- 60 minutes

(b) Tidal windows across high water to be considered HW slack +/- 15 minutes

1.13 It has been concluded that the overall residual risk is low for powered vessels and moderate for non-powered vessels when warning signs and lights are used to warn vessel operators during a CSO discharge event at low water subject to confirmation in the NRA, detailed design and operational plan.

1.14 Tugs towing or pushing should be considered the worst effected powered vessels where the desk study undertaken showed that all powered vessels were impacted in a very similar fashion based on categorised drift angles (with the exception of a lesser effect on uber boats) but the simulation showed that the effect was greater on tugs and tows and tugs pushing through Blackfriars Road bridge Arches 2 and 3.

1.15 It was also noted from the simulations that low powered and less manoeuvrable vessels were also greater effected from the discharge when navigating through Arch 2 of Blackfriars Road bridge.

1.16 The main works contractor FLO will need to undertake a navigational risk assessment to consider the residual risks and confirm the mitigations, in consultation with the Port of London Authority, required to be in place for the phase that is covered by this DRA.

1.17 The main works contractor FLO will need to consider the detailed design and the NRA to develop an operational plan, in consultation with the PLA, outlining how they will manage a CSO discharge event with the use of a warning system in line with Tideway's "Technical Memorandum on CSO warning performance specification and strategy".

1.18 The main works contractors FLO will revisit their navigational risk assessment and detailed design if the agreed mitigations are not sufficiently effective.

1.19 To analyse the risk in greater detail for the permanent DRA the following studies have been undertaken:

a. Simulations of the discharge flows on vessels to assess the actual impact caused by the discharges.

b. Closed circuit television (CCTV) recordings of actual vessel traffic from September 2023 to December 2023, transiting the site and analysed to determine numbers of different vessel types, when in the tide cycle they were transiting and direction of travel.

1.20 The permanent case has been risk assessed incorporating the findings of the ship simulations and will be subject to a navigational risk assessment by the Main Works Contractor to determine, in agreement with the Port of London Authority, any permanent mitigations that may be required. The Technical Memorandum on CSO warning performance specification and strategy should be considered to confirm the mitigations.

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Acronyms and abbreviations

Abbreviation	Abbreviation Description
ALARP	As Low As is Reasonably Practicable
BLABF	Blackfriars Bridge Foreshore
CCTV	Closed Circuit Television
CDM	Construction Design and Management Regulations 2015
CFD	Computational Fluid Dynamics
CSO	Combined Sewer Overflow
DRA	Designers Risk Assessment
EDM	Discharge Monitor
GPS	Global Positioning System
LAT	Lowest Astronomical Tide
LRT	Lowest Recorded Tide
LTT	London Tideway Tunnel
MHWN	Mean High Water Neaps
MHWS	Mean High Water Springs
MLWN	Mean Low Water Neaps
MLWS	Mean Low Water Springs
NRA	Navigational Risk Assessment
PLA	Port of London Authority
SCADA	Supervisory Control and Data Acquisition
TWUL	Thames Water Utilities Limited
UWWTD	Urban Waste Water Treatment Directive
VTS	Vessel Traffic Service

2. Introduction

2.1 Introduction

2.1.1 As part of the Thames Tideway Tunnel project a new foreshore structure to intercept the Fleet Main combined sewer overflow and Low-Level Sewer No1 and connect them to the main tunnel has been constructed at Blackfriars Bridge Foreshore (BLABF).

2.1.2 At the BLABF site the new combined sewer overflow (CSO) outfall will be relocated from its original location, within Arch 1 of Blackfriars Road bridge, to discharge from the new permanent structure.

2.1.3 Jacobs as the designer for the reference design has the duty under the CDM regulations to eliminate risks as far as reasonably practicable, where the risks cannot be eliminated the risks need to be reduced as far as reasonably practicable and information provided on residual risk.

2.1.4 Under the CDM regulations the Principal Designer "Jacobs" has a responsibility to plan, manage, monitor and coordinate the health and safety in the pre-construction phase of the project.

2.1.5 During the development of the design a designer's risk assessment was undertaken to identify risks through design whilst also identifying any residual risks that would need to be considered.

2.1.6 As part of Designers Risk Assessment Blackfriars Bridge Foreshore PCL1X/TA the impact of the CSO outfall was considered under risk reference CDM-BLABF-023, as presented below in Table 2-1.

Table 2-1 Extract from Designers Risk Assessment Blackfriars Bridge Foreshore PCL1X/TA

Risk ref.	Title / description	Phase	Activity	Potential hazards	Effect summary inc person at risk.	Severity	Probability	First Risk Rating	Design measures to eliminate hazards	Design measures to reduce risk and/or design assumptions	Severity	Probability	Risk Rating after E & R	Residual risk (if significant, etc.)	How is it communicated and / or documented?
CDM-BLABF-023	CSO warning sign	Operation	Normal operation of river traffic	Fleet storm relief carries a large catchment area and flows rise suddenly and quickly during rainfall events	Smaller vessels could be capsized by sudden large flows from the CSO, putting public at risk	3	2	Medium	Unable to eliminate hazard further.	Possible mitigation could include a warning sign. Exact solution will depend on outcome of navigation risk assessment carried out as part of detailed design	3	2	Medium	Smaller vessels could be capsized by sudden large flows from the CSO, putting public at risk	No further communication required

2.1.7 CDM-BLABF-23 recognises that there is a risk to vessels in the river from a discharge and identifies that the use of a warning sign as a mitigation is likely to be required but relies on the outcome of the Navigational Risk Assessment to provide the final mitigations.

2.1.8 To ensure that all the relevant risks and mitigations are covered through a Designers Risk Assessment this document will be an addendum which will consider all current information to support a detailed risk assessment of the FLEET CSO discharges impacting the vessels on the river.

2.1.9 This designer's risk assessment (DRA) considers:-

(a) The permanent case with the new foreshore structure in place and the flows able to be intercepted and diverted to the main tunnel.

(b) When the tunnel is out of operation for maintenance and inspection works.

2.1.10 The DRA makes the assessment based on the information that has been produced by the contractor - document 4410-FLOJV-BLABF-520-VZ-RG-100001 CSO Discharge Modelling for permanent works Blackfriars Bridge Foreshore, by Jacobs - the interim DRA 665397CH-BLABF-DRA-Interim-REV.01 and the updated rainfall information produced by Tideway.

2.1.11 The DRA should be read in conjunction with HR Wallingford document 4410-FLOJV-BLABF-520-VZ-RG-100001 CSO Discharge Modelling for permanent works Blackfriars Bridge Foreshore. Within the HR Wallingford report the discharges are modelled with a mean absolute error of 6% for neaps and 7% for springs when compared to the peak flow.

2.1.12 HR Wallingford document 4410-FLOJV-BLABF-520-VZ-RG-100001 CSO Discharge Modelling for permanent works Blackfriars Bridge Foreshore only considers a steady state where the variability of environmental and climatic conditions such as, but not limited to, wind, rain and surge are not considered due to the infinite, possible scenarios.

2.1.13 In addition, it considers additional information:-

(a) LL1658-R-01 Navigational Risk Assessment Review Port of London Authority, which was undertaken by Rendel Limited with Waves Group,

(b) The latest discharge modelling data and vessel impact modelling undertaken by Jacobs (and HR Wallingford Physical Model).

(c) The outputs of the HR Wallingford Ship Simulation centre; and

(d) The CCTV river traffic survey report produced by Nash Maritime.

2.2 Report Structure

2.2.1 The Structure of this report is as follows:

a. Section 3 – Outline methodology

b. Section 4 – Site discharge activity

c. Section 5 – Impact on vessels on the river

d. Section 6 – Risk assessment

e. Section 7 – Mitigations

f. Section 8 – Summary and Conclusions

g. Section 9 – References

2.3 The site and CSO discharge location

2.3.1 The BLABF site is located within the City of London, on the northern bank of the Thames, to the west of Blackfriars Road Bridge. The site extends into Arch 1 of the bridge to enable the interception of the Fleet Main CSO, whilst also allowing the construction of structures to intercept the northern Low-Level No.1. Both flows are transferred to the main tunnel, although only the Fleet Main will have a CSO in the new structure. There is no connection between the Low-Level No. 1 and the river at Blackfriars.

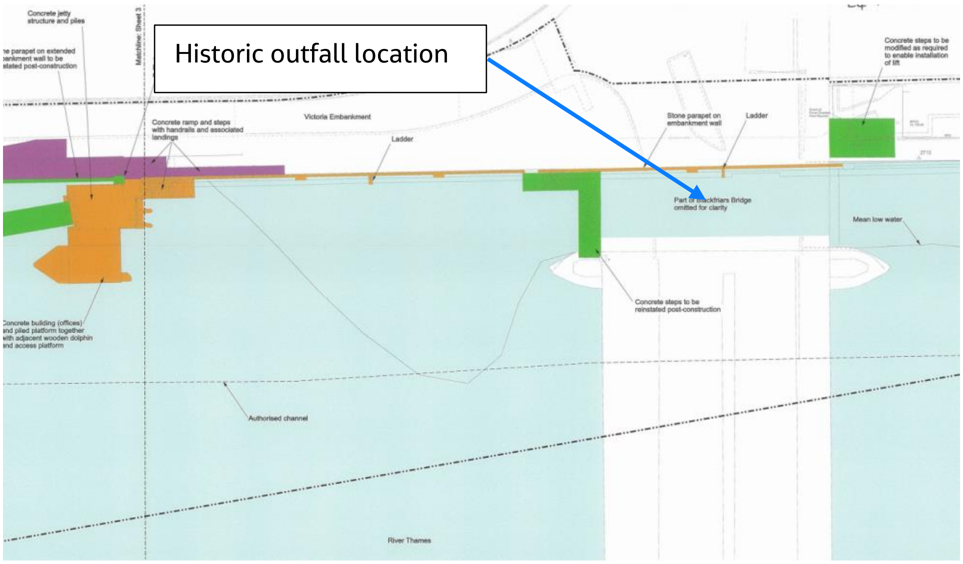
2.3.2 Prior to the construction of the site the Fleet Main CSO outfall was located within Arch 1 of Blackfriars Road Bridge and would discharge from the river wall into the bridge pier. Figure 2-1 presents the image of the Blackfriars Bridge Foreshore site, prior to the site being constructed. Arch 1 is indicated. Figure 2-2 presents the image of the Fleet Main CSO outfall within Arch 1.

Figure 2-1 Blackfriars Bridge Foreshore site before Tideway.

Figure 2-2 Fleet Main CSO outfall under Blackfriars Bridge

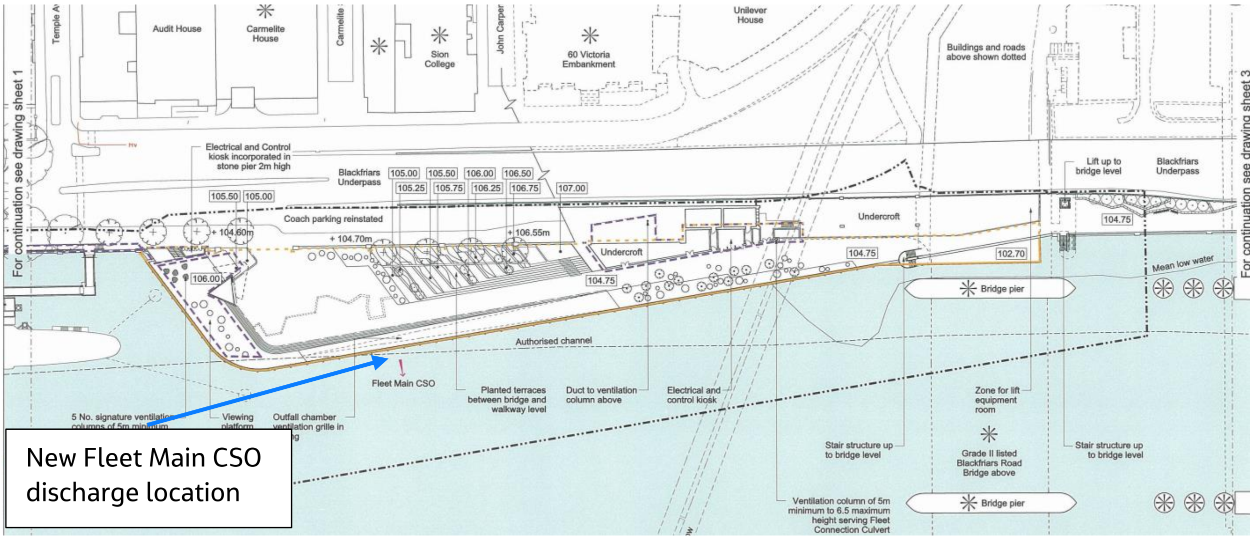
2.3.3 Figure 2-3 presents an extract of the demolition drawings with the historical outfall point indicated.

Figure 2-3 Extract of DCO-PP-17X-BLABF-190008 showing the Fleet Main CSO discharge point.



2.3.4 The new foreshore structure projects into the river and moves the Main Fleet CSO outfall approximately 160m upstream and 25m further into the river. Figure 2-4 presents the permanent works arrangement with the new outfall location.

Figure 2-4 Permanent works arrangement.



2.3.5 It should be noted that the cross-sectional area of the new Fleet Main CSO is 1.4 times larger than that of the original.

3. Outline Methodology

3.1 To analyse the impact of a CSO discharges from the site to the river, identify the risks to vessels on the river, identify the impacted vessels, propose mitigations and present the residual risks the following has been undertaken:

3.1.1 Confirm site discharge activity by:

i) Reviewing historical rain and discharge data

ii) Reviewing resilience to climate change

iii) Analyse tidal windows to confirm worst case

iv) Review and analyse the impact of discharges on the river from 4410-FLOJV-BLABF-520-VZ-RG-100001 CSO Discharge Modelling.

3.1.2 Review impact of worst-case discharge on vessels on the river by:

i) Defining areas of the river for navigation

ii) Confirming vessels that use the river in this area

iii) Confirming predicted drift angle of vessels caused by a Fleet Main CSO discharge

iv) Summarise impacted vessels on the river

3.1.3 Risk assessment

i) Hazards

ii) Receptors, incorporating the CCTV survey data reports

iii) Severity of harm

iv) Likelihood of harm

3.1.4 ERIC approach to review mitigation

i) Eliminate

ii) Reduce

iii) Inform

iv) Control

3.1.5 Summary

4. Site discharge activity

4.1 Consideration of rainfall events

4.1.1 CSO discharges were produced for a range of return period storms using an InfoWorks network model of the upstream sewer catchment.

4.1.2 Synthetic storms were generated by the software based on the Flood Estimation Handbook (FEH).

4.1.3 The critical storm duration for the system (i.e., that which produces the highest flows at the outfall) was found to be 120 minutes.

4.1.4 Normally, when generating synthetic storm events, rainfall intensities are reduced as the footprint of a storm increases. However, in this instance, the storm event was applied over the entire catchment without applying an areal reduction factor.

4.1.5 With an approximate catchment area of 550km^2, the corresponding reduction factor for the Tideway catchment would have been 0.76 - the rainfall intensities are therefore overestimated by approximately 32%.

4.1.6 In addition, the model assumes that all rainfall landing on a catchment freely enters the sewer system. In practise, for higher rainfall intensities, this cannot happen as the gullies and upstream collection pipework act as a restriction, resulting in flooding and ponding on the surface. For this reason, the modelled 100-year storm flows are considered theoretical and unlikely to ever be realised. It is the upstream sewer system that limits the peak CSO discharge rate, not the size of the CSO opening itself.

4.1.7 The InfoWorks model of the existing sewer network, without the London Tideway Tunnel, was run with free discharge as a worst-case scenario (i.e. low tide) and the flow rates included in the project's works information (WI 7706). These WI flows are shown in Table 4-1. The peak flow from the Fleet Main CSO was found to be approximately 46m^3/s for a 15-year storm.

4.1.8 Periodic updates are made to the model depending on the results of surveys/inspections. Discharge rates using the updated model are also given in Table 4-1. Peak flows are slightly less, but broadly similar.

4.1.9 At higher tides the CSO becomes submerged and there is a corresponding decrease in discharge rates, also included in Table 4-1.

Table 4-1 Comparison of Instantaneous peak discharge rates from WI 7706 and the updated model

Source		Typical Year Storm	LT 2-year storm	LT 5-year storm	LT 10-year storm	LT 15-year storm	LT 30-year storm	LT 50-year storm	LT 100-year storm
Latest DA Model	Instantaneous Peak Low water (m^3/Sec)	-	24.3	32.8	40.1	44.1	50.3	55.2	61.5
Latest DA Model	Rolling Hourly Average Low water (m^3/Sec)	-	19.2	29.8	37.1	41.2	47.0	51.3	56.6
Latest DA Model	Instantaneous Peak High water (m^3/Sec)	-	14.7	26.4	33.1	37.1	44.0	47.1	50.1
WI 7706	Instantaneous Peak Flow	22.6	24.3	33.5	41.5	46.0	51.0	-	-

4.1.10 It should be noted that occasionally TWUL can make minor diversions to the sewer network upstream to facilitate maintenance access. However, these are generally local in nature and don't have a significant impact on CSO discharges.

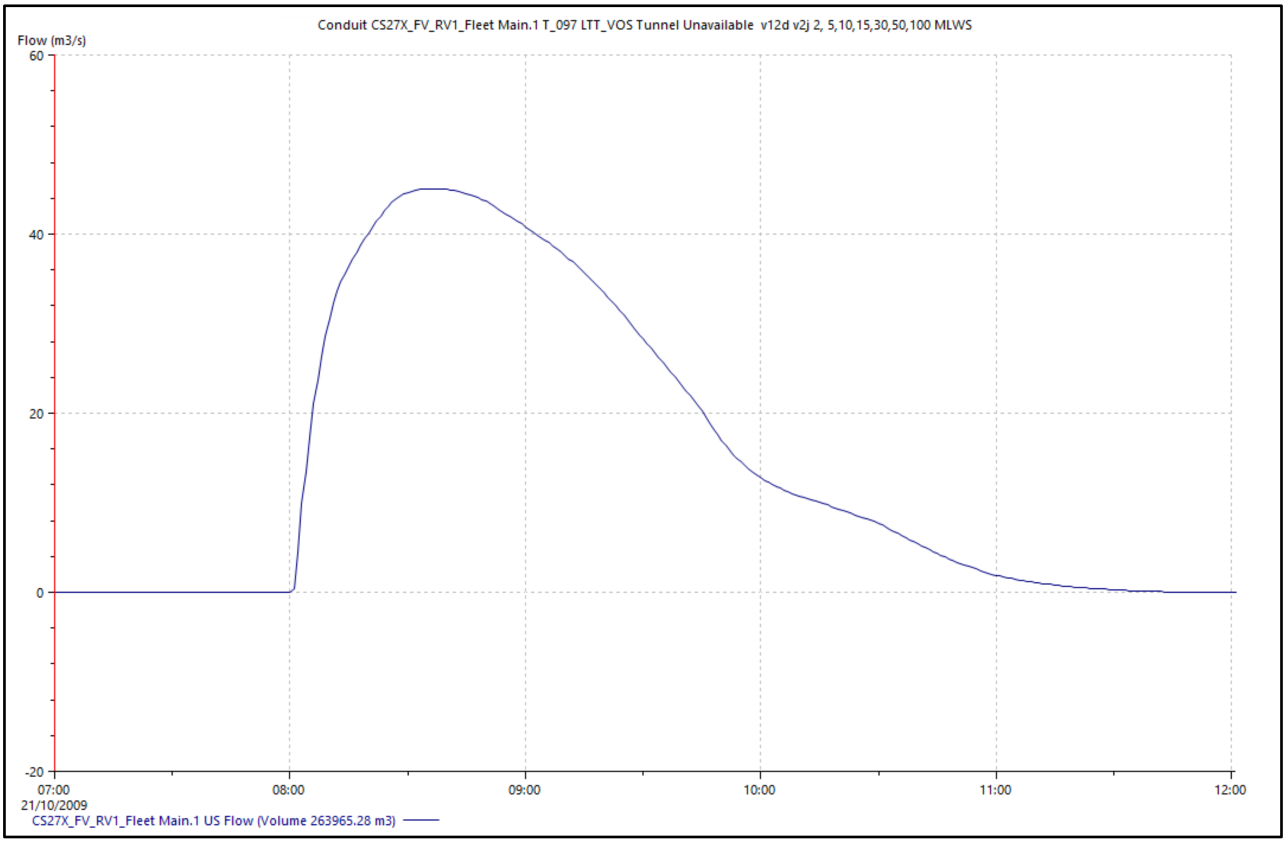
4.1.11 The developed nature of the upstream catchment means it is not possible to make substantial changes to the network connectivity that could significantly affect peak CSO discharges. Ultimately there is a fixed amount of rainfall falling on a fixed area, served by a sewer system of fixed and limited capacity.

4.1.12 Only when the works are complete will there be planned works that significantly impact CSO discharges. Every 10 years it is planned to close the tunnel for inspections - under these conditions all flow is diverted to the CSO. Whilst the exact duration of the closure is yet to be finalised, it is expected to be of the order of two weeks.

4.1.13 61m3/s is the notional peak flow from the Fleet Main CSO, which occurs during a 100-year storm event. However, given the conservative nature of the rainfall generation, the theoretical nature of the network modelling, the limited scope to significantly alter the upstream sewer network and the range of possible tide levels, 46m^3/s is considered a more realistic 'real world' maximum CSO discharge rate.

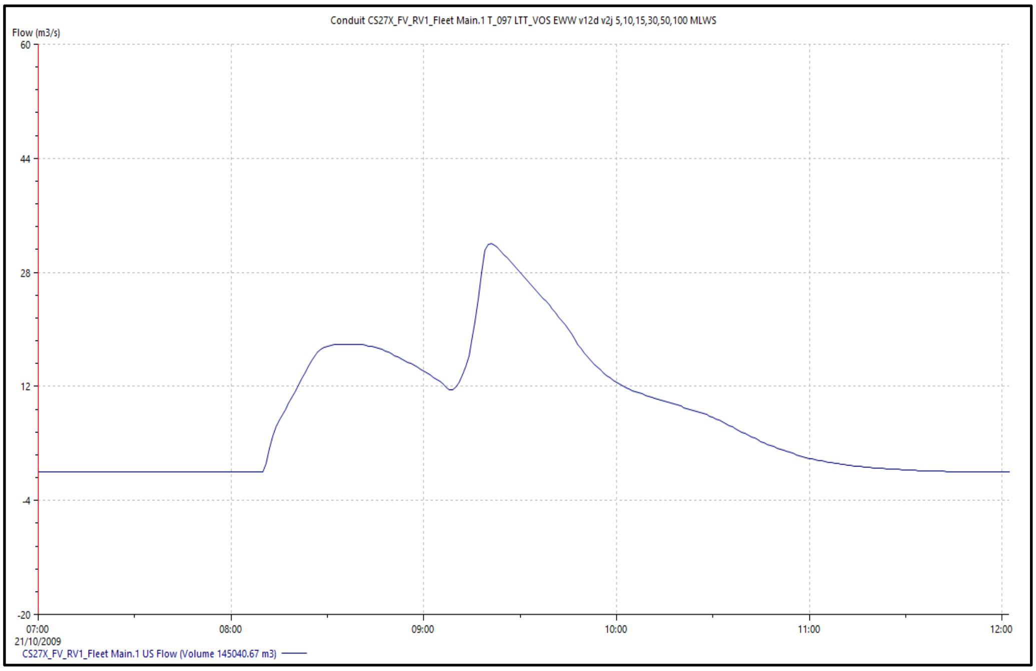
4.1.14 Figure 4-1 shows the discharge hydrograph for the 15-year storm at low tide, using the latest Design authority model. The hydrograph represents the 'Tunnel not in operation' scenario. In this instance the storm started at 07:00 - it took approximately 60 minutes for the CSO to start discharging and approximately another 35 minutes for the peak discharge (approximately 46m3/s) to be realised.

Figure 4-1 CSO Discharge Hydrograph for the 15-year storm, tunnel not in operation closed



4.1.15 Figure 4-2 shows the 15-year discharge hydrograph representing the 'Tunnel Operational' scenario. The onset of the CSO discharge is delayed by approximately 10 minutes and the hydrograph shows a 'double peak'. This is because, at Blackfriars, flow to the tunnel is limited to approximately 30m^3/s (to facilitate de-aeration). The first peak is due to the difference between this and the design flow of 46m3/s. The second peak is seen when the tunnel reaches capacity and is closed. Peak flow to the river is approximately 31.5m3/s. The Hydrograph shows that during the initial discharge a rate of 5m^3/sec occurs within approximately 2 minutes and 30 seconds of the commencement of the discharge. Where 5m^3/sec could cause a significant impact to passing vessels.

Figure 4-2 CSO Discharge Hydrograph for the 15-year storm, tunnel operational



4.1.16 At the design phase of the project, 40 years of recorded rainfall data was available, spanning 1970-2010. Following inspection of this data set it was determined that the most representative (typical) year was October 1979 to September 1980. A further review of the data up to 2020 has confirmed that this remains the case.

4.1.17 Table 4-2 summarises the peak CSO discharges at BLABF during the typical year (1979/80).

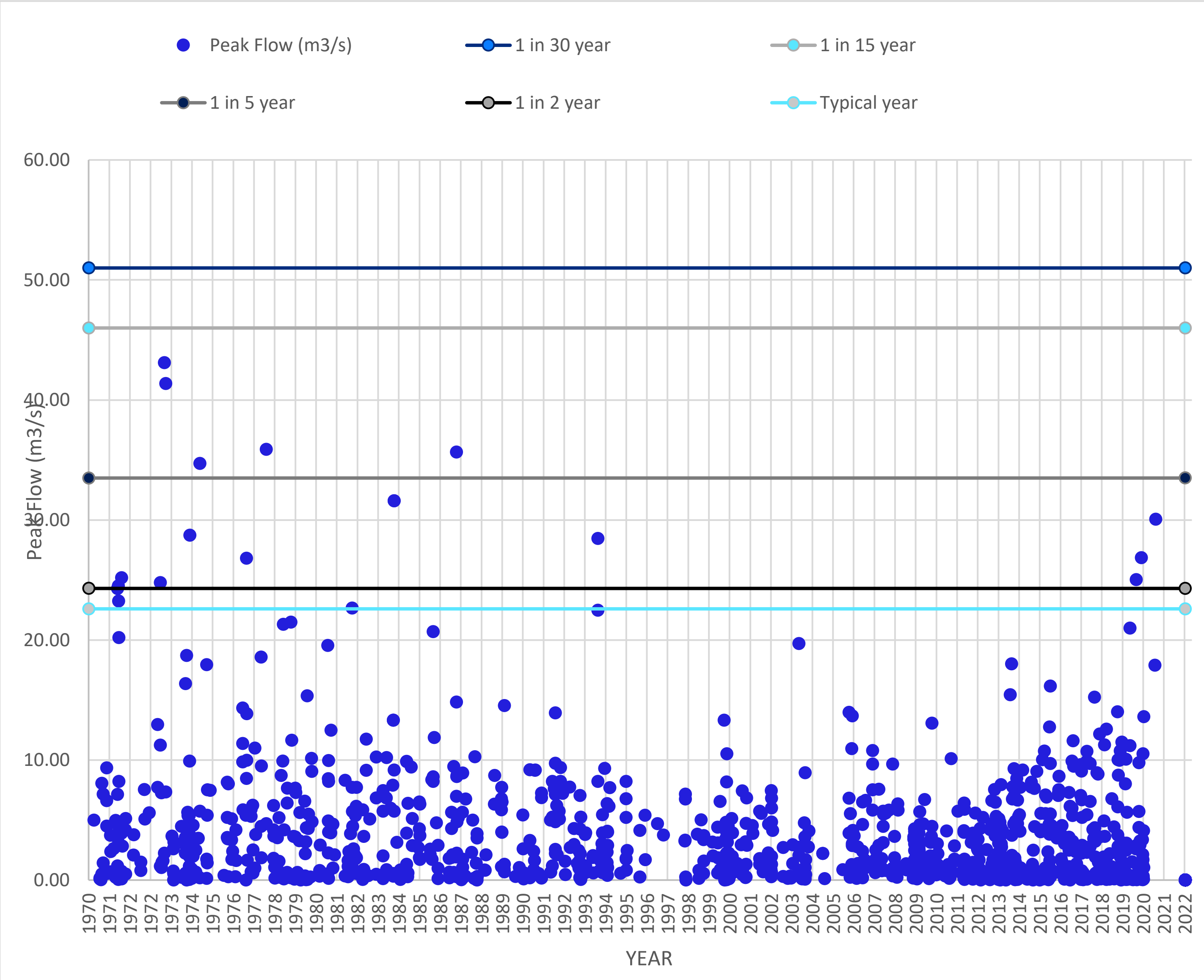
Table 4-2 Peak CSO discharges during typical year (1979/80)

Start of Spill	Spill Duration (mins)	Peak Flow (m3/s)	Spill Volume (m3)
09/10/1979 06:50	265	23.5	83,437
25/10/1979 14:05	370	13.2	66,774
26/11/1979 15:15	185	3.6	14,502
27/12/1979 02:05	682	4.5	76,156
03/01/1980 22:30	181	7.6	19,791
03/02/1980 15:25	96	0.6	1,177
06/03/1980 09:55	173	3.2	14,958
17/03/1980 07:45	317	5.7	40,590
31/03/1980 10:35	59	0.2	81
10/06/1980 14:45	58	0.2	76
13/06/1980 02:05	193	6.9	25,272

17/06/1980 17:40	74	0.3	349
22/06/1980 10:35	156	2.2	6,340
Start of Spill	**Spill Duration (mins)**	**Peak Flow (m3/s)**	**Spill Volume (m3)**
24/06/1980 09:55	147	3.1	8,319
30/06/1980 19:50	221	3.1	19,812
07/07/1980 14:05	166	4.3	14,125
25/07/1980 23:50	247	17.7	106,999
12/08/1980 21:40	147	4.2	11,721
14/08/1980 19:11	193	5.6	28,375
21/09/1980 11:40	63	0.2	145

4.1.18 Figure 4-3 below shows the simulated peak flows from the Fleet Main CSO outfall using the full set of actual rainfall data for 1970-2020.

Figure 4-3 Simulated peak flows from Fleet Main CSO outfall using actual weather data from 1970-2020 against the WI 7706 return periods.



4.1.19 From analysis of Figure 4-3 Simulated peak flows from Fleet Main CSO outfall using actual weather data from 1970-2020 against the WI 7706 return periods. It can be seen that there were only 18 modelled events that exceeded the typical year discharge threshold and only 5 of those that exceeded the 1:5-year discharge threshold whilst there were no exceedances of the 1:15 discharge threshold.

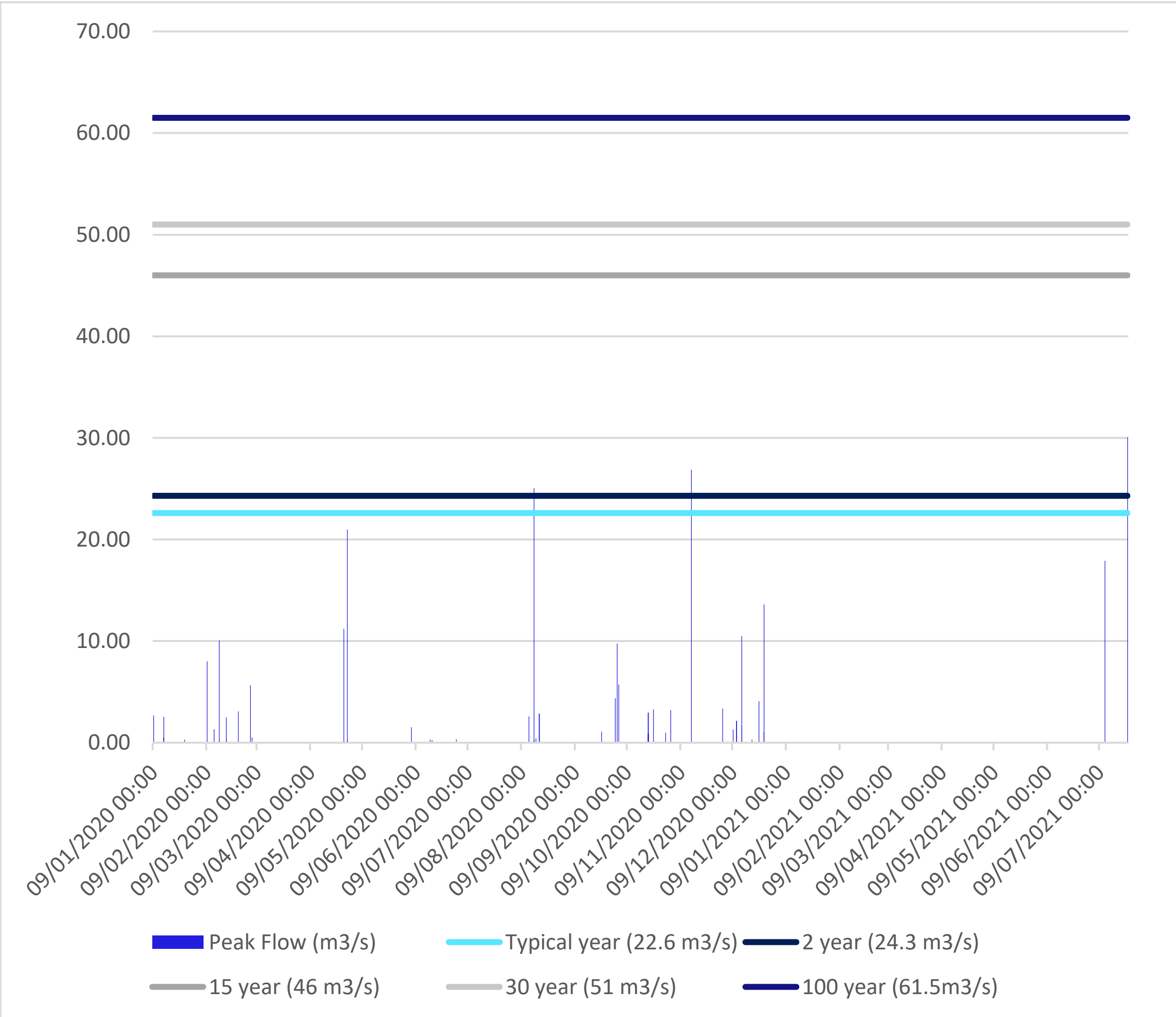
4.2 Discharge frequency and magnitude

4.2.1 The BLABF structure will be in intercepting both the Low Level 1 and the Fleet Main CSO who's flows will be diverted to the main tunnel, however there will be periods when the tunnel will be taken out of operation for inspection and maintenance. During these periods the tunnel will be isolated, and the intercepted flows will discharge through the new CSO. Whilst these works will be planned to be undertaken during periods of low flow there may be storms and therefore the magnitude of these discharges and the potential frequency needs to be understood.

Magnitude

4.2.2 The 2020 flows are presented in Figure 4-4 which also includes two storms from July 2021 which were noted for their intensity.

Figure 4-4 Modelled Fleet Main CSO discharge peak rates with actual rain data for 2020, including storms from July 2021



4.2.3 From the information presented in Figure 4-4 the average instantaneous peak discharge rate during 2020 was 3.8m^3/s with a maximum instantaneous peak of 26.85m^3/s. During the 2021 summer storm the modelled Fleet Main CSO discharge rate was 30.05m^3/s.

Frequency

4.2.4 In 2019 3 event duration monitors (EDM) were installed in the Fleet CSO to enable TWUL to deliver against the regulatory requirement to report CSO discharges capturing the number of discharges and their duration. The records from the Fleet EDMs started being reported from 2020 and since installation the 3 EDM have recorded between 39 and 125 discharges per year. It should be noted from the 3 EDMs located in the Fleet CSO, the EDM that is located at the CSO discharge has been given a long-term yearly average of 20 discharges by TWUL in their reporting to the Environment Agency.

Climate change

4.2.5 During the development of the scheme and in support of the application for Development Consent, Tideway produced document 7.23 Resilience to Change. This document was developed to assess whether the scheme would continue to meet the Urban Waste Water Treatment Directive UWWTD) requirements in the future whilst taking into consideration climate change and population increase.

4.2.6 The baseline data for the frequency and volume of CSO discharges was developed from the 1979/80 typical year of 588mm of rainfall depth which when modelled indicated a discharge of circa 39 million m^3 of sewage into the Thames.

4.2.7 Table 6.3 from document 7.23 presents the typical year CSO spill volumes and event count comparisons for the current climate and medium emission modelled scenarios from the UKCP09 government data on climate change. Table 4-3 below is the extract from that table for the modelled CSO discharges from Fleet Main at BLABF.

Table 4-3 Extract of table 6.3 from document 7.23 - typical year CSO spill volumes and event count comparisons for the current climate and medium emission modelled scenarios

LTT ID	EA Category	CSO Name	Typical Year - 2020 population and current climate			Typical year - 2080 population and medium emission scenario, 10 percentile			Typical year - 2080 population and medium emission scenario, 50 percentile			Typical year - 2080 population and medium emission scenario, 90 percentile		
			Total Volume (m^3)	No. of Spills	Spill Duration (Hrs)	Total Volume (m^3)	No. of Spills	Spill Duration (Hrs)	Total Volume (m^3)	No. of Spills	Spill Duration (Hrs)	Total Volume (m^3)	No. of Spills	Spill Duration (Hrs)
CS27X	Cat 1	Fleet Main	37,000	4	14	61,800	2	11	89,000	3	15	130,800	5	25

4.2.8 Table 4-3 demonstrates that the predicted CSO discharge frequency at BLABF is not expected to increase significantly.

4.2.9 The UK government updated the climate scenarios and presented them as UKCP18. Tideway reviewed the information to confirm that the scheme would still meet its UWWTD requirements in the future. The review confirmed there had not been significant change in the outcomes and the resilience of the scheme as described in document 7.23 still held true.

4.2.10 Table 4-4 summarises the peak rainfall climate change allowances in England up to 2125, extracted from the DEFRA website.

Table 4-4 Peak rainfall climate change allowances up to 2125

	Storm Return Period	
	30 year	100 year
Central Range (50th %ile)	20%	25%
Upper Range (95th %ile)	35%	40%

4.2.11 These allowances are of the same order of magnitude as the overestimation of the synthetic rainfall intensities explained in paragraph 4.1.5 (32%). It can therefore be considered that climate change has been adequately allowed for.

4.2.12 Notwithstanding the above, any future increase in rainfall intensities will not have a significant impact on the peak Fleet Main CSO discharge rates for the reasons set out in paragraph 4.1.6.

4.3 Tidal Considerations

4.3.1 This section is to consider the HR Wallingford report 4410-FLOJV-BLABF-520-VZ-RG-100001-CSO discharge modelling for permanent works at Blackfriars Bridge Foreshore to confirm the worst-case scenario and the impact of a CSO discharge across the tidal range.

4.3.2 The1:15-year return HR Wallingford plumes will be used to assess the zone of impact of the lateral flow on the river with its associated tidal window and is the most probable worst-case return period event that could occur without warning during a maintenance period.

4.3.3 The HR Wallingford document was commissioned to provide 2-d depth averaged velocity discharge plumes using the instantaneous peak velocities for a typical year (1:1) and 1:15 -year events at the following tide states shown in Table 4-5. Depth average velocity is the average velocity at any location within the stream and typically occurs at 60% of the depth, measured from the top

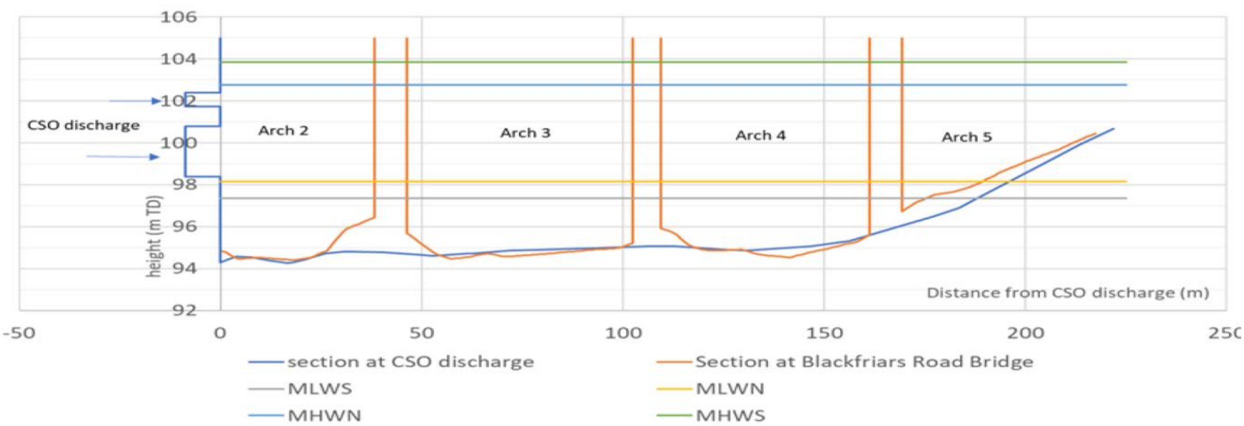
4.3.4 The report states that in considering the results it should be remembered that the model is 2D depth-averaged and hence will not model the detail of 3D aspects of the jet, especially within the distance taken for the expanding jet to mix fully with the receiving waters. Therefore, care should be taken in assessing the results close to the discharge point. Beyond 20 to 30 m of the discharge point the jet would be expected to be mixed with the receiving waters and the general modelled flow patterns are reliable. It has therefore been concluded that any effects within that zone are unpredictable and therefore the impacts within that zone cannot be established and will be considered as worst case.

Table 4-5 HR Wallingford modelling tidal discharge cases

Tidal condition	Tidal States			
Spring tide	Low water slack	Mid-ebb flow	Mid-flood flow	High water slack
Neap tide	Low water slack	Mid-ebb flow	Mid-flood flow	High water slack

4.3.5 The height of the new CSO outfall, relative to the riverbed and the river level is presented in Figure 4-5. The figure also identifies the distance to the relevant bridge arches.

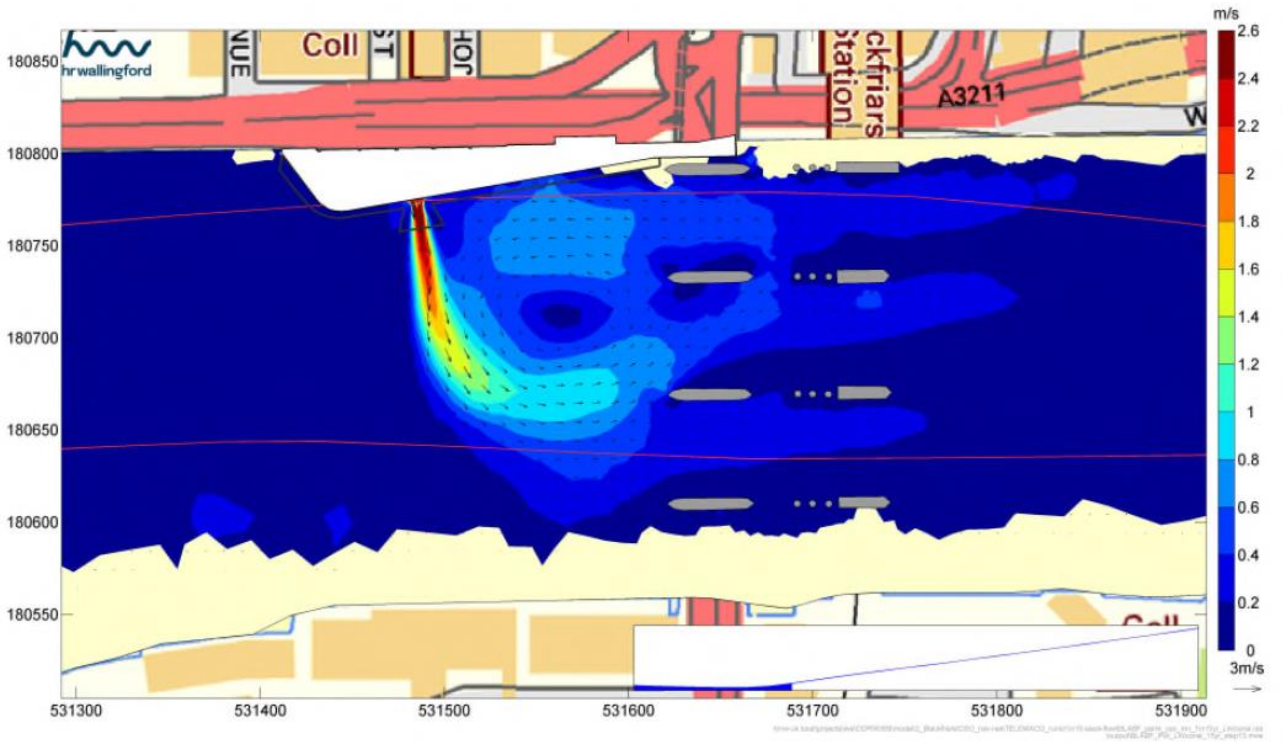
Figure 4-5 River section showing the new CSO outfall position relative to the river bed and piers of Blackfriars Road Bridge.



4.4 Zone of Fleet Main CSO discharge impact

4.4.1 Figure 4-6 presents the 1:15-year return period event at spring low water which indicates a CSO discharge velocity of approximately 2.6m/s from the outfall. The lateral flow maintains this velocity perpendicular to the channel for approximately 40m before it starts decreasing to 1.8m/s by the time it gets to mid channel. From that point the lateral flow starts to veer eastwards towards Arch 4 whilst decreasing further, to 0.6m/s as it enters the Arch, although the flow is now running west to east. The remainder of the flow velocity dissipates through the Arches becoming negligible as it clears Blackfriars Rail bridge. It is also noted that there is potentially some cyclonic effect creating a south-north current of 0.6m/s as it enters arch 3 and continues to rotate the flow east to west in front of Arch 2 and the new foreshore structure.

Figure 4-6 1:15-year return period depth average currents at spring low water slacks

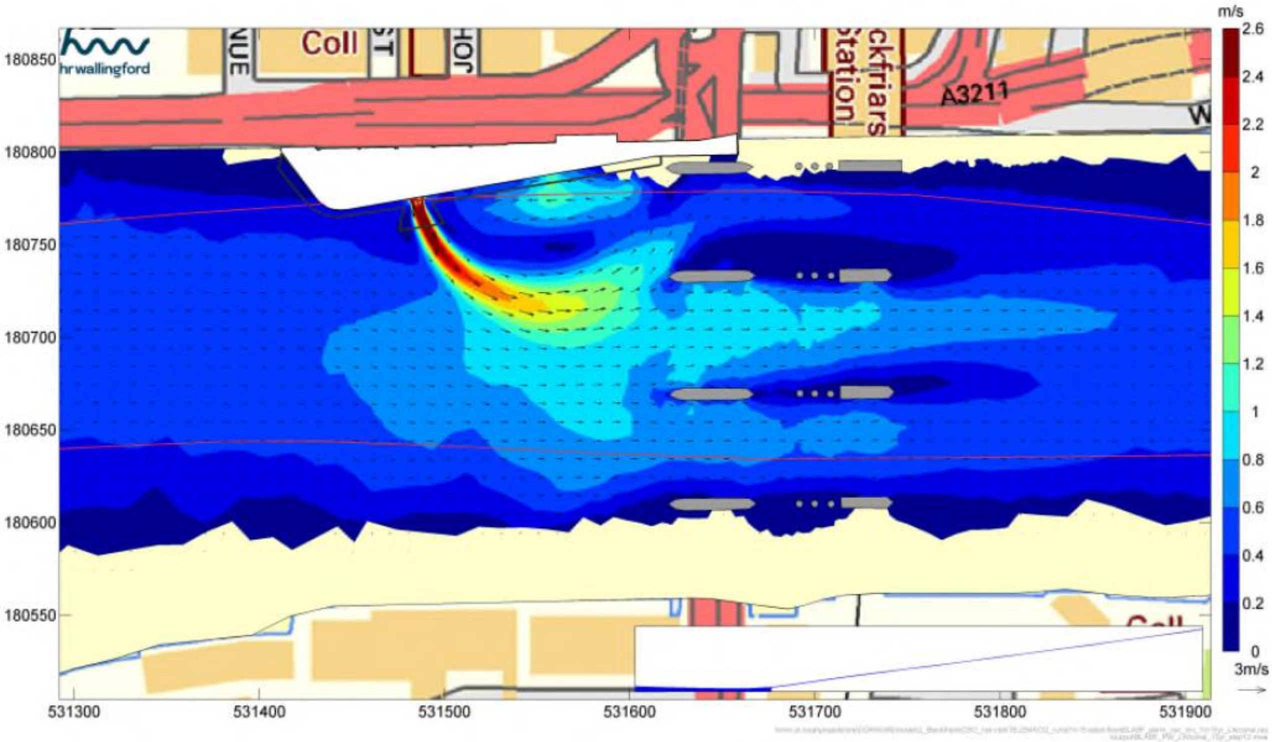


4.4.2 During the low water period the vessels moving upstream will be able to pass through Arches 2 without being impacted by the lateral flow. As they exit the arch the vessels will see the Fleet Main CSO discharging into the river and will receive a flow of approximately 2-2.5m/s on the beam as they pass the Fleet Main CSO. Once the vessel has passed through the lateral flow, approximately 20m wide, the vessel can continue its passage unaffected. A vessel moving upstream through Arch 3 may be slightly impacted from the south to north current before receiving the current on the bow. As it continues to progress upstream it will start to receive a lateral flow of approximately 1.8-2m/s on the beam.

4.4.3 During the low water period vessels moving downstream will be impacted by the lateral flow prior to navigating through Arches 3 and 4. As they pass the Fleet CSO outfall they will receive a flow of 1.2 – 1.8m/s on the beam. A vessel seeking to navigate through Arch 3 will pass through approximately 30m of lateral flow before being able to continue its passage with the potential to of being affected by the south north current is it enters the arch. A vessel seeking to navigate through Arch 4 will join the flow as it veers eastward and will be pushed through the Arch moving clear of the flow downstream of the bridge.

4.4.4 Figure 4-7 shows the depth average currents at 10 minutes before spring low water slacks for a 1:15-year event. A vessel passing upstream through Arch 3 during this period will receive the lateral flow on the bow whereas a vessel passing downstream through Arch 3 will receive the discharge on the stern. Vessels passing through Arch 4 will be unaffected. A vessel transiting upstream through Arch 2 may be affected from a small south to north current before being pushed by the current upstream towards the discharge, at this point the vessel would pass through the lateral flow, of approximately 2.6m/s before continuing upstream.

Figure 4-7 1:15-year return period depth averaged currents at 10 minutes before Spring low water slack

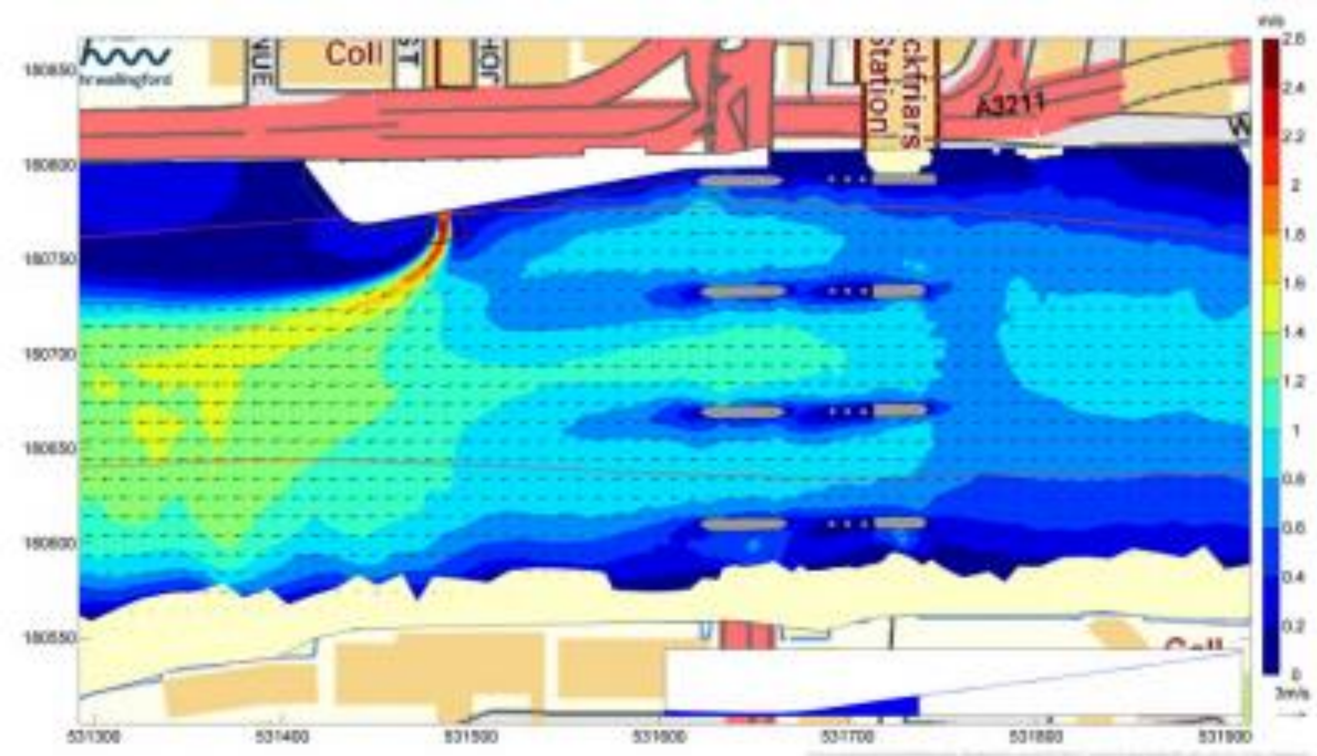


4.4.5 Figure 4-8 shows the depth average currents at 40 minutes after spring low water slacks for a 1:15-year event. Vessels transiting upstream through Arch 2 will be unaffected until it reaches the area of the Fleet Main CSO outfall, the vessels will then receive the lateral flow of approximately 2m/s on the beam.

4.4.6 Vessels passing upstream through Arch 3 will be unaffected until passing the western end of the new structure where a slight increase in current (0.2m/s) on the rear quarter, however this is primarily in alignment with the main river flow.

4.4.7 Vessels transiting downstream will receive the slight increase in flow (0.2m/s) on the port bow as it approaches the western end of the new structure which decreases to the main river flow as it passes the western end of the structure and can continue downstream unimpeded through either Arches 3 or 4.

Figure 4-8 1:15-year return period depth averaged currents at 40 minutes after Spring low water slack



4.4.8 After further analysis of the HR Wallingford reports for the period up to 50 minutes after spring low water it has been determined that vessels could be impacted by the lateral discharge from 10 minutes before low water to 40 minutes after spring low water. Outside of this period vessels in the centre or just north of centre of the channel will predominantly receiving flows on the bow, and not be affecting the vessels course. It is therefore considered that the tidal window during which mitigations would need to be in place would be from 10 minutes before low water to 40 minutes after low water. Furthermore, when considering the impacts during the neap tide there is no change to the impacting period due to the additional depth of water dissipating the lateral flow.

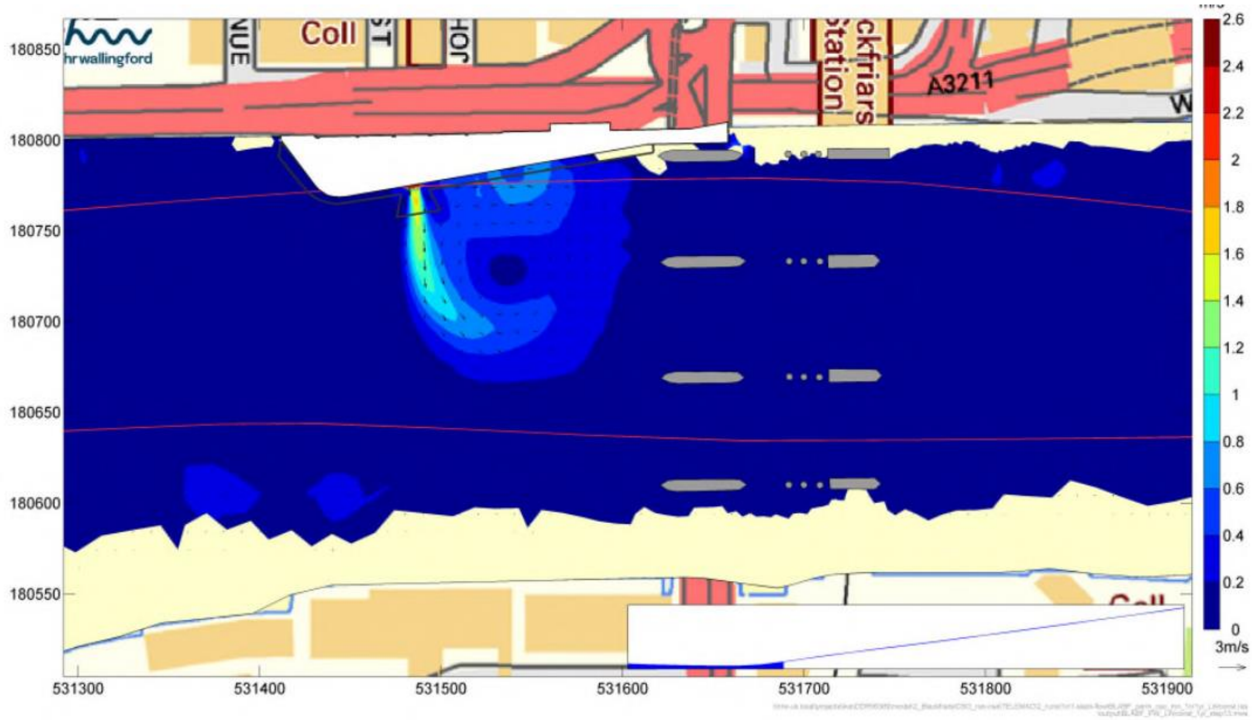
4.4.9 The HR Wallingford analysis of the scenarios includes 5 minutes either side of the time stamp e.g. 10 minutes before low water is defined as the period 15 to 5 minutes before low water. Therefore, the overall tidal window will be 60 minutes, from 15 minutes before low water to 45 minutes after low water.

4.4.10 The 60 minutes is the period where the lateral flows could impact the navigational channel in the area of the outfall. Outside of this 60-minute period the main river flow is dominant, and the main navigation channel is unaffected.

4.4.11 Having determined the zone of impact in the 1:15-year probable worst case the zone of impact using the typical year discharge plumes will be assessed.

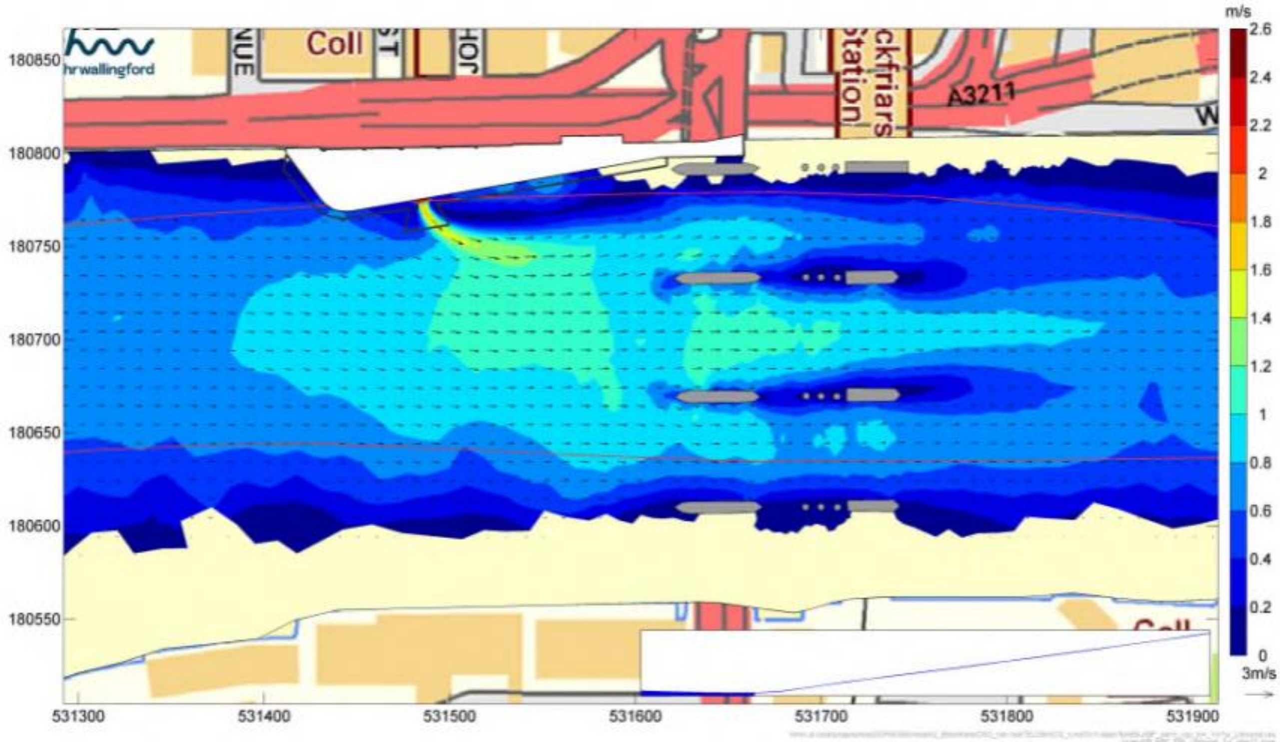
4.4.12 Figure **4-9** shows the CSO discharge from a typical year at spring low water slacks. The lateral flow discharges at 1.4 m/s which is retained across the scour apron area. The velocity starts to reduce as it leaves the apron and is diminished by the time it reaches mid channel.

Figure 4-9 Typical year discharge at spring low water slacks



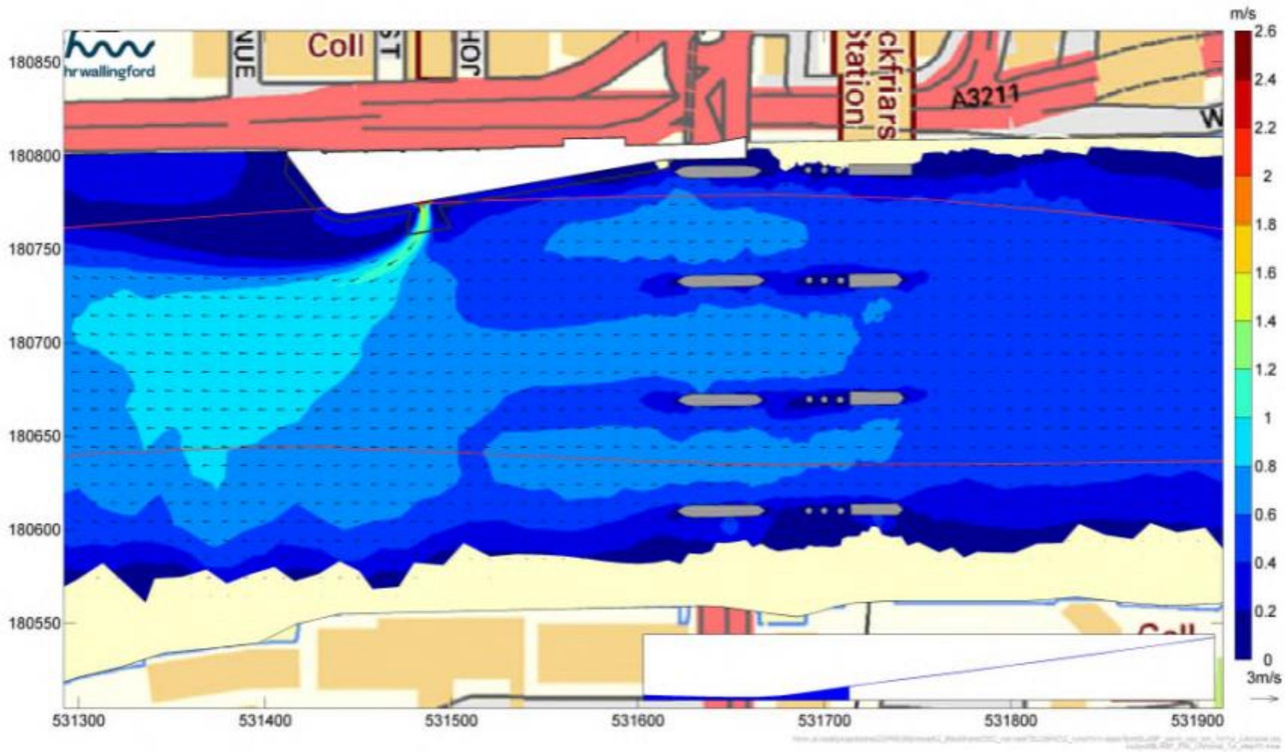
4.4.13 Figure 4-10 shows the typical return period discharge at 20 minutes after spring low water. The lateral flow is discharging at the 1.4m/s but is quickly turned due to the dominance of the river flow and a minimal velocity difference with main flow downstream of the outfall.

Figure 4-10 Typical year discharge 20 minutes before spring low water



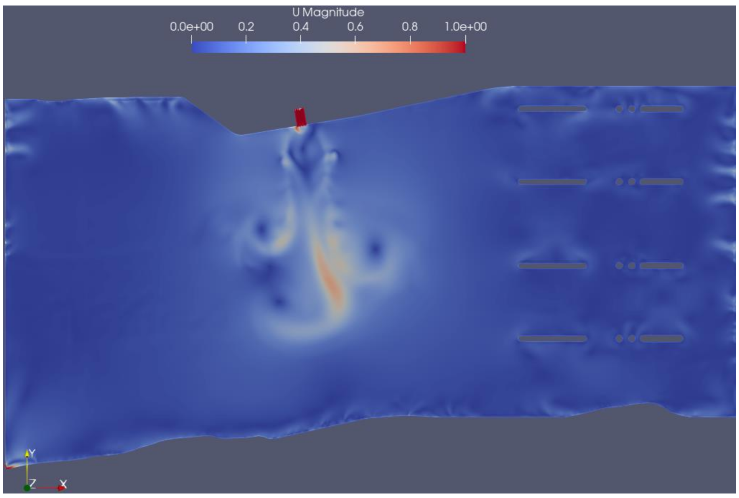
4.4.14 Figure 4-11 shows the typical year discharge 20 minutes after low water. The lateral flow is discharging 1.4m/s but its direction changes rapidly due to the dominance of the main river flow and minimal velocity difference with the main flow.

Figure 4-11 Typical year discharge 20 minutes after low water



4.4.15 Following the completion of the DRA further analysis was undertaken into the potential impact of the 1:15 return period CSO discharge could have at neap high water slacks. 3d CFD modelling was undertaken by Jacobs to support the ship simulation work. This provides a better level of definition and identified an increased level of activity at the surface.

Figure 4-12 Jacobs CFD model of 1:15 year return period discharge at neap high water slacks.



4.4.16 It should be noted that this is a highly conservative assessment of a 1:15 year discharge at $46m^3/s$, which would be reduced to $31.5m^3/s$ with the main tunnel in operation. There is further conservatism in the CFD model as it assumes the water is in a steady state during a 1:15 year storm event.

5. Impact on vessels on the river

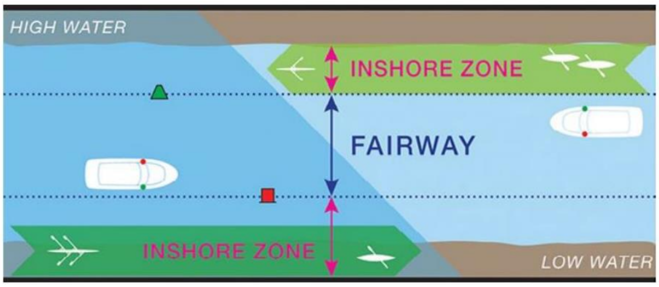
5.1 Assessment of the discharges

5.1.1 The 1:15 year event discharge plumes and sections are taken from document 4410-FLOJV-BLABF-520-VZ-RG-100001- CSO Discharge Modelling for permanent works Blackfriars Bridge Foreshore.

5.1.2 As stated in 4.3.1 the assessment for the impact on vessels on the river will be carried out using a 1:15 return period BLABF CSO discharge of 46 m^3/s at low water springs which produces the discharge plume that is most likely to impact vessels.

5.1.3 The assessment will consider the impact on vessels on the river navigating upstream through the bridge arches following their standard course past the CSO outfall and navigating downstream using a standard course before navigating through the arches.

Figure 5-1 Diagram showing Fairway and Inshore Zones, (P58, The Tideway Code, PLA, 2019)



5.2 Outline which vessels have been assessed for and why.

5.2.1 Table 5-1 presents the vessels, and their characteristics, that have been chosen to represent the different types of vessels on the river that could be affected by a CSO discharge at Blackfriars Foreshore

Table 5-1 Vessels and their characteristics that could be affected by a BLABF CSO Discharge

	Vessel Classification	Vessel Type	Min Speed (knots)(SOG)	Max Speed (knots)(SOG)	Power	Manoeuvrability	VHF
1	Commercial Powered Vessels	Uber Boat	6	25	High	High	Yes
2		RIB/Emergency services	3	12 (40+ Emergency only)	High	High	Yes
3		Sightseeing/Pax	3	12	Medium	Medium	Yes
4		Restaurant/Pax	3	10	Medium	Medium	Yes
5		Tug vessel engaged in pushing	3	6	High	Low	Yes
6		Tug vessel engaged in towing	3	6	High	Low	Yes
7		Workboats	3	6	Low	Medium	Yes
8	Recreational Powered Vessels	Narrow Boat/cabin cruisers	3	4	Low	Low	No
9	Un-Powered Vessels	Dinghy	1	3	V. Low	Low	No
10		Kayak/Rowers/SUP	1	2	V. Low	Low	No

5.3 Impacts of discharge on the different classes of vessel.

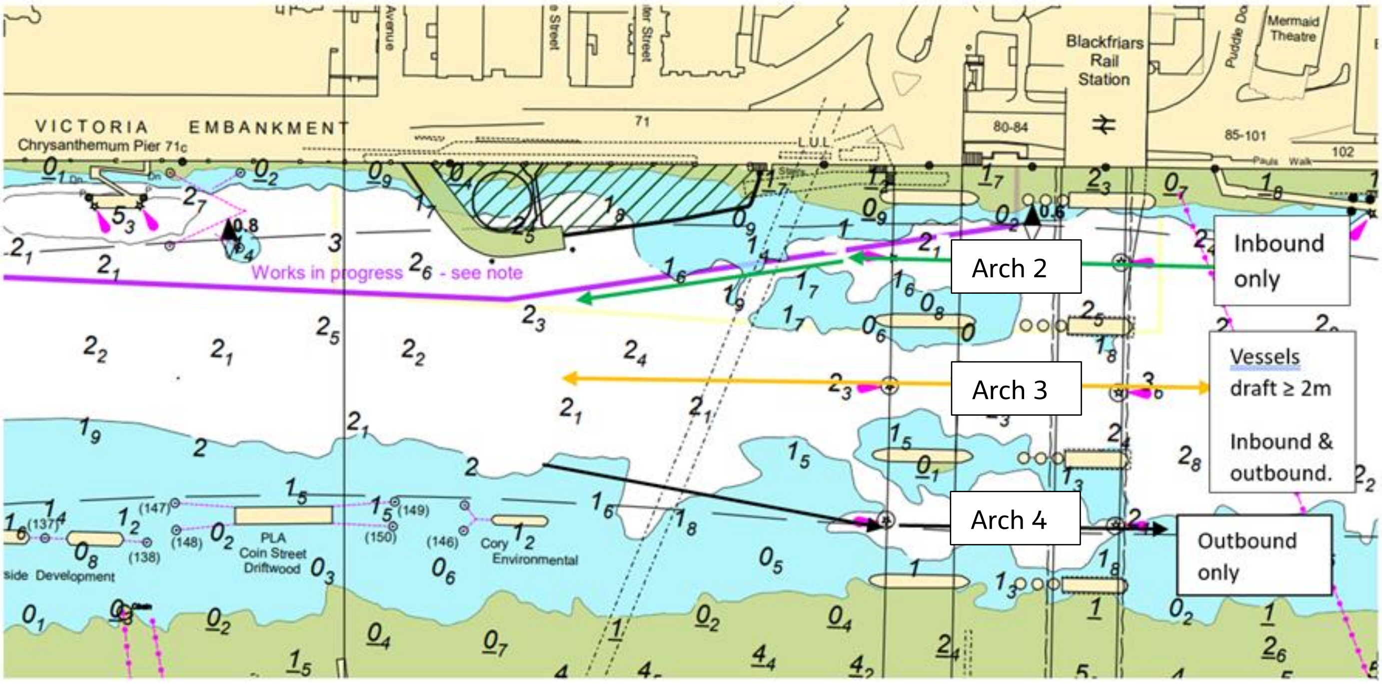
5.3.1 This section sets out the vessels that could be impacted by the CSO discharge, where the vessels are in relationship to the discharge and the corresponding drift angle that impact the vessels from the magnitude of the discharge flow.

5.3.2 Section 4.4 of 665397CH-BLABF-DRA-Permanent-Rev.04 established the zone of BLABF CSO discharge impact and displays the sections and plan of the zone in figures 4-9 to 4.17.

5.3.3 To confirm the impacts of a discharge on vessels Figure 5-2, an extract of chart 317, has been produced to identify the normal course of a vessel undertaking passages upstream through Arches 2 and 3, and downstream through Arches 3 and 4.

5.3.4 For the purposes of identifying where the impacts occur and the magnitude of those Figure 5-2 is used in conjunction with Figure 5-4.

Figure 5-2 Extract of PLA chart 317 with normal courses through Blackfriars Bridge.



5.3.5 Figure 5-2 presents the course for the expected safe draft clearance of vessels at periods of low water based on chart datum. It is accepted that there is additional navigable water during low water neaps and springs for a period +/-1hours but it is highly unlikely that this would materially affect the passage planning of an experienced mariner, where they would plan to chart datum.

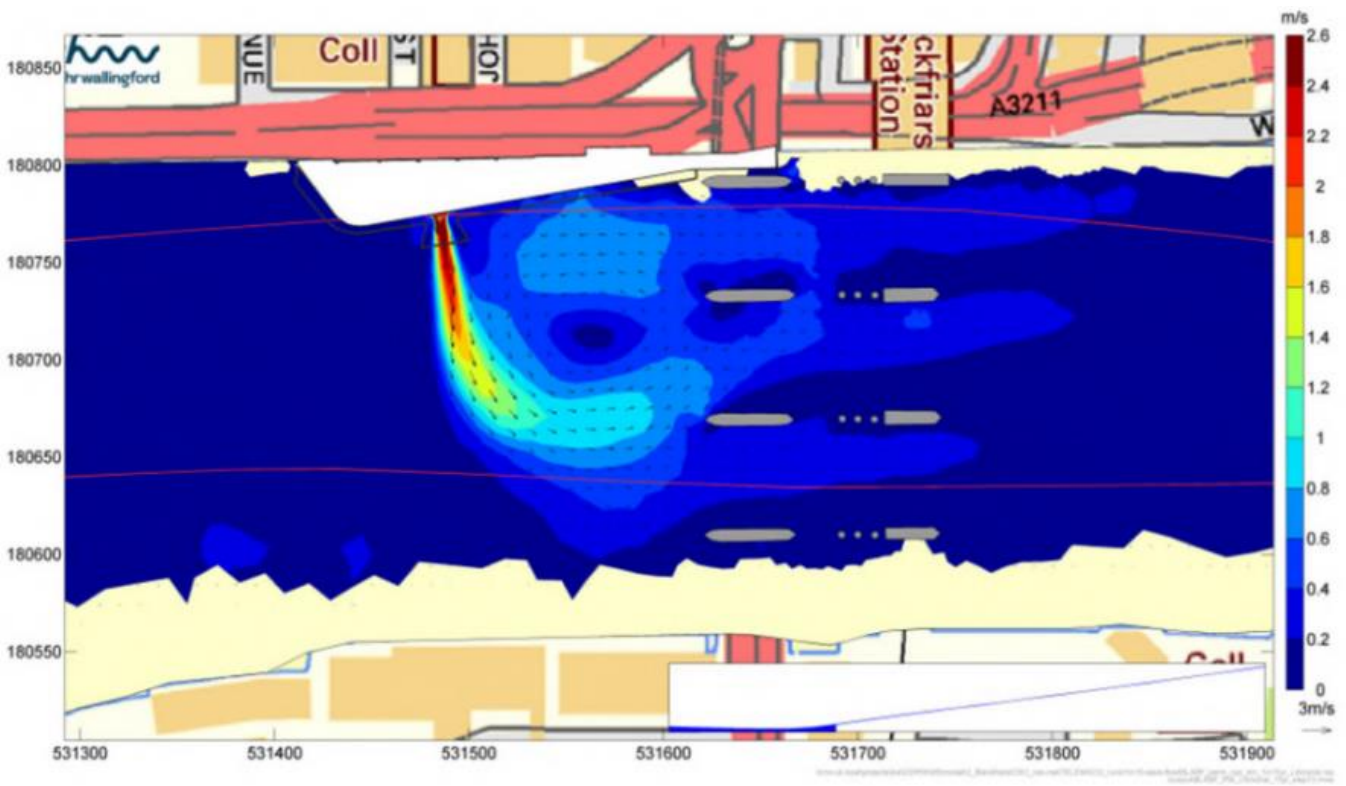
5.3.6 From Figure 5-2 it can be determined that all powered vessels with a draft including under keel clearance ≥ 2m would need to use Arch 3 maintain a safe course upstream or downstream. All other vessels may use either Arch 2 or Arch 4, when transiting upstream or downstream, respectively.

5.3.7 For vessels transiting through in Arch 2 the CSO discharge impact could be 2.6m/s when using the normal running position. For vessels transiting through Arch 3 in normal running position the CSO discharge impact could be 1.6m/s.

5.3.8 Table 5 2 has determined that all vessels navigating past the BLABF CSO discharge at Low Water slack through Arch 2 and Arch 3 will be impacted, unpowered vessels are impacted more significantly.

5.3.9 Figure 5-3 presents the 1:15-year return period event at spring low water which indicates a CSO discharge velocity of approximately 2.6m/s from the outfall. The lateral flow maintains this velocity perpendicular to the channel for approximately 40m before it starts decreasing to 1.8m/s by the time it gets to mid channel. From that point the lateral flow starts to veer eastwards towards Arch 4 whilst decreasing further, to 0.6m/s as it enters the Arch, although the flow is now running west to east. The remainder of the flow velocity dissipates through the Arches becoming negligible as it clears Blackfriars Rail bridge. It is also noted that there is potentially some cyclonic effect creating a south-north current of 0.6m/s as it enters arch 3 and continues to rotate the flow east to west in front of Arch 2 and the new foreshore structure.

Figure 5-3 1:15-year return period depth average currents at spring low water slacks



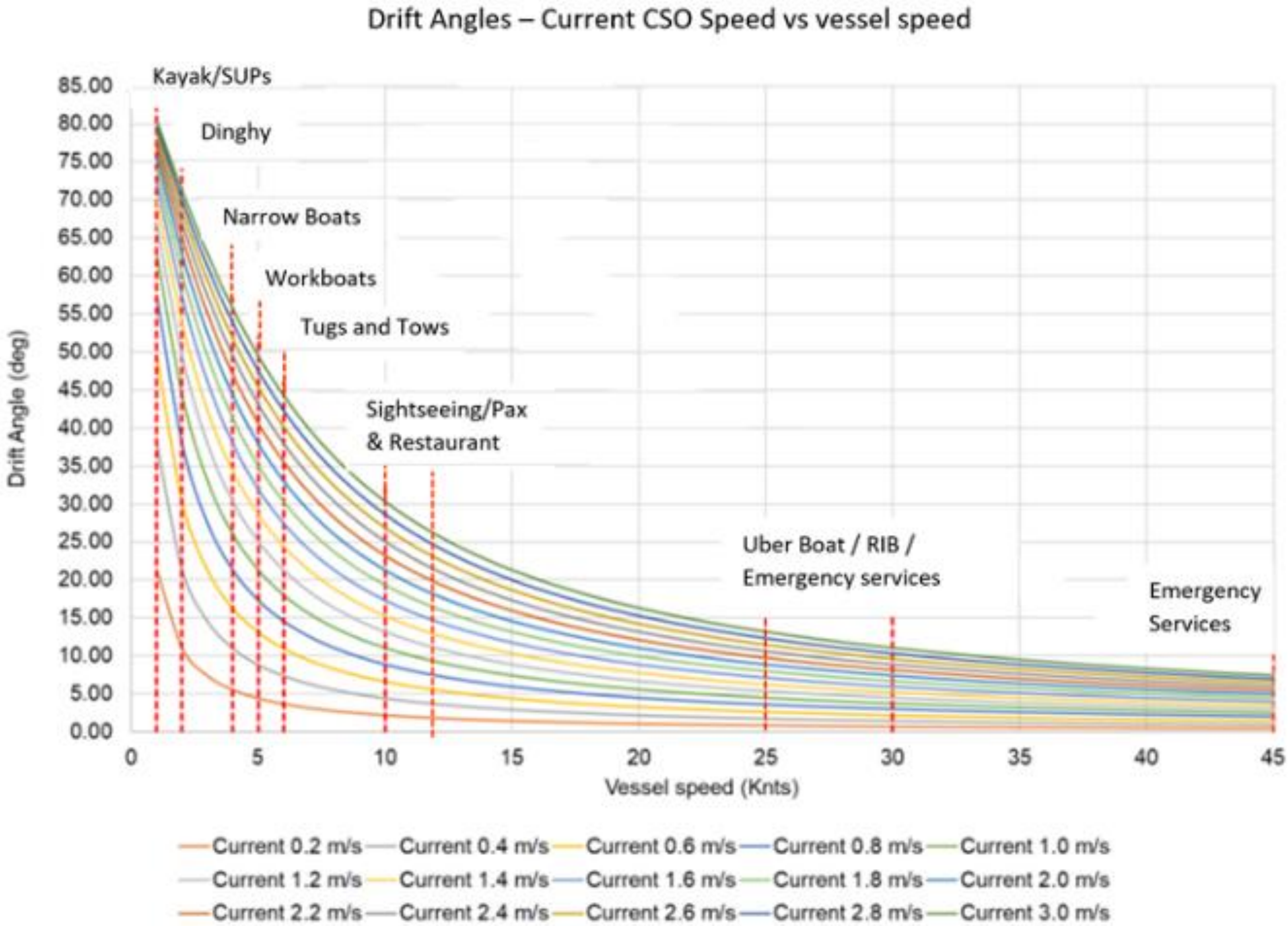
5.3.10 The governing parameters for the choice of Arch to navigate, and therefore the continued passage after the bridge, is the draft of a vessel which in turn determines the minimum depth of water that the vessel needs to safety operate without grounding. This parameter is therefore listed in Table 5-4.

5.3.11 Although it is probable that reporting vessels will operate in Arch 3 there is a possibility that vessels could transit through or require access to Arch 2. Therefore, all vessel types that have the draft to enable transiting Arch 2 will also be assessed.

5.3.12 The drift angle will be determined in relation to the vessels lowest operating speed when passing the Fleet Main CSO on its normal course from and to the relevant Arch transit as lowest speed will incur the highest magnitude impact. The impact data is presented in Table 5-2.

5.3.13 The drift angles of the vessels are a function of the vessel speed while impacted by the CSO discharge current speed without any course correction, this will be taken as the worst-case scenario. The results are presented below in Figure 5-4 noting that drift angles are related to the speed of vessel and not category of vessel.

Figure 5-4 Drift angle - Current CSO vs vessel speed



5.3.14 This approach allows a direct evaluation of the CSO discharge as a potential hazard to the vessels passing the area.

5.3.15 Modelled flow velocities from CSO outfall discharge during a 1:15-year event, shown in Figure 5-3.

5.3.16 Table 5-2 presents the assessed impact of a 1:15-year CSO discharge on the different vessel types, using the drift angle curves when the vessels are operating through the nominated Arches.

5.3.17 The estimated speed over ground for vessels passing the CSO, as stated in the Table 5-2, is recorded as an estimate of the slowest probable speed whilst still maintaining steerage.

Table 5-2 Approximated drift angle in Arch location when passing the CSO, during a 1:15-year BLABF Main CSO discharge at MLWS.

Vessel Type	Vessels Speed passing CSO. (SOG)	Minimum Vessels Draft (metres)	Water depth allowing for Under Keel Clearance (Add 0.5m)	Approximation of drift angle (* denotes degrees) when passing the CSO via Arch 2	Approximation of drift angle when passing the CSO via Arch 3
Uber Boat (i.e., Hunt Class)	6 knots	1.2	1.7	40 º	27 º
RIB/Emergency Services	3 knots	0.5	1.0	63 º	47 º
Sightseeing/Pax	3 knots	1.5	2.0	63 º	47 º
Restaurant/Pax (i.e., Symphony)	3 knots	1.8	2.3	63 º	47 º
Tug vessel pushing	3 knots	3	3.5	N/A	47 º
Tug vessel towing	3 knots	3	3.5	N/A	47 º
Workboats	3 knots	0.5	1.0	63 º	47 º
Narrowboats/Motor cruisers	3 knots	1.0	1.5	63 º	47 º
Dinghy	1 knot	0.8	1.3	79 º	73 º
Kayak/Rower/SUP	1 knot	0.2	0.7	79 º	73 º

5.3.18 Table 5-3 presents the assessed impact of a typical year CSO discharge on the different vessel types, using the drift angle curves when the vessels are operating through the nominated Arches

Table 5-3 Approximated drift angle in Arch location when passing the CSO, during a Typical year BLABF Main CSO discharge at MLWS

Vessel Type	Vessels Speed passing CSO. (SOG)	Minimum Vessels Draft (metres)	Water depth allowing for Under Keel Clearance (Add 0.5m)	Approximation of drift angle (* denotes degrees) when passing the CSO via Arch 2	Approximation of drift angle when passing the CSO via Arch 3
Uber Boat (i.e., Hunt Class)	6 knots	1.2	1.7	27 º	18 º
RIB/Emergency Services	3 knots	0.5	1.0	45 º	32 º
Sightseeing/Pax	3 knots	1.5	2.0	45 º	32 º
Restaurant/Pax (i.e., Symphony)	3 knots	1.8	2.3	45 º	32 º
Tug vessel pushing	3 knots	3	3.5	N/A	32 º
Tug vessel towing	3 knots	3	3.5	N/A	32 º
Workboats	3 knots	0.5	1.0	45 º	32 º
Narrowboats/Motor cruisers	3 knots	1.0	1.5	45 º	32 º
Dinghy	1 knot	0.8	1.3	72º	62 º
Kayak/Rower/SUP	1 knot	0.2	0.7	72 º	62º

5.4 Summary of impacted vessels and outcomes.

5.4.1 The summary of the 1:15-year Fleet Main CSO discharge impacts on the different vessel types spring at low water is presented in table 5-3 below.

Table 5-4 Impact of 1:15-year CSO discharge on vessels at Low water.

Vessel Type	Transit Arch 2 or Arch 3	Impact on vessel	
		Normal Running Position	Minimum achievable distance from CSO at MLWN
Uber Boat	Arch 2	High impact. Course and/or speed adjustment required.	High impact. Course and/or speed adjustment required.
	Arch 3	Minor/Moderate impact. Course and/or speed adjustment required.	Minor/Moderate impact. Course and/or speed adjustment
RIB/Emergency services	Arch 2	High impact. Course and/or speed adjustment required.	High impact. Course and/or speed adjustment required.
	Arch 3	Moderate/High impact. Course and/or speed adjustment required.	Moderate impact. Course and/or speed adjustment
Sightseeing/Pax	Arch 2	High impact. Course and/or speed adjustment required.	High impact. Course and/or speed adjustment
	Arch 3	Moderate/High impact. Course and/or speed adjustment required.	Moderate impact. Course and/or speed adjustment
Restaurant/Pax	Arch 2	High impact. Course and/or speed adjustment required.	High impact. Course and/or speed adjustment
	Arch 3	Moderate/High impact. Course and/or speed adjustment required.	Moderate impact. Course and/or speed adjustment
Tug vessel engaged in pushing/Towing	Arch 2	N/A	N/A
	Arch 3	Moderate/High impact. Course and/or speed adjustment required. Towing barge to be affected	Moderate/High impact. Course and/or speed adjustment required. Towing barge to be affected
Workboats	Arch 2	High impact Course and/or speed adjustment required.	High impact Course and/or speed adjustment
	Arch 3	Moderate/High impact. Course and/or speed adjustment required.	Moderate impact. Course and/or speed adjustment
Narrow boat/Motor cruisers	Arch 2	High impact Course and/or speed adjustment required.	High impact Course and/or speed adjustment
	Arch 3	Moderate/High impact. Course and/or speed adjustment required.	Moderate impact. Course and/or speed adjustment
Dinghy/Kayak/SUP/Rower	Arch 2	High impact Unable to maintain course and/or speed, Risk of collision with other vessels due to inability to maintain course. Risk of swamping or capsizing if too close.	High impact Unable to maintain course and/or speed, Risk of collision with other vessels due to inability to maintain course. Risk of swamping or capsizing.
	Arch 3	High impact Unable to maintain course and/or speed, Risk of collision with other vessels due to inability to maintain course.	High impact Unable to maintain course and/or speed, Risk of collision with other vessels due to inability to maintain course.

5.4.2 The desk top assessment of a 1:15 year return period event indicates: -

- There is minimal impact for vessels that will be using Arch 4 unless there is a deviation from using Arch 3.
- There is moderate/high impact on vessels using Arch 3 except for the Uber boats which receive a minor/moderate impact and high impact on Dinghy/Kayak/SUP/Rowers.

- There is a high impact on all vessels using Arch 2.
- There is generally a reduction in the impact on vessels during mean low water neaps due to the increase in water depth and reduced impact of the lateral flow, with the exception of the Dinghy/Kayak/SUP/Rowers.

5.4.3 Section 5 and the summary of impacted vessels and outcomes in Table 5-4 provides a summary of the desk top study but does not consider or record any differences that may have been evidenced in the simulations. Table 6-1 in the next section serves to substantiate any of the findings from Table 5-4 and record any differences that were seen during the simulations. Table 6-1 therefore takes precedence over Table 5-4.

6. Ship simulation comparison

6.1.1 As part of the works to identify the impact of a CSO discharge on the safe navigation of vessels passing the area Tideway engaged HR Wallingford to undertake a real time navigation simulation to assist in the assessment of this impacts.

6.1.2 The outputs of the simulations would be used to corroborate the desktop analysis undertaken in sections 4.3 and 4.4 if the permanent DRA which identified the periods and zones of impact, and section 5 which used predicted drift angles as a function of the lateral flow velocities and the vessel velocities to determine the level of impact on passing vessels or indicate if additional considerations needed to be made.

6.1.3 The HR Wallingford ship simulation centre did not have a suitable model that would represent Class V vessels. It was proposed, and agreed by the mariners at both simulation sessions, that the impact of the CSO and the response of Narrowboats, Tug Pushing and clippers would be representative of the response of a range of Class V vessels.

6.1.4 The simulations for Blackfriars Bridge Foreshore were undertaken at the HR Wallingford Ship Simulation Centre during the 8th, 9th and 10th of November 2023 with representatives from HR Wallingford, Tideway, Waves, the Port of London Authority and several river operators and the 5th March 2024 with Tideway, Waves and the Port of London Authority.

6.1.5 The full table of simulations undertaken for BLABF on the 8th, 9th and 10th of November 2023 are presented Figure 6-1 in which include the comments on the run, which were agreed by the attendees following each simulation.

Figure 6-1 Extract of simulated cases for BLABF

Run ID	CSO	Ship	Manoeuvre	Bridge arch	Tidal condition	Comments
01	BLABF	28m tug	Outbound at 6 knots	No. 3	Low water slack	Initial run. Approach centre of arch, track disrupted by flow, bow to starboard. Master reacted by use of rudder and increasing power. As the vessel recovers heading the master reduces power and corrects with rudder as required.
02	BLABF	28m tug pulling 50m unladen barge	Outbound at 3 knots	No. 3	Low water slack	The barge overran the 28m tug when the 28m tug changed course due to the outflow. 28m tug lost control.
03	BLABF	28m tug pulling 50m unladen barge	Outbound at 6 knots	No. 3	Low water slack	The barge overran the 28m tug when the 28m tug changed course due to the outflow. 28m tug lost control.
04	BLABF	28m tug pushing 50m unladen barge	Outbound at 6 knots	No. 3	Low water slack	Power and rudder used to correct the track of the barge. Significant changes in direction.
05	BLABF	28m tug pushing 50m unladen barge	Outbound at 6 knots	No. 3	6 minutes after low water slack	Barge tow lines were insufficiently tensioned which reduced the manoeuvrability of the vessel in this scenario.
06	BLABF	28m tug pushing 50m unladen barge	Outbound at 3 knots	No. 3	6 minutes after low water slack	Noted that 3 knots is slow for pushing resulting in low directional stability. Track was quickly recovered but the result was marginal.
07	BLABF	28m tug pulling 50m unladen barge	Outbound at 6 knots	No. 3	6 minutes after low water slack	Significant correction required by the master in an attempt to regain control. It was possible to correct but the manoeuvre was considered high risk.
08	BLABF	28m tug pulling 50m unladen barge	Outbound at 6 knots	No. 3	20 minutes before low water slack	Minimal effect during this run, the manoeuvre was low risk.
09	BLABF	Thames Clipper	Inbound at 8 knots and outbound at 8 knots	Inbound No. 2 Outbound No. 3	Low water slack	Multiple passes through no.2 arch and a pass outbound through no.3 arch. Control can be regained with some variability in the width of the river used to do so. Low to moderate risk as the recovery required multiple changes to helm orders in a short space of time.
10	BLABF	Thames Clipper	Inbound at 8 knots	No .2	6 minutes after low water slack	Manageable with minimal additional control input required to maintain the desired track.
11	BLABF	21m Narrowboat	Inbound at 4 knots	No. 2	Low water slack	Significant response of the vessel in the discharge. However, this did not pose a significant risk in the inbound direction when there is no conflicting traffic. Due to proximity to the outfall the high cross flows were confined to a narrow area.
12	BLABF	21m Narrowboat	Inbound at 4 knots	No. 2	6 minutes after low water slack	Vessel set bodily into channel by flow this was due to the increased distance to the outfall. Otherwise a similar response to the previous run
13	BLABF	21m Narrowboat	Inbound at 4 knots	No. 2	6 minutes before low water slack	After bridges there is limited impact from the eddy that needed some correction for. Closer to the outflow the impact was more significant, the barge gains a rate of turn and is set away from the outflow.
14	BLABF	28m tug pushing 50m unladen barge and kayak	28m tug outbound at 3 knots and kayak inbound at 1 knot	No. 2	Low water slack	Kayak was released and drifted into the channel past the 50m line from the outflow. The 28m tug reacted in a similar manner previous run in the same condition. The 28m tug was not under full control.
15	BLABF	28m tug pushing 50m unladen barge and kayak	28m tug outbound at 3 knots and kayak inbound at 1 knot	No. 3	6 minutes after low water slack	The kayak wasn't seen until it was close to the port quarter of the 28m tug and no avoiding action was taking.
16	BLABF	28m tug pushing 50m unladen barge and kayak	28m tug outbound at 3 knots and kayak inbound at 1 knot	Tug No. 3 Kayak None	20 minutes before low water slack	The kayak was seen at half way along side of barge. The 28m tug was able to manoeuvre safely through the arch no. 3.
17	BLABF	Clipper and kayak	Clipper inbound at 6 knots and kayak inbound at 1 knot	Clipper No. 3 Kayak None	Low water slack	The Kayak was allowed to drift into river. The clipper had the option to take avoiding action but this was not necessary in this scenery.
18	BLABF	Clipper and 28m tug pushing 50m unladen barge	Clipper inbound at 6 knots and 28m tug outbound at 3 knot	Clipper No. 2 Tug No. 3	Low water slack	Manageable with moderate impact. The Clipper took action to prevent any potential conflict with the approaching tug.

6.1.6 The full table of simulations undertaken on the 5th of March 2024 focused on the transit of tugs past the CSO outfall at neap high water slacks, in different configurations, past the CSO outfall as the HR Wallingford model suggested minimal CSO impact at high water, however Jacobs undertook additional CFD modelling which determined that there was the potential for an impact. The Jacobs CFD velocities were then used by HR Wallingford to simulate a CSO discharge at high water neaps.

6.1.7 The record and comments on the runs, which were agreed by the attendee's following the simulation, are provided in Figure 6-2.

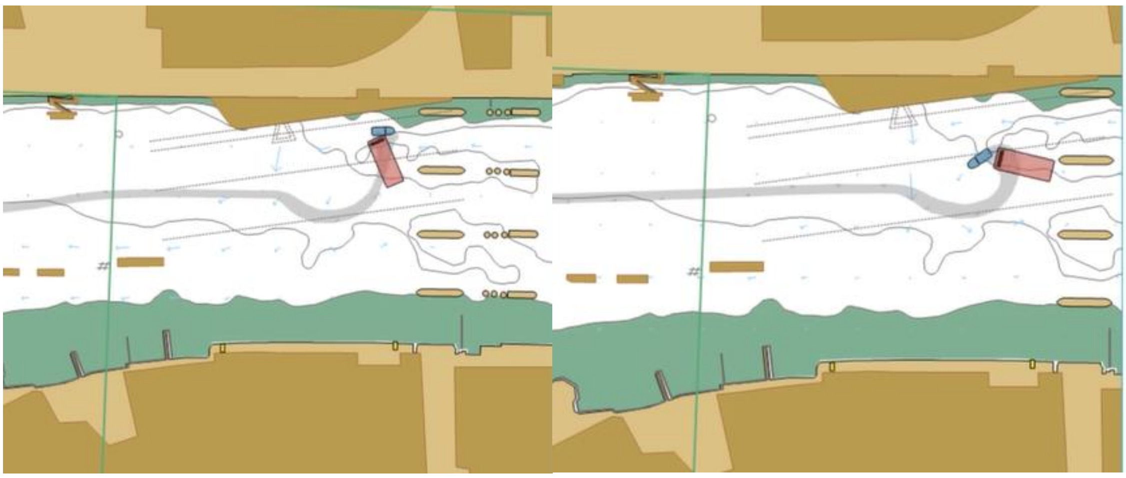
Figure 6-2 Simulated cases for BLABF on 5th of March 2024

Run ID	CSO	Ship	Manoeuvre	Bridge arch	Tidal condition	Comments
01	BLABF	28 m tug pulling 50 m unladen barge Centre line	Outbound at 6 knots	Arch 3	Mean HW neap slack	Trial run to test new flow model - no comments
30	BLABF	28 m tug pulling 50 m unladen barge	Inbound 6 knots	3	Slack high water neaps(derived from Jacobs CFD)	Vessel deflected by the discharge and was nearly overrun by the barge. Vessel was able to regain control
31	BLABF	28 m tug pulling 50 m unladen barge	Outbound 6 knots	3	Slack high water neaps (derived from Jacobs CFD)	Vessel deflected by the discharge and was nearly overrun by the barge. Vessel was able to regain control
32	BLABF	28 m tug pushing 50 m unladen barge	Outbound 6 knots	3	Slack high water neaps (derived from Jacobs CFD)	Vessel deflected by the discharge but under control throughout
33	BLABF	28 m tug pushing 50 m unladen barge	Outbound 6 knots	4	Slack high water neaps (derived from Jacobs CFD)	Transit not affected by the discharge
34	BLABF	28 m tug pushing 50 m unladen barge	Inbound 6 knots	3	Slack high water neaps (derived from Jacobs CFD)	Transit not affected by the discharge
35	BLABF	Narrowboat	Outbound	4	Slack high water neaps (derived from Jacobs CFD)	Transit not affected by the discharge
36	BLABF	Narrowboat	Inbound	2	Slack high water neaps (derived from Jacobs CFD)	Transit not affected by the discharge
37	BLABF	Clipper	Outbound	3	Slack high water neaps (derived from Jacobs CFD)	Transit not affected by the discharge
38	BLABF	Narrowboat	Outbound	4	Slack high water neaps (derived from Jacobs CFD)	Vessel deflected slightly by the discharge but in full control throughout

6.1.8 During the simulations the vessels were operated by a master who established the course and speed of the vessel to align with the case. Once the simulation started the master made the necessary corrections to allow the vessel to maintain course and then feedback to the group.

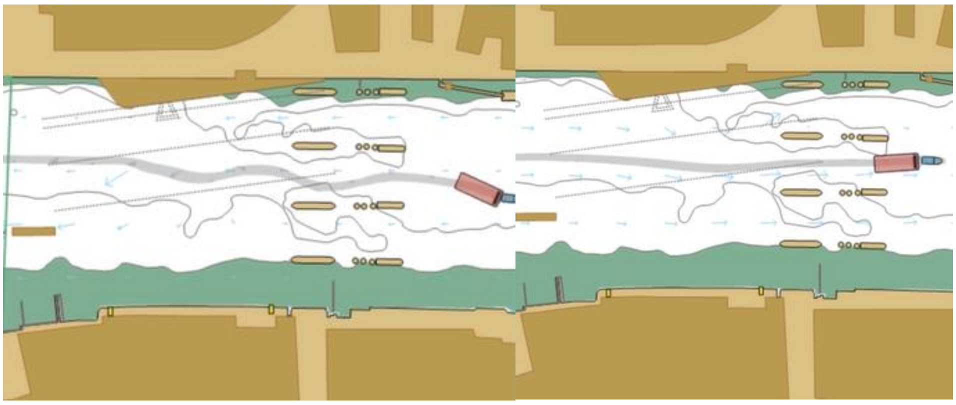
6.1.9 The track of each simulated run was recorded so that it could be reviewed. Figure 6-3 shows tracks 02 and 03 which were undertaken at low water slacks. Track 02 is of a tug towing a barge outbound at 3 knots passing 60m from the outfall towards Arch 3 whilst Track 03 is of a tug towing a barge outbound at 6 knots passing 60m from the outfall towards Arch 3. On both occasions once the barge was impacted by the CSO discharge the barge overran the tug and the tug lost control.

Figure 6-3 Record of runs 02 and 03



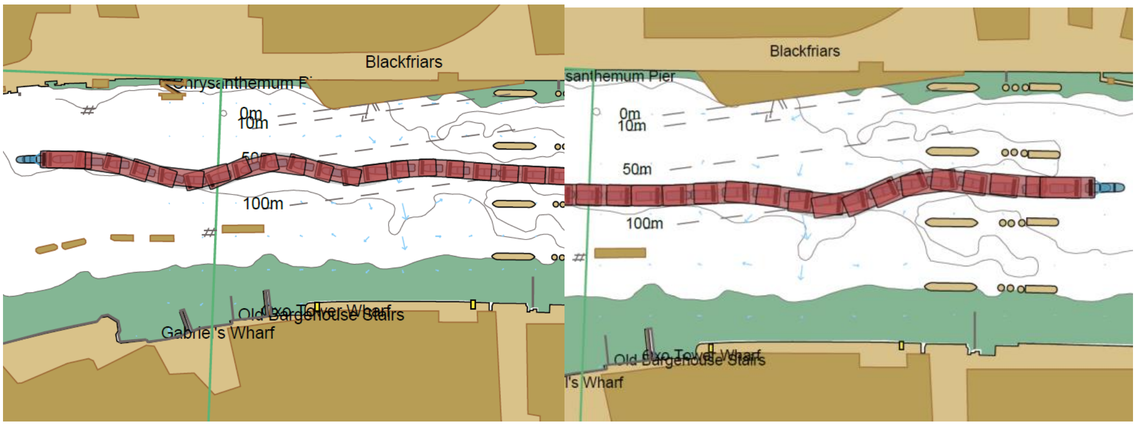
6.1.10 Figure 6-4 shows tracks 07 and 08 which were undertaken at 6 minutes after low water slack and 20 minutes before low water slack respectively. Track 07 is of a tug towing a barge outbound at 6 knots passing 60m from the outfall towards Arch 3, the tug needed significant corrections to its course to make it through the Arch, but this was achieved and the course was restored. Track 08 is of a tug towing a barge outbound at 6 knots passing 60m from the outfall towards Arch 3, the tug needed minor corrections to its course.

Figure 6-4 Record of runs 07 and 08



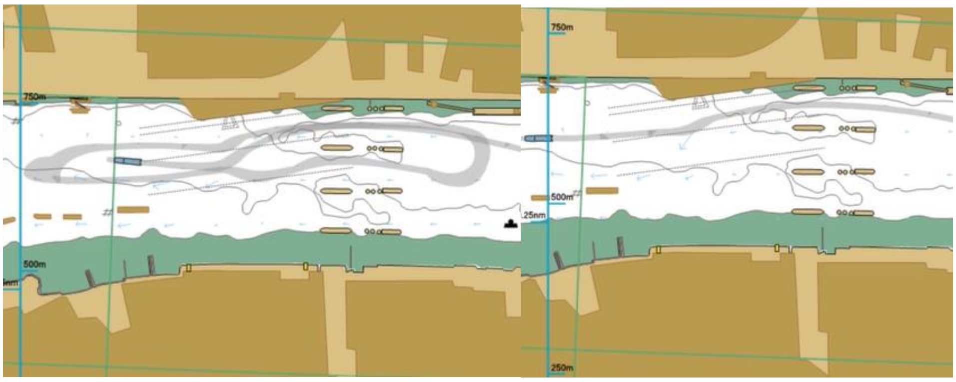
6.1.11 Figure 6-5 shows Tracks for runs 30 and 31 which were undertaken at high water slacks with the discharge flows derived from the Jacobs CFD model. Track 31 is of a tug towing a barge inbound at 6 knots passing 75m from the outfall from Arch 3, the tug needed corrections but was ultimately able to regain its course. Track 31 is of a tug towing a barge outbound at 6 knots passing 75m from the outfall towards Arch 3, the tug needed minor corrections to its course.

Figure 6-5 Record of runs 30 and 31



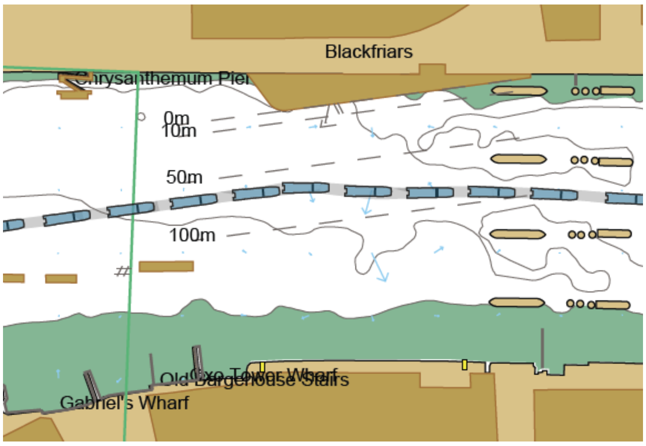
6.1.12 Figure 6-6 shows tracks for runs 09 and 10. Track 09 is of a Thames Clipper was undertaken at low water slacks transiting upstream through Arch 3, downstream through Arch 2 and upstream through Arch 2 at 8 knots. There were several corrections required during the passes but the courses were regained. Track 10 is of the Thames Clipper transiting upstream through Arch 2 at 6 minutes after low water slacks. There was minimal corrective adjustments required by the master during the passage.

Figure 6-6 Record of runs 09 and 10



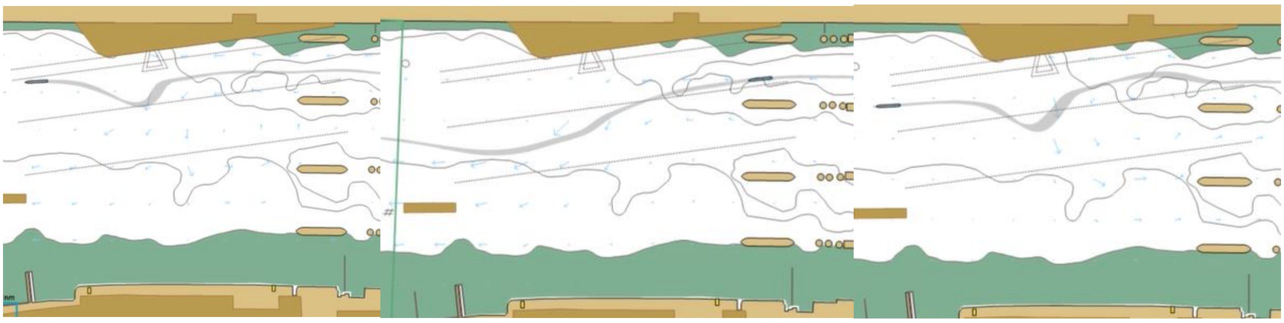
6.1.13 Figure 6-7 Shows a track of a Thames Clipper transiting downstream through Arch 3 at high water slacks using the discharges form the Jacobs CFD model. The transit of the clipper was unaffected by the CSO discharge.

Figure 6-7 Record of run 37



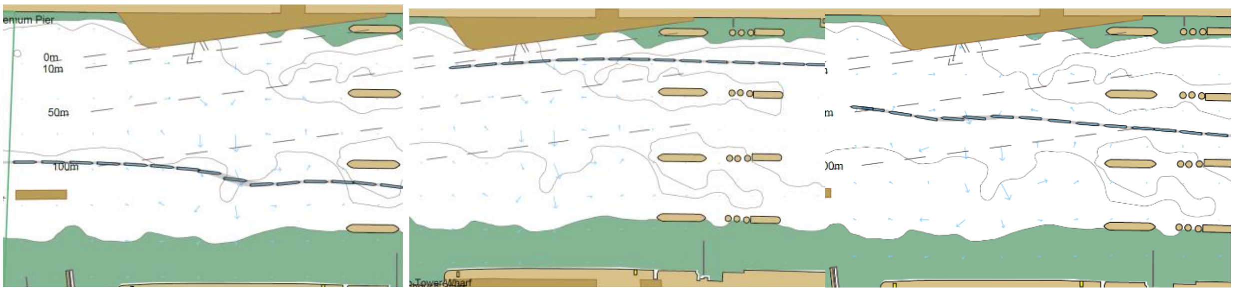
6.1.14 Figure 6-8 shows tracks for runs 11,12 and 13. Run 11 is a narrowboat transiting inbound at 4 knots through Arch 2 at low water slacks. Run 12 is a narrowboat transiting inbound at 4 knots through Arch 2 at 6 minutes after low water slacks. The vessel had a similar response to the vessel from run 11but appeared more pronounced as it started further from the CSO. Run 13 is a narrowboat transiting inbound at 4 knots through Arch 2 at 6 minutes before low water slacks. The vessel responded similarly to run 11 with a similar deviation from course, however the course was corrected without much difficulty.

Figure 6-8 Record of runs 11, 12 and 13



6.1.15 Figure 6-9 shows tracks for runs 35, 36 and 38 are of narrowboats transiting past the CSO at high water slacks. Run 35 is of a narrowboat transiting downstream through Arch 4, the passage of the vessel was unaffected by the discharge. Run 36 is of a narrowboat transiting upstream through Arch 2, the passage of the vessel was unaffected by the discharge. Run 38 is of a narrowboat transiting upstream using Arch 3. There was a minor deviation of the vessel but the course was corrected without a problem.

Figure 6-9 Record of Runs 35, 36 and 38



6.1.16 Following the completion of the ship simulations past the BLABF CSO outfall the impacts on the vessels was considered against the desk top assessment presented in Table 5.3. The summary of these changes are presented in Table 6-1. This table also highlights the impact of the discharge at high water slacks as the desk top assessment did not consider this case.

6.1.17 Another key feature from the simulations was about the tidal window during which the CSO discharge impacted vessels. From the desktop study it was determined that the tidal window was from 15 minutes before low water slacks to 45 minutes after, whereas the runs undertaken in the simulator at 6 minutes before and after low water slacks produced a significant reduction in that CSO impact on vessels, further reinforcing the conservative nature of this assessment. The key changes are related to reductions in impacts on vessels transiting through Arch 2, with the exception of an increase in the impact on a tug towing downstream through Arch 3.

Table 6-1 Record of changes of impact on vessels

Vessel Type	Transit Arch 2 or Arch 3	Impact on vessel		
		Normal Running Position	Minimum achievable distance from CSO at MLWS	High water Neaps
Uber Boat	Arch 2	Moderate impact Course and/or speed adjustment	Moderate impact Course and/or speed adjustment	Minimal impact
	Arch 3	No change	No change	Minimal impact
RIB/Emergency services	Arch 2	No change*	No change*	Minimal impact
	Arch 3	No change*	No change*	Minimal impact
Sightseeing/Pax	Arch 2	No change*	No change*	Minimal impact
	Arch 3	No change*	No change*	Minimal impact
Restaurant/Pax	Arch 2	No change*	No change*	Minimal impact
	Arch 3	No change*	No change*	Minimal impact
Tug vessel engaged in pushing/Towing	Arch 2	N/A	N/A	N/A
	Arch 3	High Impact Course and/or speed adjustment required. Tow severely impacted	No change	Moderate impact Course and/or speed adjustment required

Vessel Type	Transit Arch 2 or Arch 3	Impact on vessel		
		Normal Running Position	Minimum achievable distance from CSO at MLWS	High water Neaps
Workboats	Arch 2	No change*	No change*	Minimal impact
	Arch 3	No change*	No change*	Minimal impact
Narrow boat/Motor cruisers	Arch 2	Mod/High impact Course and/or speed adjustment	Mod/High impact Course and/or speed adjustment required.	Minimal impact
	Arch 3	No change*	No change*	Minimal impact
Dinghy/Kayak/SUP /Rower	Arch 2	No change*	No change *	Minimal impact
	Arch 3	No change*	No change*	High impact

* = No additional modelling undertaken.

7. Risk Assessment

7.1 Risk Assessment

7.1.1 The Risk Assessment is undertaken using the Jacobs design hazard elimination and risk reduction register and can be found in Appendix A.

7.1.2 The following sections of this document present the risk associated with the hazard linked to a Fleet Main CSO discharge impacting on vessels operating on the Thames.

7.1.3 The Risk Assessment has been undertaken to eliminate or reduce risk to vessels on the Thames and provide mitigations for the risk so far as reasonably practicable by assessing the design and operation risks for the permanent state of the Fleet Main CSO discharge.

7.1.4 The residual design / operational risks identified in this will be used to inform an NRA. The NRA will be produced by navigational experts for consideration by the PLA and any further mitigations established if required.

7.2 Hazards

7.2.1 The Risk Assessment considers the impact of the flows from the Fleet Main CSO discharge to Vessels on the river with consideration to the change in drift angle incurred by contact with the flow. The hazards associated with the impact are:

i) Swamping

ii) Capsizing

iii) Grounding

iv) Collision between unpowered vessels and powered vessels

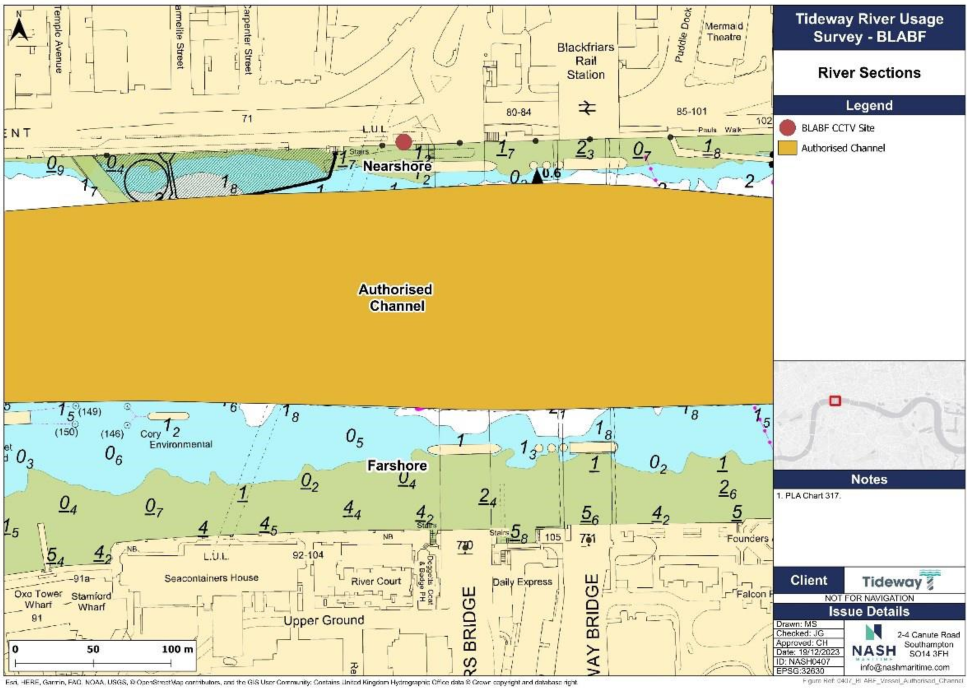
v) Contact between bridge pier and powered vessel.

7.3 Receptors

7.3.1 CCTV surveys of the river were undertaken at BLABF from the 22nd September 2023 to the 31st December 2023, but data has been processed from the period 22nd September 2023 to 10th of November 2023 giving a 7 week data set and the analysis of the data is presented in document "Tideway Central BLABF Traffic Survey Report 14I02".

7.3.2 The analysis was carried out to determine the class of vessel and which area of the river the vessel was operating from nearshore, authorised channel and farshore, as indicated in Figure 7-1

Figure 7-1 Nearshore, Authorised Channel and Farshore sections of the River Thames at BLABF



7.3.3 Table 7-1 presents the data received from the CCTV surveys, which were also correlated with AIS information.

Table 7-1 Number of recorded vessels transiting nearshore, through the Authorised Channel and farshore

PLA Vessel Class	Nearshore	Authorised Channel	Farshore	Total
Uber Boat	0	5,553	144	5,697
RIB/Emergency Services	9	2,210	458	2,677
Class 5 Passenger	0	4,797	296	5,093
Tug	0	229	35	264
Tug (Pushing)	61	162	3	226
Tug (Towing)	1	185	50	236
Workboat	268	675	58	1,001
Recreational Cruiser	0	181	23	204
Narrowboat	0	35	0	35
Kayak	0	30	29	59
Rowing Boat	0	10	7	17
Coach / Safety Boat	2	6	0	8
Total	341	14,073	1,103	15,517

7.3.4 For the impacts of a discharge from the BLABF CSO outfall and the area that needs to be considered are vessels transiting in the authorised channel past the outfall. Over the analysed period there were 14,073 vessel transits past the outfall within authorised channel. The data for the nearshore movements is not being considered at it is likely that these movements would be associated with the site construction activity.

7.3.5 From the analysis of the impacts of the discharges on vessels and the ship simulation tracks the summary tables indicate that the vessels which are most impacted are tugs towing at Low water slacks and the kayaks. There were 185 recorded passages of tugs transiting past the site whilst towing, however within the key period of concern is within the window of 15 minutes before low water to 45 minutes after low water there were just 5 passages identified as taking place between 1 and 2 hours after low tide, but none within the impact window. In addition, there are 28 transits by tugs towing at around high water (± 15 minutes) could receive the impact as presented in 6.1.10.

7.3.6 Other vessels which could be significantly impacted by a CSO discharge are the non-powered vessels such as Kayakers. The record of the kayakers transiting the site indicate that there were no passages undertaken over the low water period. The data over the period indicates that the kayaks passed the site in two distinct periods, transiting upstream in the authorised channel at between 2 and 4 hours after low water and transiting downstream in the farshore zone at between 5 and 3 hours before low water.

7.3.7 Tables 5.4 serve to list the vessels that are subject to the impact of the Fleet Main CSO discharge flow. Table 6-1 presents the update of impacts on vessels following the work undertaken using the ship simulations.

7.3.8 Figure 5-2 provides the normal operating passage through the Blackfriars Arches whilst considering draft.

7.3.9 It has been determined that only vessels undertaking the passage through Arch 2 and Arch 3 during a 1:15 year return period discharge during the low water tidal window will be impacted by the Fleet Main CSO with the non-powered vessels being most affected.

7.3.10 Vessels that cannot navigate through Arch 2 due to the vessel draft, are assessed undertaking the passages though Arch 3 only.

7.3.11 Traditional class V vessels are assessed separately, due to the increased limitations of manoeuvrability and power, for a potential collision with a bridge pier when transiting downstream.

7.4 Severity of Harm

7.4.1 Jacobs rate the hazard on worst potential severity:

i) 1: Nil or slight injury / illness, property damage or environmental issue.

ii) 2: Minor injury / illness, property damage or environmental issue.

iii) 3: Moderate injury or illness, property damage or environmental issue.

iv) 4: Major injury or illness, property damage or environmental issue.

v) 5: Fatal or long-term disabling injury or illness. Significant property damage or environmental issue.

vi) 10. Multiple fatalities and catastrophic event

7.4.2 The hazard identified above has potential to cause harm to the vessel users:

i) Swamping leading to a major injury or drowning.

ii) Capsizing leading to a major injury or drowning.

iii) Grounding leading to major Injury or illness due to exposure to sewage.

iv) Contact between a bridge pier and a vessel moving downstream.

v) Collision with another vessel due to a CSO discharge event forcing non-powered vessel to drift from previous course leading to major injury or drowning.

vi) Collision between third party vessels caused by one of the vessels changing course to avoid collision with a non-powered vessel.

7.5 Likelihood of Harm

7.5.1 Jacobs risk assessment rates the likelihood of harm with the following probabilities:

1: Highly Unlikely
2: Unlikely
3: Possible
4: Likely
5: Highly Likely

7.5.2 The assessment has been undertaken by analysing the 1:15 year return data presented in document 410-FLOJV-BLABF-520-VZ-RG-100001- CSO Discharge Modelling for permanent works Blackfriars Bridge Foreshore as this is the most realistically probable event, to present the discharge characteristics.

7.5.3 It has been established from the desk top study that the peak flow velocity plumes, presented in the 2-d HR Wallingford report, will impact vessels operating on the Thames for a period of 60 minutes from 15 minutes before low water slack to 45 minutes after

7.5.4 There was an additional tidal window identified at neap high water slacks which also has an impact on vessels, principally tugs towing past the site.

7.5.5 The likelihood coincidence of the instantaneous peak flow and the minimal period of still water, or indeed a period of dominant flow from the Fleet Main CSO discharge, are low for the worst-case scenario.

7.5.6 There is minimal likelihood of harm due to the bridge Arches themselves, but they do create the corridor for the passage further upstream or downstream past the Fleet Main CSO outfall.

7.5.7 Current annual frequency of discharge has been established as an average of 62.25 with a maximum record of 125 discharges which could impact river users. This is forecast to be reduced to between 3 and 5 discharges in a typical year once the tunnel is operational.

8. Mitigation

8.1.1 The ERIC approach will be adopted to review mitigation for this DRA.

- ERIC stands for Eliminate, Reduce, Inform and Control.
- This is a four -level hierarchy that outlines the steps it should take to mitigate risk.

8.2 Eliminate

8.2.1 The Fleet Main CSO outfall is needed to allow sewers to discharge when they reach capacity and prevent the risk of flooding upstream in the catchment area. To eliminate the flows entirely would require the closing of the CSO outfall and would flood the upstream catchment area during storm events and is therefore not feasible.

8.3 Reduce

8.3.1 The number of discharges will be reduced by bringing the main tideway tunnel into operation. This will reduce the number of discharges from the average of 62.25 per typical year down to 4 discharges anticipated in a typical year.

8.3.2 To reduce the risk of impact to vessels transiting the site a warning system could be adopted for the permanent works in line with the proof of concept which is being developed in consultation with the PLA and main works contractors.

8.3.3 To reduce the discharge rate from the new Fleet Main CSO outfall consideration was made for the retention of the current temporary discharge point within Arch 1. However, this has been discounted due to the temporary nature of the design and there being no secondary isolation available for these gates which could undermine the operation of the main tunnel and create unacceptable risks to personnel that may need to work within the culverts.

8.4 Inform

8.4.1 During the development in the interim phase warning lights have been developed and designed by the MWC and offered for to the PLA for acceptance. Any warning lights installed as part of the agreed interim arrangements to be adopted for the permanent case.

8.4.2 Promulgation of the operational plan to river users.

8.4.3 It is likely that the PLA will need to provide a new notice to mariners identifying new CSO operation and mitigations.

8.4.4 Tideway or TWUL will notify the PLA when tunnel maintenance is to planned, it is likely that the PLA will issue a notice to mariners during periods of LTT maintenance to identify that there could be an increase in the frequency and severity of a CSO discharge.

8.5 Control

8.5.1 All agreed CSO signage and warning lights to be installed and adopted.

8.5.2 Operation plan for the warning system to include warning trigger points, which will need to be considered and agreed with the PLA.

9. Summary

9.1 Summary

9.1.1 Jacobs as Designer for the reference design have a duty to eliminate and reduce risks so far as reasonably practicable (SFARP) and to identify residual risks. Jacobs have undertaken this risk assessment to assess the magnitude of this risk for each vessel type and to consider whether mitigation measures can be adopted that can reduce the risks to an acceptable low level.

9.1.2 The risk assessment has looked at the most reasonable conservative case of a 1:15 year return period storm event without the flows being intercepted.

9.1.3 Overall, the residual risk has been determined as low due to: -

(a) Limited impact of CSO discharges on powered vessels.

(b) Limited number of transits past the CSO by tugs towing during the period of most impact, low water slacks.

(c) The introduction of an effective warning system to advise powered vessels that the CSO is discharging and to proceed with caution or follow any additional advice generated by the NRA and promulgated by the PLA.

(d) The introduction of an effective warning system to advise non-powered vessels that the CSO is discharging and to proceed with caution or follow any additional advice generated by the NRA and promulgated by the PLA.

Powered Vessels

9.1.4 In the case of powered vessels during low water periods, the risk is low as all powered vessels, with the exception of tugs towing, can pass the CSO outfall discharge safely, accepting that they will need to adjust course and speed to maintain control. It is recognised that Tugs are highly unlikely to be towing past the site during periods of low water.

9.1.5 In the case of powered vessels during high water slack periods the risk is very low, assuming the use of an effective warning system and that the vessel operator is following any advice concluded in the NRA and promulgated by the PLA.

Unpowered Vessels

9.1.6 In the case of manually operated or unpowered vessels transiting the CSO outfall discharge upstream during periods of low water the risk is moderate, assuming the use of an effective warning system and that the vessel operator is following any advice concluded in the NRA and promulgated by the PLA.

Navigational Risk Assessment

9.1.7 A Navigational Risk Assessment (NRA) is to be undertaken by navigational specialists with expert knowledge of waterway traffic and the conditions in the Blackfriars area.

9.1.8 This designers risk assessment will be considered by the MWC in addition to the navigation risk assessment as part of the iterative process to develop the detailed design and Operational Plan. The navigational risk specialists will need to consider both the DRA and the Operational Plan to produce the Navigational Risk Assessment.

9.1.9 The MWC should consider the following in the development of the detailed design and the operational plan,

- The recommendations of the NRA,
- the optimal "on" time for the live warning signal(s), taking account of the discharge hydrograph and the actions to be taken by powered vessels and unpowered vessels or a member of the public on the foreshore nearby,
- the locations, lux, visibility, and particulars of the warning signs,
- the optimal "off" time for the warning signal,
- the manner of promulgation of information and communication with the river community, including what is required of Tideway, the PLA and the river users,

9.1.10 The NRA will consider the residual risks from the DRA, the detailed design and the Operational Plan to determine the most appropriate mitigation in consultation with the PLA and other river users. In particular the NRA should consider:-

- The MWC's operational plan to assess whether there is any change to the hazards and risk levels through the introduction of the mitigations
- the necessary responses of powered vessels to a discharge through the different Arches (e.g., adjust course as required, proceed with caution and look out for unpowered vessels affected by a discharge) and the time needed to action the responses.
- the necessary responses of unpowered vessels to a discharge through the different Arches and the time needed to action the responses,
- the assessment of any increased risk to normal river operations arising from the implementation of mitigations.

9.1.11 In the development of the NRA and operational plan, the timings of the mitigation implementation should also be considered and detailed for agreement with the PLA.

9.1.12 The updated NRA with its proposed mitigations will be reviewed by the MWC to confirm that the design risks have been mitigated insofar as is reasonably practicable for the permanent works.

9.2 Key Information

9.2.1 The most credible worst case CSO discharge is for a 1:15 year return period storm without the tunnel in operation with a discharge of $46m^3/s$. The frequency of discharges once the tunnel in in operation is expected to between 4 and 5 per year when the tunnel is in operation. When the tunnel is to be taken out of operation additional information will need to be made available to stakeholders outlining the potential for increased frequency of discharges.

9.2.2 The assessment considers the river in three zones as defined in figure 7-1, and the critical discharge occurring at low water springs and acknowledges there is some impact at slack high water. The discharges are considered to impact within the following tidal windows represented below in Table 9-1.

Table 9-1 Times of impact

Main Fairway – Low Water[1]		Main Fairway – Slack High Water	
Start	End	Start	End
LW -15 minutes	LW +45 minutes	HW -15 minutes	HW +15 minutes

9.2.3 Table 9-1 does not provide any information on the nearshore zone because the edge of the new BLABF structure is the northern line of the navigable channel.

9.2.4 It should be noted it is not possible to predict the discharges within 30m of the CSO outfall at any state of the tide and in this instance that zone is in the fairway.

9.2.5 For any periods of slack water, such as a Thames Barrier closure, the same considerations should be given to low or high slack water period.

9.2.6 This document provides information on the timing and intensity of the discharges and the hydrographs are presented in Figures 4.1 and 4.2. The proof of concept document (LONDON TIDEWAY TUNNELS PROOF OF CONCEPT - CSO DISCHARGE WARNING DRAFT 27/02/24) provides further detailed discharge hydrographs that should be utilised in the development of suitable warning times in the development of the detailed design undertaken by the MWC.

9.2.7 Any unmitigated risks arising from the detail design development, such as insufficient warning time, should be identified in the MWCs design documentation and potential mitigation measures identified for consideration by the PLA.

9.2.8 A warning system, such as lights and signs, has been established as a mitigation measure suitable to reduce the risk to vessels. During the development of the NRA and the operational plan the MWC should assess the suitability of the mitigation measures and substantiate their proposals within the detailed design documentation.

Appendix A. Designers Risk Assessment

Jacobs

DESIGN HAZARD ELIMINATION AND RISK REDUCTION REGISTER

Latest Meeting Date

Update Critical Risk Summary Tab

Phase	
C	Construction
M	Maintain/Clean
U	Use as a Workplace
D	Demolish

Project Name:	Tideway
Project Number:	665397CH
Client:	Bazalgette Tunnel Limited

Probability

1: Highly Unlikely
2: Unlikely
3: Possible
4: Likely
5: Highly Likely

Worst Potential Severity (WPS) of Impact

1: Nil or slight injury / illness, property damage or environmental issue.
2: Minor injury / illness, property damage or environmental issue.
3: Moderate injury or illness, property damage or environmental issue.
4: Major injury or illness, property damage or environmental issue.
5: Fatal or long term disabling injury or illness. Significant property damage or environmental issue.
10. Multiple fatalities and catastrophic event

Risk Rating

NOTE: The purpose of Risk Rating is to determine which risks are significant. It is a subjective assessment and not an absolute or precise determination

High	HSEiD risk resulting from design is unacceptably high. Revise design to reduce
Medium	HSEiD risk resulting from design is permitted with appropriate design controls and management oversight in
Low	HSEiD risk resulting from design is permitted.

1 Risk ID.	2 Formal Review Description	3 Phase	4 Activity	5 Potential Hazard	6 Person(s) Most at Risk	7 Prob	8 WPS	9 Initial Risk Rating	10 Discipline	11 Design Measures to Eliminate Hazards	12 Design Measures to Reduce Risk	13 Residual Prob	14 Residual WPS	15 Residual Risk Rating	16 Residual Risk Description	17 Included on Drawing No(s) or other doc. (give ref.)
CDM-BLABF-023-A	Non-powered craft underway - Low tide	Permanent	Kayak/Rower/Dinghy/SUP navigating upstream through Arch 2 and proceeding to the vicinity of a CSO discharge	Swamping due to CSO discharge event	Public: Major injury and/or drowning	2	5	10	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by	1	5	5	Public: Major injury and/or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-B	Non-powered craft underway - Low tide	Permanent	Kayak/Rower/Dinghy/SUP navigating upstream through Arch 2 and proceeding to the vicinity of a CSO discharge	Capsizing due to a CSO discharge event	Public: Major injury and/or drowning	2	5	10	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by	1	5	5	Public: Major injury and/or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-C	Non-powered craft underway - Low tide	Permanent	Kayak/Rower/Dinghy/SUP navigating upstream through Arch 2 and proceeding to the vicinity of a CSO discharge	Grounding due to a CSO discharge event	Public:Major Injury or illness due to exposure to sewage	2	4	8	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by	1	4	4	Public:Major Injury or illness due to exposure to sewage	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-D	Non-powered craft underway - Low tide	Permanent	Kayak/Rower/Dinghy/SUP navigating downstream approaching Arch 3 and passing through the vicinity of a CSO discharge	Contact with bridge pier leading to capsize and entrapment	Public: Major injury and/or drowning	1	5	5	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by	1	5	5	Public: Major injury and/or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-E	Non-powered and Rec. powered vessel underway - Low Tide	Permanent	Kayak/Rower/Dinghy/SUP and recreational powered vessel navigating through Arch 2and proceeding to the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing non-powered craft to drift from previous course	Public: Major injury and or drowning	2	5	10	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-F	Non-powered and Rec. powered vessel underway - Low Tide	Permanent	Kayak/Rower/Dinghy/SUP navigating upstream through Arch 2, recreational powered vessel navigating upstream through Arch 3 and proceeding to the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing non-powered craft to drift from previous course	Public: Major injury and or drowning	2	5	10	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents

Jacobs

DESIGN HAZARD ELIMINATION AND RISK REDUCTION REGISTER

Latest Meeting Date

Update Critical Risk Summary Tab

Phase	
C	Construction
M	Maintain/Clean
U	Use as a Workplace
D	Demolish

Project Name:	Tideway
Project Number:	665397CH
Client:	Bazalgette Tunnel Limited

Probability

1: Highly Unlikely
2: Unlikely
3: Possible
4: Likely
5: Highly Likely

Worst Potential Severity (WPS) of Impact

1: Nil or slight injury / illness, property damage or environmental issue.
2: Minor injury / illness, property damage or environmental issue.
3: Moderate injury or illness, property damage or environmental issue.
4: Major injury or illness, property damage or environmental issue.
5: Fatal or long term disabling injury or illness. Significant property damage or environmental issue.
10. Multiple fatalities and catastrophic event

Risk Rating

NOTE: The purpose of Risk Rating is to determine which risks are significant. It is a subjective assessment and not an absolute or precise determination

Rating	Description
High	HSEiD risk resulting from design is unacceptably high. Revise design to reduce
Medium	HSEiD risk resulting from design is permitted with appropriate design controls and management oversight in place
Low	HSEiD risk resulting from design is permitted.

LIKELIHOOD	RISK				
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5
	1	2	3	4	5
	SEVERITY				

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Risk ID.	**Formal Review Description**	**Phase**	**Activity**	**Potential Hazard**	**Person(s) Most at Risk**	**Prob**	**WPS**	**Initial Risk Rating**	**Discipline**	**Design Measures to Eliminate Hazards**	**Design Measures to Reduce Risk**	**Residual Prob**	**Residual WPS**	**Residual Risk Rating**	**Residual Risk Description**	**Included on Drawing No(s) or other doc. (give ref.)**
CDM-BLABF-023-G	Non-powered and Commercial powered vessel underway - Low tide	Permanent	Kayak/Rower/Dinghy/SUP navigating upstream through Arch 2 and a commercial powered vessel navigating upstream through Arch 3 and proceeding to the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing non-powered craft to drift from previous course	Public: Major injury and or drowning	2	5	10	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-J	Rec. Powered Vessel underway - Low tide	Permanent	Rec. Powered Vessel navigating upstream through Arch 2 and proceeding to the vicinity of a CSO discharge	Swamping due to CSO discharge event	Public: Injury/illness due to exposure to sewage or Major injury	2	4	8	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	4	4	Public: Injury/illness due to exposure to sewage or Major injury	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-K	Rec. Powered Vessel underway - Low tide	Permanent	Rec. Powered Vessel navigating upstream through Arch 2 and proceeding to the vicinity of a CSO discharge	Grounding due to a CSO discharge event	Public: Major injury	1	4	4	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	4	4	Public: Major injury	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-L	Rec. Powered Vessel and Commercial Powered Vessel underway - Low tide	Permanent	Rec. Powered Vessel navigating upstream Arch 2 and a commercial powered vessel navigating upstream through Arch 3 and proceeding to the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing Rec.Powered vessel to drift from its previous course	Public: Major injury	1	4	4	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	4	4	Public: Major injury	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-M	Commercial Powered Vessel underway - Low tide	Permanent	Commercial Powered Vessel navigating upstream through Arch 2 and proceeding to the vicinity of a CSO discharge	Swamping due to CSO discharge event	Public: Injury/ illness due to exposure to sewage	1	3	3	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	3	3	Public: Injury/ illness due to exposure to sewage	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-N	Commercial Powered Vessel underway - Low tide	Permanent	Commercial Powered Vessel navigating upstream through Arch 2 and proceeding to the vicinity of a CSO discharge	Grounding due to a CSO discharge event	Public: Injury	1	3	3	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	3	3	Public: Injury	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents

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DESIGN HAZARD ELIMINATION AND RISK REDUCTION REGISTER

Latest Meeting Date	
Phase	
C	Construction
M	Maintain/Clean
U	Use as a Workplace
D	Demolish
Project Name:	Tideway
Project Number:	665397CH
Client:	Bazalgette Tunnel Limited

Update Critical Risk Summary Tab

Probability

1: Highly Unlikely
2: Unlikely
3: Possible
4: Likely
5: Highly Likely

Worst Potential Severity (WPS) of Impact

1: Nil or slight injury / illness, property damage or environmental issue.
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3: Moderate injury or illness, property damage or environmental issue.
4: Major injury or illness, property damage or environmental issue.
5: Fatal or long term disabling injury or illness. Significant property damage or environmental issue.
10. Multiple fatalities and catastrophic event

Risk Rating

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High	HSEiD risk resulting from design is unacceptably high. Revise design to reduce
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Low	HSEiD risk resulting from design is permitted.

LIKELIHOOD \ SEVERITY (RISK)	1	2	3	4	5
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5

1 Risk ID.	2 Formal Review Description	3 Phase	4 Activity	5 Potential Hazard	6 Person(s) Most at Risk	7 Prob	8 WPS	9 Initial Risk Rating	10 Discipline	11 Design Measures to Eliminate Hazards	12 Design Measures to Reduce Risk	13 Residual Prob	14 Residual WPS	15 Residual Risk Rating	16 Residual Risk Description	17 Included on Drawing No(s) or other doc. (give ref.)
CDM-BLABF-023-O	Commercial Powered Vessel underway - Low tide	Permanent	Commercial powered vessel navigating downstream for Arch 3 passing through the CSO discharge	Contact with bridge abutment due to a CSO discharge event	Public: Injury Property damage (bridge pier), Disruption	2	3	6	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	3	3	Public: Injury Property damage (bridge pier), Disruption	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-P	Non-powered craft underway - All other states of tide	Permanent	Kayak/Rower/Dinghy/SUP navigating upstream through Arch 2 and proceeding to the vicinity of a CSO discharge	Swamping due to CSO discharge event	Public: Illness due to exposure to sewage or Drowning	2	5	10	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by	1	5	5	Public: Illness due to exposure to sewage or Drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-Q	Non-powered craft underway - All other states of tide	Permanent	Kayak/Rower/Dinghy/SUP navigating upstream through Arch 2 and proceeding to the vicinity of a CSO discharge	Capsizing due to a CSO discharge event	Public: Illness due to exposure to sewage or Drowning	2	5	10	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by	1	5	5	Public: Illness due to exposure to sewage or Drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-R	Non-powered and Rec. powered vessel underway - All other states of tide	Permanent	Kayak/Rower/Dinghy/SUP and recreational powered vessel navigating through Arch 2 and proceeding to the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing non-powered craft to drift from previous course	Public: Major injury and or drowning	2	5	10	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-S	Non-powered and Rec. powered vessel underway - All other states of tide	Permanent	Kayak/Rower/Dinghy/SUP navigating upstream through Arch 2, recreational powered vessel navigating upstream through Arch 3 and proceeding to the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing non-powered craft to drift from previous course	Public: Major injury and or drowning	2	5	10	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-T	Non-powered and Commercial powered vessel underway - All other states of tide	Permanent	Kayak/Rower/Dinghy/SUP navigating upstream through Arch 2 and Commercial powered vessel navigating upstream through Arch 3 and proceeding to the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing non-powered craft to drift from previous course	Public: Major injury and or drowning	2	5	10	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents

Jacobs

DESIGN HAZARD ELIMINATION AND RISK REDUCTION REGISTER

Latest Meeting Date	
Phase	
C	Construction
M	Maintain/Clean
U	Use as a Workplace
D	Demolish
Project Name:	Tideway
Project Number:	665397CH
Client:	Bazalgette Tunnel Limited

Update Critical Risk Summary Tab

Probability

1: Highly Unlikely
2: Unlikely
3: Possible
4: Likely
5: Highly Likely

Worst Potential Severity (WPS) of Impact

1: Nil or slight injury / illness, property damage or environmental issue.
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Low	HSEiD risk resulting from design is permitted.

LIKELIHOOD	RISK				
5	5	10	15	20	25
4	4	8	12	16	20
3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5
SEVERITY	1	2	3	4	5

1 Risk ID.	2 Formal Review Description	3 Phase	4 Activity	5 Potential Hazard	6 Person(s) Most at Risk	7 Prob	8 WPS	9 Initial Risk Rating	10 Discipline	11 Design Measures to Eliminate Hazards	12 Design Measures to Reduce Risk	13 Residual Prob	14 Residual WPS	15 Residual Risk Rating	16 Residual Risk Description	17 Included on Drawing No(s) or other doc. (give ref.)
CDM-BLABF-023-U	Rec. Powered Vessel underway - All other states of tide	Permanent	Rec. Powered Vessel navigating through Arch 2 proceeding to the vicinity of a CSO discharge	Swamping due to CSO discharge event	Public: Injury or illness due to exposure to sewage	1	3	3	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by	1	3	3	Public: Injury or illness due to exposure to sewage	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-V	Rec. Powered Vessel and Commercial Powered Vessel underway - All other states of tide	Permanent	Rec. Powered Vessel navigating through Arch 2 proceeding to the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing Rec.Powered vessel to drift from its previous course	Public: Major injury	1	4	4	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	4	4	Public: Major injury	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-W	Powered Emergency Vessels underway - Low tide	Permanent	Powered Emergency Vessels responding to an emergency in close proximity of a CSO discharge	Grounding due to CSO discharge event	Public: Injury/ illness due to exposure to sewage	1	3	3	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	3	3	Public: Injury/ illness due to exposure to sewage	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-X	Powered Emergency Vessels underway - All other states of tide	Permanent	Powered Emergency Vessels responding to an emergency in close proximity of a CSO discharge	Swamping due to CSO discharge event	Public: Injury/ illness due to exposure to sewage	1	4	4	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	4	4	Public: Injury/ illness due to exposure to sewage	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM-BLABF-023-Y	Traditional Class 5 Vessels underway - Low tide	Permanent	Traditional Class 5 vessel navigating downstream for Arch 3 passing through the CSO discharge	Contact with bridge abutment due to a CSO discharge event	Public: Major injury and or drowning	2	5	10	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM -BLABF-023-Z	Traditional Class 5 Vessels underway - All other states of tide	Permanent	Traditional Class 5 vessel navigating downstream for Arch 3 passing through the CSO discharge	Contact with bridge abutment due to a CSO discharge event	Public: Major injury and or drowning	1	5	5	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents

Jacobs

DESIGN HAZARD ELIMINATION AND RISK REDUCTION REGISTER

Latest Meeting Date	
Phase	
C	Construction
M	Maintain/Clean
U	Use as a Workplace
D	Demolish
Project Name:	Tideway
Project Number:	665397CH
Client:	Bazalgette Tunnel Limited

Update Critical Risk Summary Tab

Probability

1: Highly Unlikely
2: Unlikely
3: Possible
4: Likely
5: Highly Likely

Worst Potential Severity (WPS) of Impact

1: Nil or slight injury / illness, property damage or environmental issue.
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LIKELIHOOD	RISK				
5	5	10	[illegible]	[illegible]	[illegible]
4	4	8	[illegible]	[illegible]	[illegible]
3	3	6	9	[illegible]	[illegible]
2	2	4	6	8	10
1	1	2	3	4	5
	1	2	3	4	5
	SEVERITY				

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Risk ID.	Formal Review Description	Phase	Activity	Potential Hazard	Person(s) Most at Risk	Prob	WPS	Initial Risk Rating	Discipline	Design Measures to Eliminate Hazards	Design Measures to Reduce Risk	Residual Prob	Residual WPS	Residual Risk Rating	Residual Risk Description	Included on Drawing No(s) or other doc. (give ref.)
CDM -BLABF-023-A1	Non-powered craft underway - Neap high tide	Permanent	Kayak/Rower/Dinghy/SUP navigating upstream through Arch 2 and proceeding to the vicinity of a CSO discharge	Capsizing due to a CSO discharge event	Public: Major injury and/or drowning	1	5	5	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM -BLABF-023-A2	Non-powered craft underway - Neap high tide	Permanent	Kayak/Rower/Dinghy/SUP navigating downstream approaching Arch 3 and passing through the vicinity of a CSO discharge	Contact with bridge pier leading to capsize and entrapment	Public: Major injury and/or drowning	2	5	10	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM -BLABF-023-A3	Non-powered and Rec. powered vessel underway - Neap high Tide	Permanent	Kayak/Rower/Dinghy/SUP and recreational powered vessel navigating through Arch 2and proceeding to the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing non-powered craft to drift from previous course	Public: Major injury and or drowning	1	5	5	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM -BLABF-023-A4	Non-powered and Rec. powered vessel underway - Neap high Tide	Permanent	Kayak/Rower/Dinghy/SUP navigating upstream through Arch 2, recreational powered vessel navigating upstream through Arch 3 and proceeding to the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing non-powered craft to drift from previous course	Public: Major injury and or drowning	1	5	5	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM -BLABF-023-A5	Non-powered and Commercial powered vessel underway - Neap high tide	Permanent	Kayak/Rower/Dinghy/SUP navigating upstream through Arch 2 and a commercial powered vessel navigating upstream through Arch 3 and proceeding to the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing non-powered craft to drift from previous course	Public: Major injury and or drowning	1	5	5	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM -BLABF-023-A6	Rec. Powered Vessel and Commercial Powered Vessel underway - Neap high tide	Permanent	Rec. Powered Vessel navigating upstream Arch 2 and a commercial powered vessel navigating upstream through Arch 3 and proceeding to the vicinity of a CSO discharge	Collision due to a CSO discharge event forcing Rec.Powered vessel to drift from its previous course	Public: Major injury	1	5	5	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents

Jacobs

DESIGN HAZARD ELIMINATION AND RISK REDUCTION REGISTER

Latest Meeting Date

Phase	
C	Construction
M	Maintain/Clean
U	Use as a Workplace
D	Demolish

Project Name:	Tideway
Project Number:	665397CH
Client:	Bazalgette Tunnel Limited

Update Critical Risk Summary Tab

Probability

1: Highly Unlikely
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Worst Potential Severity (WPS) of Impact

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LIKELIHOOD	RISK				
5	5	10	15	20	25
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3	3	6	9	12	15
2	2	4	6	8	10
1	1	2	3	4	5
	1	2	3	4	5

SEVERITY

1 Risk ID.	2 Formal Review Description	3 Phase	4 Activity	5 Potential Hazard	6 Person(s) Most at Risk	7 Prob	8 WPS	9 Initial Risk Rating	10 Discipline	11 Design Measures to Eliminate Hazards	12 Design Measures to Reduce Risk	13 Residual Prob	14 Residual WPS	15 Residual Risk Rating	16 Residual Risk Description	17 Included on Drawing No(s) or other doc. (give ref.)
CDM -BLABF-023-A7	Commercial Powered Vessel underway - Neap high tide	Permanent	Commercial powered vessel navigating downstream for Arch 3 passing through the CSO discharge	Contact with bridge abutment due to a CSO discharge event	Public: Injury Property damage (bridge pier), Disruption	1	5	5	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Injury Property damage (bridge pier), Disruption	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM -BLABF-023-A8	Traditional Class 5 Vessels underway - Neap high tide	Permanent	Traditional Class 5 vessel navigating downstream for Arch 3 passing through the CSO discharge	Contact with bridge abutment due to a CSO discharge event	Public: Major injury and or drowning	1	5	5	Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of discharges by intercepting flows.	1	5	5	Public: Major injury and or drowning	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents
CDM -BLABF-023-A9	Powered Emergency Vessels underway - Neap high tide	Permanent	Powered Emergency Vessels responding to an emergency in close proximity of a CSO discharge	Contact with structure/bridge abutment due to a CSO discharge	Public: Injury/ illness due to exposure to sewage	1	5		Civil / Structural	Unable to eliminate Hazard - The foreshore site is fixed	1. CSO Signage 2. CSO Warning light 3. Reduction in number of	1	5	5	Public: Injury/ illness due to exposure to sewage	Notice to Mariners, Port Information Guide, Tideway Code and any other pertinent documents