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Rotherhithe to Canary Wharf River Crossing

Value Engineering

Transport for London

04 October 2018

Notice

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This document has 20 pages including the cover.

Document history

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Introduction

The Rotherhithe to Canary Wharf River Crossing value engineering workshop was undertaken on 4th July 2018. In the workshop, individual disciplines – structures, architecture, mechanical and electrical, geotechnical and constructability – presented their current design proposals and potential value engineering ideas. This was followed by an individual attendee's idea generation round. All ideas were collated and summarised with following actions identified and agreed with TfL in Document ST_PJ585C-ATK-BAS-ZZ_12-REP-ZZ-00001 P01 (Refer Appendix D).

Following the value engineering workshop, concept design (including optioneering and construction methodology) has continued in parallel with the value engineering idea progression. The value engineering ideas have been assessed and compared against the design presented at the value engineering workshop. In this report the design presented at the value engineering workshop is was used as the baseline design.

This report includes:

- The status of the value engineering items (VE1 to 37) and briefing of the key VE items selected for further assessment to compare it with the baseline designs (and concept designs, where applicable).

- The value engineering on the permanent works design undertaken based on the ideas generated from the value engineering workshop are presented in independent assessment forms (Refer Appendix C). Each assessment form describes a summary of the proposal, advantages, disadvantages and impact evaluations – cost, programme, risk, environmental, buildability, safety and operation and maintenance.

  Note: Quite few of the proposals been incorporated in the concept design to date (as instructed by TfL and part of Atkins concept design progress).

- The constructability methodology options raised at the value engineering workshop are presented in independent assessment forms (Refer Appendix C).

Note: Costain has provided valuable and vital support on the constructability methodology options and contributions on early indications of constructability and programme for the permanent works value engineering proposals.

Following completion of concept design, Costain will be producing a detailed proposed construction methodology document. It is currently envisaged that this document will detail final recommendations with some options/opportunities/risks. This document may include further detail on the construction methodology options detailed in this report if they are deemed appropriate for the agreed concept design.

Executive Summary

The purpose of this report is to discuss the feasibility and quantify cost savings on value engineering ideas captured in the workshop conducted on 4th July 2018. For each opportunity, a basic concept design has been undertaken and assessed for advantages, disadvantages and impact evaluations – cost, programme, risk, environmental, buildability, safety and operation and maintenance.

From the VE workshop, 37 permanent works and construction opportunities and risks have been identified, discussed and analysed. All the opportunities where applicable have been assessed; a total of 23 opportunities. This includes 12 opportunities with verified cost estimates against the baseline and 2 opportunities with cost estimates pending TfL estimating team review (at the time of writing). Each opportunity is summarised in Table 2-1.
Each opportunity is not mutually exclusive and various opportunities either cannot be applied together or there is a reduction in benefits in doing so. Furthermore, each opportunity comes with new and unique risks that should be considered carefully.

Note: Only basic calculations have been undertaken for each opportunity - additional design / analysis activity is required to incorporate any value engineering opportunities into the concept design and justify opportunity evaluations.

1. Value Engineering Baseline Design

1.1. Highway Design

The baseline alignment option (denoted as alignment CB5 to CA5) is a 1km route from Rotherhithe street opposite Durand's Wharf to Westferry Circus in Canary Wharf and assumes a 12m air draught from Mean High Water Springs (MHWS) over a 40m width at the centre of the River Thames navigation channel. Refer to drawing ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00007 in Appendix A for details on CB5-CA5 baseline alignment.

The eastern landing site (CA5) in Canary Wharf is found in the river almost in its entirety, with seven river supports in addition to the main span piers immediately adjacent to the navigation channel. The alignment ramp runs parallel to the JP Morgan development site for 150m with the finished level at least 5m above Thames path level. The ramp is 380m from midspan to the landing site, which is Westferry Circus. The requirement for split decks is eliminated on the moving span due to the modest gradients leading from the crest curve. CA5 would achieve maximum 3% gradients for 80m but with an extended flat 0% gradient section running for 85m before tying into Westferry Circus. Similar to the CB5 landing, a 1% gradient transition at chainage marker 625m from the 2% gradient incline leading from the moving span would provide access to lifts and stairs which would be situated to the south of JP Morgan development site.

The western landing site (CB5) in Durand's Wharf provides a ramp length of ca. 450m from midspan to landing site. CB5 cycle ramp includes three inclined sections at 4% gradient to fit the alignment. The remaining inclines are at a maximum of 3% gradient and maximum 80m in length. Two extended sections at 2% gradient from midspan eliminate the need for split decks on the moving span.

1.2. Structure Design

The early phases of the concept design main span consisted of the Arcadis lifting bridge option planted on CB5-CA5 alignment (Section 1.1) which comprises a 160m long twin bowstring tied arch made of steel sections (Figure 1-1). The soffit of the deck is 12m above MHWS in its lowered position and 60m above MHWS in its elevated position. The deck has a consistent width of 8.1m and minimum 2.4m vertical clearances through the tied arch for cyclist and pedestrians.

Prior to the value engineering workshop this was progressed to a Pratt Truss Bridge with the diagonal members as slender architectural tension struts (Figure 1-2). A Pratt Truss Bridge is significantly simpler to fabricate, and construct compared to a tied arch. The same deck width and vertical clearances were maintained. The Pratt Truss Bridge is taken as the baseline design for value engineering.

The baseline tower design at each end of the main span consists of two separate "mushroom" shape in plan towers. The towers are braced together at the bottom, near the machine room and counterweight, and the top. They consist of 80mm thick painted structural steel stiffened plates. They are 80m above mean high water springs (MHWS) and are supported on reinforced concrete foundations. The towers provide sufficient space internally for the plant room, access stairs / ladders and a lift. The floors of the ladders and stairs doubling up as regularly spaced diaphragms. The steel block counterweights to rise and fall outside of the tower.

The approach spans over the river comprise of steel box girders below deck level with varying spans. The river approaches are supported by reinforced concrete piers on caissons for the main and side spans and on driven piles elsewhere.

Figure 1-1 - Architectural render of Arcadis lifting bridge main span and towers

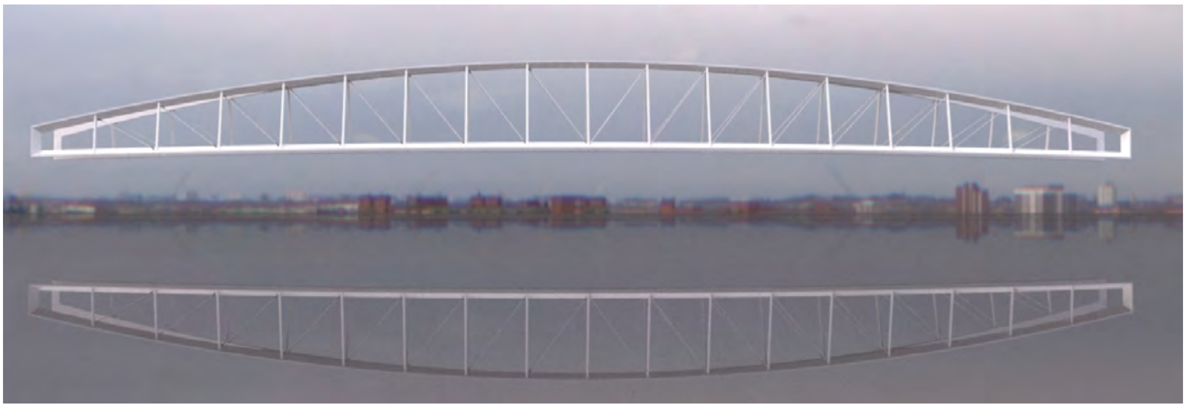

Figure 1-2 - Architectural render of baseline design lift bridge main span

1.3. Mechanical and Electrical Design

In the baseline M&E design, at the top of each tower is a set of sheave pulleys which support the deck and counterweight. The weight of the deck is balanced by a counterweight in each tower which is connected to the deck by counterweight 'lift ropes' that pass over the sheaves at the top of the towers.

'Drive ropes' connect the soffit of the deck with the underside of the counterweight via the 'drive drum' in the pier base. When the drum is rotated the counterweight is pulled down which lifts the deck. Rotating the drum in the opposite direction allows the counterweight to rise and the deck to fall. The counterweight weighs slightly less than the deck dead load.

Each drum is electrically powered by motors and have full redundancy with two electric motors and gearboxes. Normal service braking is incorporated within the motor drives, and emergency braking is provided by spring-applied, hydraulic release disc brakes mounted directly on the drum.

Longitudinal guidance of the bridge deck is provided by guide wheels mounted on the bridge deck with allowance for thermal expansion. Lateral guidance during bridge deck lifting is provided by guide wheels mounted on the bridge deck. The counterweights are also guided to reduce noise and impacts from wind.

In the lowered position the deck is restrained vertically by electrically actuated locking pins in the abutment which engage the bridge deck and the drive cable is tensioned before locking the motor to ensure the deck cannot lift from the bearings. *Note: there are no mechanisms on the lifting deck.* In the raised position the bridge is supported by the lift ropes. When the bridge is in the raised position for maintenance, the deck and counterweight is fixed with additional supports (spragging beams) which would allow the ropes to be removed.

A staircase and maintenance elevator are contained in the tower at each end of the bridge for maintenance access to the top of the tower.

1.4. Design Progression to Concept Design to Date

The baseline design has progressed towards concept design in parallel with the assessment of value engineering opportunities. The critical change is under Employers Instruction Notice 005 (EIN005), which instructs the consultant to develop the design of C2 alignment. This change is equivalent to opportunity VE1 listed in Table 2-1 and described in Appendix C.
Refer to drawing ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00010 in Appendix B for details on CB5-CA5 baseline alignment.

In the C2 alignment the western landing site (CB5) and eastern landing site (CA5) remain the same as the baseline design. However, the route between the two land sites is more direct, which reduces the approach ramp length on the eastern landing site. This modification increases the skew angle of the main span over the navigational channel; hence, increasing the main span length.

2. Value Engineering - Permanent Works and Constructability

The value engineering assessments undertaken on the baseline design are summarised in Table 2-1 and detailed in Appendix C. Some of the items have been included in the baseline design to date under the request of TfL.
Costain has provided valuable and vital support on the constructability methodology options and contributions on early indications of constructability and programme for the permanent works value engineering proposals.

Note: Only basic calculations have been undertaken for each opportunity - additional design activity is required to incorporate any value engineering opportunities into the concept design and to justify opportunity evaluations.

Table 2-1 - Value Engineering Summary

* - Reference savings costs in LumpSum and refer to respective VE assessment form in Appendix C for details

Value Engineering Item (Reference - ST PJ585C-ATK-BAS-ZZ_12-REP-ZZ-00001)	**Action & Results** Green – Further developed in Appendix C (24 items) Red – Risk items that have prevented development (3 items) Purple – To be considered and developed at a later stage (11 items)	**Cost Impact in Estimated Final Cost*** (comparison with baseline design)	**Critical Risks** (Further risks and details specified in Appendix C)
VE1 – Different route across river that provides a more direct route to Westferry Circus	Further developed in the VE report. Refer Appendix C.	£34.9 million saving (C2 alignment)	Departure from BS8300 required – inclusivity and accessibility. PLA consultation – undesirable increased skew across river.
VE2 – Construction on land behind the river wall, adjacent to JP Morgan development site	Further developed in the VE report. Refer Appendix C.	£2.4 million saving	JP Morgan consultation – vicinity and visual impact. Unknown existing river wall details. EA consultation – maintenance access and structural changes to existing river wall.
VE3 – Reduce deck width from recommended values to minimum values	Further developed in the VE report. Refer Appendix C.	£16.2 million saving	Does not meet published Sustrans guidance.
VE3a- Reduce ramp widths from landing site to intersection with lifts and stairs	Combined with VE3.	Refer to VE3	Refer to VE3
VE4 – Challenge PLA on the navigable headroom	Further developed in the VE report. Refer Appendix C.	£12.5 million saving	PLA consultation – 15m above MHWS has not currently been approved. 10m above MHWS is a significant further reduction.
VE5 - Temporary causeway or bridge to access main piers (half of the river at a time)	Further developed in the VE report. Refer Appendix C.	Cost saving to be agreed with TfL Estimating Team	PLA consultation – span width required. Note: this is not planned to intrude on the navigable channel.

Value Engineering Item	Action & Results	Cost Impact in Estimated Final Cost	Critical Risks
VE6 - Auger tubular piles	Further developed in the VE report. Refer Appendix C.	Cost saving to be agreed with TfL Estimating Team	Foundation design currently in development, which dictates suitable foundations.
VE7 - Precast caissons in dry dock and floated into position	This had been developed; however, the pilecap size due to ship impact loads has made this unviable. Further details in Appendix C.	N/A – Option no longer feasible for foundation design	N/A – Option no longer feasible for foundation design
VE8 - Precast units used inside the cofferdam to form the caisson	This had been developed; however, the pilecap size due to ship impact loads has made this unviable. Further details in Appendix C.	N/A – Option no longer feasible for foundation design	N/A – Option no longer feasible for foundation design
VE9 - Precast post-tensioned units to form the tower	Discussion on potential differences in reinforced concrete and post-tensioned concrete tower discussed in VE24.	Increase when compared to VE24.	Constructability of post tensioning at 80m height over the river.
VE10 - Intrusion of temporary works into navigation channel	Discussion regarding reducing navigable channel width is discussed in VE17. Temporary works intrusion is a risk item not VE.	N/A	Refer to VE17.
VE11 - Construction noise. Potentially require double skin cofferdam to mitigate.	Further developed in the VE report. Refer Appendix C.	Cost saving to be agreed with TfL Estimating Team	PLA consultation – Currently suggested that PLA will object to any intrusion into the navigable channel that cannot be removed within 24hrs. Cofferdam will need to be evacuated when largest vessels pass through.

Value Engineering Item	Action & Results	Cost Impact in Estimated Final Cost	Critical Risks
VE12 - Remote logistics and compound area adjacent to river required	This has been identified as a necessity by TfL. Insufficient granularity on baseline cost estimates to calculate potential relative cost saving. The cost estimate associated to this identified opportunity will be ascertained in the construction methodology report.	Cost saving anticipated – to be presented in Construction Methodology Report	N/A
VE13 - Steelwork connection details	Simplified main span truss and connection details shown in VE19.	Refer to VE19	Refer to VE19
VE14 - Use bridge lift mechanism to lift central span into position	To be considered in the construction methodology report.	Not assessed in this report	Not assessed in this report
VE15 - Use weathering steel to avoid maintenance painting	To be considered after concept design.	N/A	The appearance shown at public consultation needs to be consistent with the final proposed finish. Weathering steel of visible elements will look significantly different to the current visualisations.
VE16 - Deck drainage – drain directly off deck without channelling.	Deck drainage considered by core team. Not included in this report.	Not assessed in this report	EA approval
VE17 – Challenge PLA on the navigable width	Further developed in the VE report. Refer Appendix C.	£0.5 million saving (potential additional saving in M+E and tower design have not been accounted for)	PLA consultation – Currently suggested that PLA would prefer to maintain the navigable channel and only permit temporary works that can be removed within 24hrs.
VE18 – Architectural truss form (tapered top cord)	Combined with VE19.	Refer to VE19	Refer to VE19

Value Engineering Item	Action & Results	Cost Impact in Estimated Final Cost	Critical Risks
VE19 – Main span standard truss form	Further developed in the VE report. Refer Appendix C.	£19.9 million saving	TWAO consent and LA consultation – Less aesthetic when viewing from river and bank. Deck to feel more enclosed. Increase in weight – M+E needs to be reassessed.
VE 20 – Limit design wind speed in lifted position. Justified by assessing ship movements in high wind.	To be considered after concept design.	N/A	N/A
VE21 – Fibre reinforced polymer bridge	Further developed in the VE report. Refer Appendix C.	No data available to make justifiable comparison	Procurement risk – Minimal FRP bridges in the UK. Design risk – Minimal FRP bridge standards and guidance available.
VE22 – Main span steelwork fabrication offsite and transportation.	This has been identified as a necessity by TfL. Insufficient granularity on baseline cost estimates to calculate potential relative cost saving. The cost estimate associated to this identified opportunity will be ascertained in the construction methodology report.	Cost saving anticipated – to be presented in Construction Methodology Report	N/A
VE23 – Steel truss lifting span towers	Further developed in the VE report. Refer Appendix C.	£9.1 million saving	TWAO consent and LA consultation – Steel truss form is industrial and does not fit with the surrounding Canary Wharf Environment.
VE24 – Concrete lifting span towers	Further developed in the VE report. Refer Appendix C.	£21.2 million saving	TWAO consent and LA consultation – Concrete towers increase footprint, which can remove from the desirable slender appearance of the steel towers. Increase in foundation size due to concrete tower weight may potentially impact on the Jubilee Line Tunnels.

Value Engineering Item	Action & Results	Cost Impact in Estimated Final Cost	Critical Risks
VE25 – Concrete counterweight	Further developed in the VE report. Refer Appendix C.	Cast iron billets- £0.8 million saving	Normal weight concrete will increase the height of the tower. This can be mitigated by using heavyweight concrete; however, there is less certainty on cost and availability of heavyweight concrete.
VE26 – Approach span deck form – concrete or steel concrete composite.	Further developed in the VE report. Refer Appendix C.	£15.2 million saving.	TWAO consent and LA consultation – Less slender appearance.
VE27 – Earthwork ramp – Durand's Wharf	Not included in this report. Core team have developed 6 different options carefully considering many different criteria.	Assessment not undertaken in VE scope	Assessment not undertake in VE scope
VE28 - Maximise approach ramp spans to minimise number of piers in the river	Combined with VE26	Refer to VE26	Refer to VE26
VE29 – Approach Span Steelwork erection	This has been identified as a necessity by TfL. Insufficient granularity on baseline cost estimates to calculate potential relative cost saving. The cost estimate associated to this identified opportunity will be ascertained in the construction methodology report.	Cost saving anticipated – to be presented in Construction Methodology Report	N/A
VE30 – Control of pedestrians and cyclists	No further work at this stage. Part of operation & maintenance concept report.	N/A	N/A
VE31 – Remove maintenance access lift and replace with stairs and hoist	Further developed in the VE report. Refer Appendix C.	£1.0 to £1.5 million saving.	HSW in maintenance.

Value Engineering Item	Action & Results	Cost Impact in Estimated Final Cost	Critical Risks
VE32 – Remove backup generators and replace with hook-up generator	Further developed in the VE report. Refer Appendix C.	£0.8 to 1.2 million saving.	Requirements on emergency lifts – Probability of power failure and emergency bridge lift needs to be assessed.
VE33 – Carbon fibre main span lift ropes	Further developed in the VE report. Refer Appendix C.	Capital costs are unknown due to patented technology	Product availability – Carbon fibre lift ropes are patented products that are solely used in elevators (significantly lighter).
VE34 – Energy regeneration options	No further work at this stage.	N/A	Additional cost and complexity of energy regeneration systems outweighs potential saving
VE35 – Fire suppression system. Note: not many flammable elements in plant room	No further work at this stage. Part of operation & maintenance concept report.	N/A	N/A
VE36 – Intelligent monitoring systems to reduce maintenance requirements	No further work at this stage. Part of operation & maintenance concept.	N/A	N/A
VE37 – Public barriers for when the bridge is open.	No further work at this stage. Part of operation & maintenance concept report.	N/A	N/A

Appendices

Appendix A. C1 Alignment Baseline Design

DO NOT SCALE

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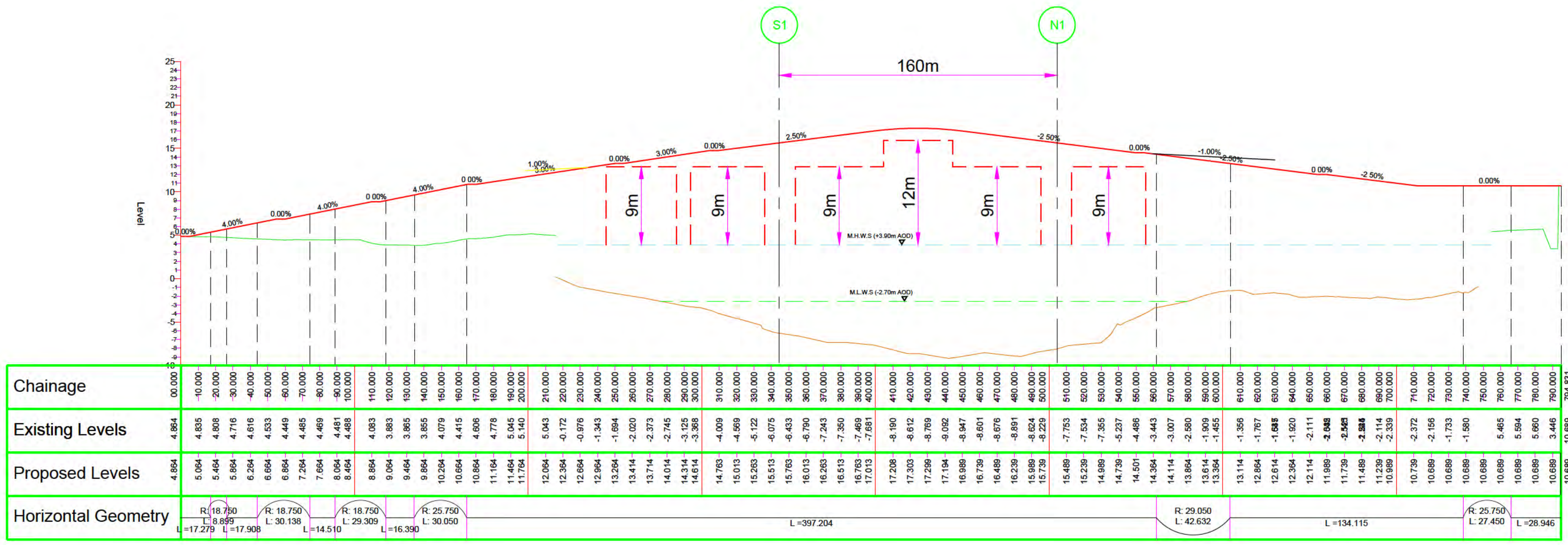

VERTICAL PROFILE
SCALE 1:2000 HORIZONTAL 1:400 VERTICAL

NOTES:

1. THIS DRAWING IS FOR INFORMATION PURPOSES ONLY.
2. ALL DIMENSIONS AND DATUM LEVELS ARE IN METRES.
3. ALIGNMENT ON PLAN IS SHOWN OVER CYCLE PATH/FOOTPATH CENTRELINE. THE LONG SECTION IS BASED ON FINISHED LEVELS.

KEY:

- THE JUBILEE GREENWAY
- SOUTHWARK CYCLE ROUTES - COMMITED ROUTE
- SOUTHWARK CYCLE ROUTES - PROPOSED ROUTE
- SUSTRANS ROUTES - COMITTED ROUTE
- SUSTRANS ROUTES - PROPOSED ROUTE
- SUPPORT LOCATION
- BUS STOP
- SCHOOL
- JP MORGAN DEVELOPMENT SITE
- JUBILEE LINE TUNNEL (WITH 15m ZONE)
- GRADE II LISTED BUILDING
- GRADE II* LISTED BUILDING
- INDIVIDUAL TPO ZONES
- BOROUGH OPEN LAND
- METROPOLITAN OPEN LAND
- OUTDOORS GYMNASIUM
- CHILDRENS PLAYGROUND

LOCATION PLAN

BOROUGH 08 SOUTHWARK

BOROUGH 05 TOWER HAMLETS

Description						
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Description						
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
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Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
S0	P01.1					00/05/18

Drawing Suitability: WORK IN PROGRESS

Status: S0

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Client: Transport for London

Project Title: Rotherhithe to Canary Wharf Crossing

Drawing Title: CENTRAL ALIGNMENT PLAN AND PROFILE ALIGNMENT OPTION C1 40m PIER CENTRES

Drawing Number: ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00007

Original Size: A1 | Scale: As Shown | Project Ref. No: 5162977 | Sheet: 1 of 1 | Rev: P01.1

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Appendix B. Initial C2 Alignment Concept Design

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PLAN

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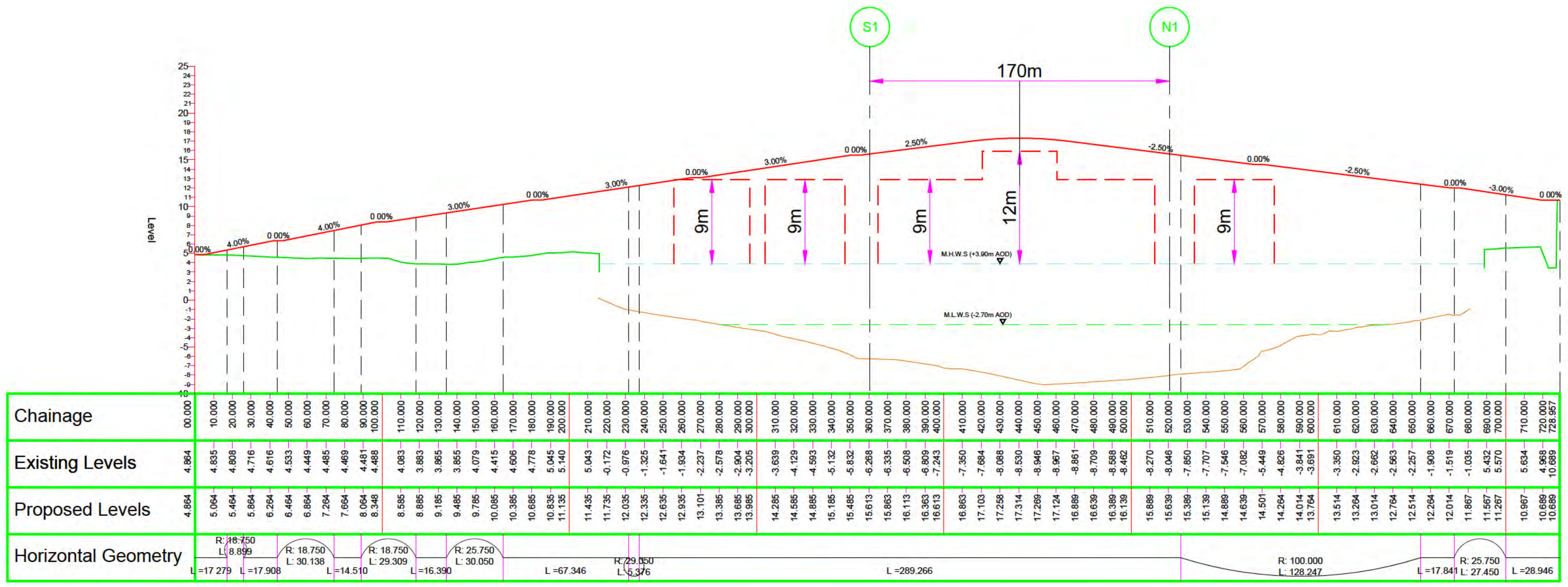

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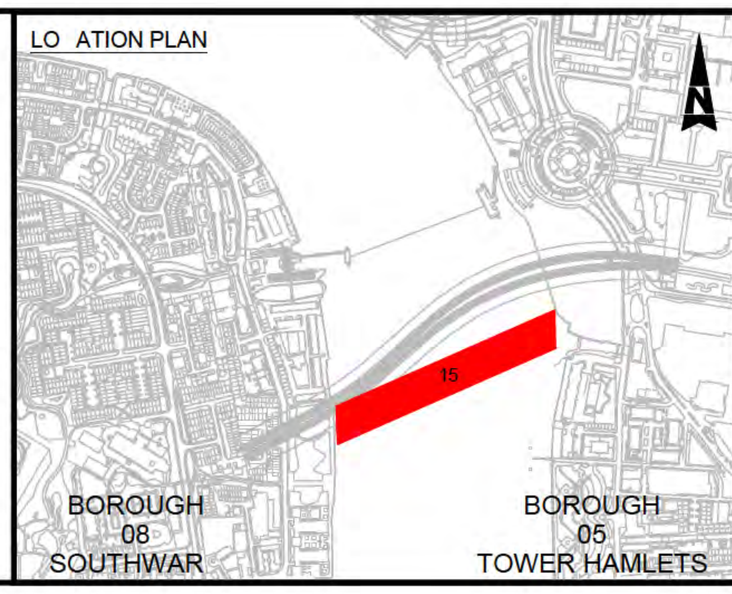
LO ATION PLAN



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Description: DRAWING CREATED						
Status: S0	Revision: P01.1	Draw	Checked	Reviewed	Authorised	Issue Date: 00/05/18

Drawing Suitability: WORK IN PROGRESS

Status: S0

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Client: Transport for London

Project Title: Rotherhithe to Canary Wharf Crossing

Drawing Title:

CENTRAL ALIGNMENT
PLAN AND PROFILE
ALIGNMENT C2
40m PIER CENTRES

Drawing Number: ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00010

Project | Originator | Volume | Location | Type | Role | Number

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Appendix C. Value Engineering

Rotherhithe to Canary Wharf River Crossing	
VALUE ENGINEERING ASSESSMENT FORM	**DATE: 28/09/2018**
- *Item Ref: VE01 – Different route across river that provides a more direct route to Westferry Circus*	

SUMMARY DESCRIPTION OF VE PROPOSAL

The baseline alignment option (C1) is from CB5 to CA5. The ramp of the eastern landing site in Canary Wharf (CA5) runs parallel to the JP Morgan development site. The alignment then turns to the South West to achieve the shortest feasible route across the river to the landing site in Durand's Wharf. Almost the entirety of the ramp is founded in the river. The ramp is 380m from midspan to the landing site.

The proposal consists of a variation in the alignment to provide a more direct route to Westferry Circus, denoted C2 alignment, refer to ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00010. The C2 alignment is closer to the Jubilee Line alignment. In moving to the C2 alignment there is no feasible place to locate lifts and stairs on Canary Wharf side. To locate the lifts and stairs in the same place as the C1 alignment would result in significant additional permanent structure.

The extents of the river channel, navigation channel and the location of the Jubilee Line tunnels crossing beneath the River Thames prevents a direct alignment from Durand's Wharf to Westferry Circus. The comparison of C1 versus C2 alignment is presented in ST_PJ585C-ATK-BAS-ZZ_21-DIA-ST-00001.

Note: This VE1 item cannot co-exist with VE2 – Construction on land behind the river wall adjacent to JP Morgan development site.

ADVANTAGES:	DISADVANTAGES:
• 66m (8%) reduction in overall length of the bridge due to a more direct route across the river. • 1 to 3 fewer river foundations and piers compared to the C1 alignment due to a more direct route across the river. • Towers and ramps further away from JP Morgan and Cascades building • Follows key desire lines more closely	• Increase main span by 10m due to spanning the navigational channel at a larger angle. • Increase in M+E requirements due to increased weight of main span. • Increase in deck clearance time due to length of main span. • Loses connection to Impounding Lock • Less accessible from the Canary Wharf side as there is no feasible location to locate stairs and lifts (Rotherhithe landing site remains unaffected). Note: the ramp gradient on the Canary Wharf side does not exceed 3%, which would have to be considered for accessibility.

LIST OF SUPPORTING DOCUMENTS:

- ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00010 (C2 alignment)
- 5162977-43-0215 C1 vs C2 Comparison (Memo detailing comparison)
- ST_PJ585C-ATK-BAS-ZZ_21-DIA-ST-00001 (COMPARISON OF C1 AND C2
- ALIGNEMENT OPTIONS)

IMPACT EVALUATION

COST BENEFIT

The saving in Estimated Final Cost (EFC) of adopting the C2 alignment versus CB5-CA5 has been assessed and previously reported as being £34.9 million (Excluding Land and third-party compensation costs) This assumed that 40m pier spacings were maintained and that the requirement for lifts and stairs is omitted from both ends of the bridge. This saving also assumed a main span length of 170m. Current concept design development however suggests that the main span length may need to increase to 180m. This is likely to reduce the potential saving and a preliminary assessment pending completion of the concept design is that this could reduce to £33.4 million. This does not however reflect any potential impact on cost should the increased span length generate the need for the foundations to be similarly increased.
PROGRAMME BENEFIT
Assuming similar structural details for both alignment options; It would be expected that a shorter bridge with less support structures would be quicker to install. However, back-span construction is not currently envisaged to be on the critical path. Consequently, no reduction in the overall R2CW construction programme will be evident. Down scaling the number of non-critical path work elements does reduce the potential for over running works to impact on the critical path duration.
RISK EVALUATION
Departure from BS8300 required – inclusivity and accessibility PLA consultation – 1) PLA are concerned with C2 alignment about safe navigation as the aspect of the bridges is skewed for approaching pilots. They however acknowledge that this needs to be assessed in a simulator and anticipate that a straighter alignment across the channel would significantly reduce this issue. 2) PLA believe that (in C2 alignment), it is very likely the bridge pier will need to be relocated further to the North as it will likely impact on existing cruise ship operations as well as impacting on the approach and departure angles for Thames Clippers (concern about Clipper approach angles was related to north of JL tunnels) utilising Canary Wharf Pier. This will likely be further compounded by the addition of impact protection. The southern bridge pier is also close to the navigational channel as evidenced by previous cruise ship tracks because of the proximity of the bridge location to the nearby bend in the river. The simulation modelling is under progress and if it is ok there will not be any change expected. If not, the pier will need to be moved to the drying line on the south side of the river. 3) C2 alignment may need to be moved further away from the JL (Jubilee Line) tunnels when the foundation design is developed, depending on its size. 4) The C2 alignment may need to be moved further away from the JL tunnels when the foundation design is developed, depepnding on its size.
ENVIRONMENTAL
The reduction in river foundation and piers minimises the impact on the river both in construction and operation. The reduction in overall length of the structure reduces the amount of material required, energy utilised and CO2 generated by construction.

The bridge and towers are further away from the Cascades building and JP Morgan.
BUILDABILITY
Closer (still outside) to Jubilee Line exclusion zone – C2 achieved by rotating main leg of C1 alignment by ca. 10° anti-clockwise such that the perpendicular distance from the main span of C2 alignment to the Jubilee Line exclusion zone is ca. 30m compared to 70m as was the case for C1 alignment. The core design team have developed this further under EIN005. Early considerations of temporary works suggest the temporary works cofferdams will clash with the Jubilee Line exclusion zone. Note: 12.2m thick twin wall cofferdams considered. Potential tweaks to alignment may follow.
SAFETY
Similarly, as with other risk related impacts, reducing the bridge length will reduce exposure to construction dangers by requiring less construction and maintenance activity.
OPERATIONS AND MAINTENANCE
The overall structure is shorter and therefore requires less maintenance. Fewer piers; hence, fewer bearings to maintain.

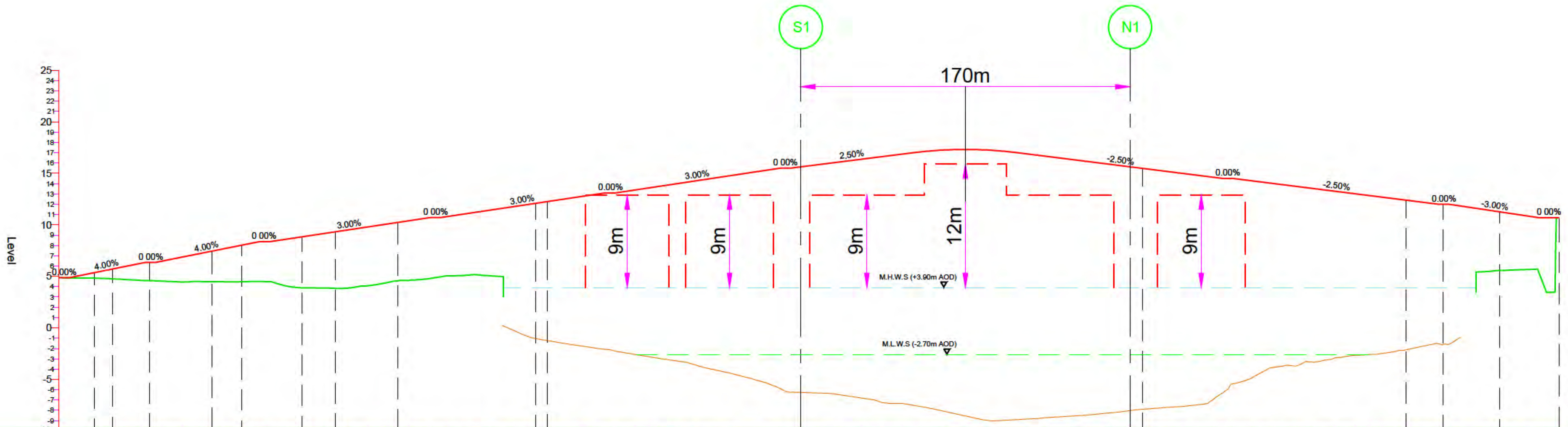
ACCEPTANCE		
Prepared: [redacted]	**Name:** [redacted]	**Signed:** [redacted]
Proposal Implemented:	**Yes, implemented in the core design with changes**	
Approved by:	**Name:**	**Signed:**

IMPLEMENTATION
COMMENTS / ACTIONS
To be completed by TfL

DO NOT SCALE

Millimetres 0 10 100

PLAN
SCALE 1:2000



Chainage	Existing Levels	Proposed Levels
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20.000	4.808	5.464
30.000	4.716	5.864
40.000	4.616	6.264
50.000	4.533	6.464
60.000	4.449	6.864
70.000	4.485	7.264
80.000	4.469	7.664
90.000	4.481	8.064
100.000	4.488	8.348
110.000	4.083	8.585
120.000	3.883	8.885
130.000	3.865	9.185
140.000	3.855	9.485
150.000	4.079	9.785
160.000	4.415	10.085
170.000	4.606	10.385
180.000	4.778	10.685
190.000	5.045	10.835
200.000	5.140	11.135
210.000	5.043	11.435
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290.000	-2.904	13.685
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330.000	-4.593	14.885
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370.000	-6.335	15.863
380.000	-6.508	16.113
390.000	-6.809	16.363
400.000	-7.243	16.613
410.000	-7.350	16.863
420.000	-7.684	17.103
430.000	-8.088	17.258
440.000	-8.530	17.314
450.000	-8.946	17.269
460.000	-8.967	17.124
470.000	-8.861	16.889
480.000	-8.709	16.639
490.000	-8.588	16.389
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540.000	-7.707	15.139
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620.000	-2.923	13.264
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670.000	-1.519	12.014
680.000	-1.035	11.867
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710.000	5.634	10.967
720.000	4.968	10.689
728.957	10.689	10.689

Horizontal Geometry: L =17.279; R: 18.750 L: 8.899; L =17.908; R: 18.750 L: 30.138; L =14.510; R: 18.750 L: 29.309; L =16.390; R: 25.750 L: 30.050; L =67.346; R: 29.050 L: 5.376; L =289.266; R: 100.000 L: 128.247; L =17.841; R: 25.750 L: 27.450; L =28.946

VERTICAL PROFILE
SCALE 1:2000 HORIZONTAL 1:400 VERTICAL

NOTES:

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- METROPOLITAN OPEN LAND
- OUTDOORS GYMNASIUM
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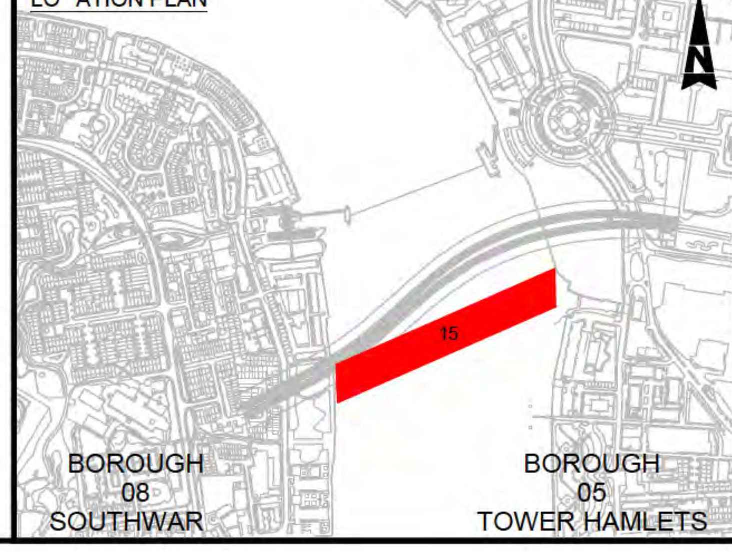
LO ATION PLAN



Description						
Status	Revision	Draw	Checked	Reviewed	Authorised	Issue Date
Description						
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Status	Revision	Draw	Checked	Reviewed	Authorised	Issue Date
Description						
Status	Revision	Draw	Checked	Reviewed	Authorised	Issue Date
Description: DRAWING CREATED						
Status	Revision	Draw	Checked	Reviewed	Authorised	Issue Date
S0	P01.1					00/05/18

Drawing Suitability: WORK IN PROGRESS

Status: S0

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Client: Transport for London

Project Title: Rotherhithe to Canary Wharf Crossing

Drawing Title:
CENTRAL ALIGNMENT
PLAN AND PROFILE
ALIGNMENT C2
40m PIER CENTRES

Drawing Number: ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00010

Project | Originator | Volume | Location | Type | Role | Number

Original Size: A1 | Scale: As Shown | Project Ref. No: 5162977 | Sheet: 1 of 1 | Rev: P01.1

File: C:\projectwise\tfl\dms 25 8\ ST PJ585C-ATK- AS-ZZ 12-DRG-DR-0001 wg. Pl ted: 20/0 /2018 12 7:3 By: ########

C1 ALIGNMENT PLAN - BASELINE DESIGN
SCALE 1:1250

C2 ALIGNMENT PLAN - VE PROPOSAL
SCALE 1:1250

NOTE:- REFER TO APPENDIX - A & B FOR DIMENSIONS, LEVELS & OTHER DETAILS.

rev	date	details	drn	chk	app
P01.1		FIRST ISSUE			

Transport for London
TfL Engineering
Surface Transport

Palestra
197 Blackfriars Road
London SE1 8NJ

borough: Multiple Boroughs

scheme: R2CW RIVER CROSSING COMPARISON OF C1 AND C2 ALIGNEMENT OPTIONS

date	scale	drn	chk	app	sheet no
---	1:1	---	---	---	OF

suitability: S0 WORK IN PROGRESS

revision: P01.1

DRAFT

drawing No: ST_PJ585C-ATK-BAS-ZZ_21-DIA-ST-00001
(project | owner | asset | location | type | role | number)

FILE REF: C:\projectwise\tfl\dms22911\ST_PJ585C-ATK-BAS-ZZ_21-DIA-ST-00001.dwg | USER: Ellis, James | DATE: 2018 Sep 27 4:38

SENSITIVE INFORMATION

DO NOT SCALE

Rotherhithe to Canary Wharf River Crossing	
VALUE ENGINEERING ASSESSMENT FORM	**DATE: 21/09/18**

- *Item Ref: VE02 – Construction on land behind the river wall adjacent to JP Morgan development site*

SUMMARY DESCRIPTION OF VE PROPOSAL

The baseline alignment option (C1) is from CB5 to CA5. The approach ramps on the eastern landing site, Canary Wharf (CA5), runs parallel to the JP Morgan developments site, refer to the baseline in ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00014. The piers and foundations for this portion of the approach ramp are located in the river foreshore. The piers are approximately 7.5m away from the current river wall. This is assuming 2 rows of piles at 3d spacing with minimum distance of 3d from the river wall to avoid piles interacting with the wall. Note: EA require an exclusion zone in front of the wall for maintenance access; however, EA have not formally specified the required maintenance working width.

The VE proposal consists of relocating the east back span piers and foundations to minimise the amount of required river works required. Three different options have been considered:

Option 1

Option 1 consists of moving the foundation, piers and approach ramp on the eastern landing site on to the land on Thames Path, in front of the JP Morgan development site. Refer below Figure 1 and to ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00014 for the revised alignment. The foundations would consist of more frequent 750mm dia. piles.

Figure 1: Approach span on land behind the existing river wall

There is very minimal data available on the current sheet pile wall and tie bar details. The available record information (TF-116-1934, TF-117-1934 and TF-118-1934) is believed to be for the previous river wall as it does not align with that specified in ARUP Riverside South Existing Tie Bar Condition Technical Note 2007. The technical note indicates that good condition tie rods were found in the two trial holes dug.

EA consultation is required to obtain the as built data of the existing river wall. Following which an impact assessment is required to understand the influence any additional piles would have on the existing river wall. It is anticipated that a 3d spacing is required from the pile to the river wall.

Option 2
Monopile construction immediately in front of the existing river wall. The monopiles can be constructed from the Thames Path. Refer below Figure 2.

Figure 2: Approach span on the river (infront of the river wall)

Assessment of the reach and depth of available piling rigs is required. The monopiles need to be protected for ship impact loads which may happen at high tide (low probable risk).

Similar to Option 1 – record information on the existing river wall is required to assess whether it can support the piling rig.

Option 3
If the EA does not accept the vicinity of the monopiles from the front of the river wall due to their maintenance requirements, option 3 can be considered. Locally replace parts of the existing river wall with a new sheet pile wall that steps out (in plan) towards the river where the piers and foundations are to be located, refer to Figure 3. It is assumed the new river wall will require approximately 120m plan length of AZ46 sheet pile sections that are approximately 20m in length (using the baseline approach ramp foundation design).

Similar to Option 1 – record information on the existing river wall is required to assess whether it can support the piling rig.

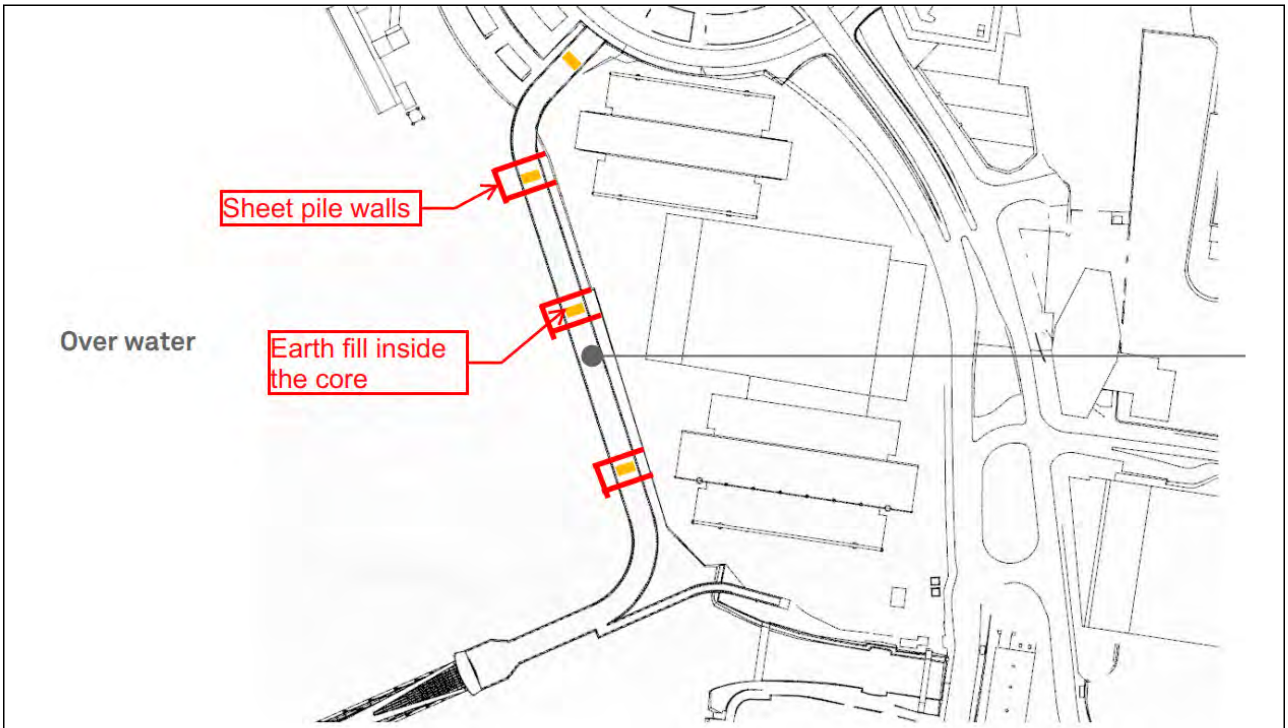


Figure 3: Option 3 - Sheet piles around the proposed piers

Consultation with EA is required to fully understand their maintenance requirements. If the EA maintenance requirements can be avoided, then it would be significantly preferable to pursue Option 2 rather than Option 3.

Each option requires significant stakeholder liaison. Considerations have been included in Risk Evaluation.

For the purpose of this study, no changes in the deck and approach ramps have been assumed.

This VE2 item cannot co-exist with VE1 – "More direct route to Westferry Circus"

ADVANTAGES:	DISADVANTAGES:
• Relocate 4 river foundations to land or readily accessible from land • Avoids having river plant for construction of 4 piers • Easier deck erection • Option 1 only - close columns would allow a more slender deck which would have less visual impact from Thames Path	• Option 1 only – Likely requirement of alternate footpaths (existing) along the Thames river • Over shadowing the Thames Path • Available details of the existing river wall are either limited or of a low quality. Site investigations may be required to ascertain the as built details of the wall such that the foundations can be configured to avoid them. • Impact on fire tender access for the JP Morgan development – fire strategy for the building would need to be obtained and reviewed before options could be verified as feasible.

LIST OF SUPPORTING DOCUMENTS:

- ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00014 (Option 1 alignment)
- PA_07_00229-RIVERSIDE_SOUTH_TIE_RODS_DETAILS-412647 (ARUP Riverside South Existing Tie Bar Condition Technical Note 2007)
- C1 Alignment on land / over water (illustrated sketches & architect's view)
- Soilmec SA-40 system mounted to an SC120 crane drawing

IMPACT EVALUATION

COST BENEFIT

The saving in Estimated Final Cost (EFC) of adopting Option 1 as described above (i.e. C1, composite deck, 55m ramp support spacing "on-land" option) versus CB5-CA5 has been assessed and previously reported as being £41.8 million (Excluding Land and third-party compensation costs). This compares with a £39.4 million saving for the C1, composite deck, 55m ramp support spacing option running along the foreshore. So, the anticipated value of the VE2 saving itself would only be the difference between the two, i.e. A £2.4 million saving in EFC.

Whilst outline design proposals and estimates have not been produced for Options 2 and 3 above, our initial assessment is that these would likely generate less potential savings than option 1.

PROGRAMME BENEFIT

Currently back span construction does not sit on the critical path so no overall programme saving will be seen, but programme risk will be reduced. Option 1 delivers the most risk reduction.

RISK EVALUATION

Vicinity, overshadowing, visual impact and future integration with JP Morgan site needs to be investigated.

Review of JP Morgan designs and discussions required to ensure the proposed pier foundations don't interfere with the JP Morgan basement design.

Currently understood that EA require maintenance access of the existing river wall. Consultations with EA regarding replacement of river wall needs to be discussed.

Currently understood that Emergency services require access along Thames Path and it should not be obstructed during construction or operational phases. Consultations with Emergency services regarding access required along the riverside walk needs to be discussed.

ENVIRONMENTAL

Reduces/eliminates environmental risk of constructing in river.

May appear more integrated into existing infrastructure.

Hydraulic modelling of crenelated pile wall would be required. This could require scour protection.

BUILDABILITY

The Contractor's designer has advised that there would likely be 2nos. of 0.75m diameter piles per location. These will require a pile cap with its top near river bed / ground level. Please note that the mobilisation costs for marine plant will still be incurred as marine piling is still required on the scheme. Delivery and erection of these shorter & lighter spans would still be from the river. Increasing the number of spans, from 3 to 12 nos., means more beam lifts & beam connections to be made on site at height. It may be possible to lift in the pre-cast deck units using a land-based crane (NB site access to be considered) or use a marine crane to lift spans with the pre-cast in place to offset some of this cost.

Option 1 (on land): This option requires high level investigation prior to the commencement of works, to confirm anchor locations, to determine risk of damage and any improvement works required for the existing wall.

There will be a construction cost saving by avoiding the need for marine plant to carry the piling rig and the need for temporary cofferdams. Earth retaining works will be required to construct 26 nos. of small pile caps and will be much simpler than cofferdams construction in the river.

Option 2 (on river): Considering 3.5m to 4m from pile centre to edge of support platform so allowing for the tracks to sit approx. 500mm from the edge. Refer attached Soilmec SA-40 system mounted to an SC120 crane drawing. A support frame will be required to support the pile casing and a scaffold accessway. The suitability of the existing sheet pile wall to support such a crane would need to be confirmed. To minimise the wall loading this should be located as far as possible.

There will be a construction cost saving by avoiding the need for marine plant to carry the piling rig for the foundations. We believe the temporary cofferdams could be formed from the shore (say within 15m of bank). However, forming these 11 smaller temporary cofferdams in different locations will involve more work, costlier and time consuming than the baseline 3 large ones. Cofferdams and the specialist piling equipment costs will diminish the gain due to Option 1.

Option 3 (with encasing): It is similar to option 2. It requires infilling of the cofferdam to provide a working platform to avoid the need for the long reach of Soilmec SA-40 piling system. Uprated sheeting and finishes incl. capping beam will likely be required (to accommodate the 120-year design life) as permanent works. The sheet piles will need to be purchased outright and additional fill will need to be brought in to backfill behind the sheets. The cost of extraction will be avoided. The resulting construction cost saving is likely to be negligible given these additional expenses. Similarly, any programme risk reduction will be lost in the additional works required.

NOTE: The contractors assume the bulk of the cost saving quoted in the cost benefit section comes from a weight related fabrication cost savings as our estimated site construction cost savings are only a fraction of that quoted. From the Contractor's investigation, Option 1 delivers the largest construction cost saving, Option 2 less & Option 3 the least

SAFETY

Positive impact on safety during construction – simpler to construct on land than in river.

Similarly for inspection and maintenance works.

OPERATIONS AND MAINTENANCE

Bearing inspection from land as opposed to river

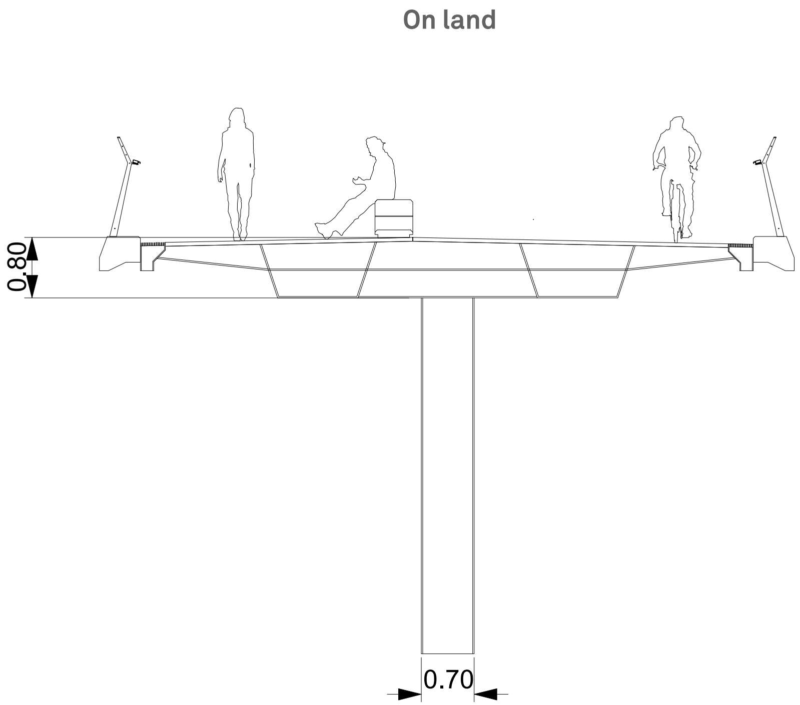
ACCEPTANCE

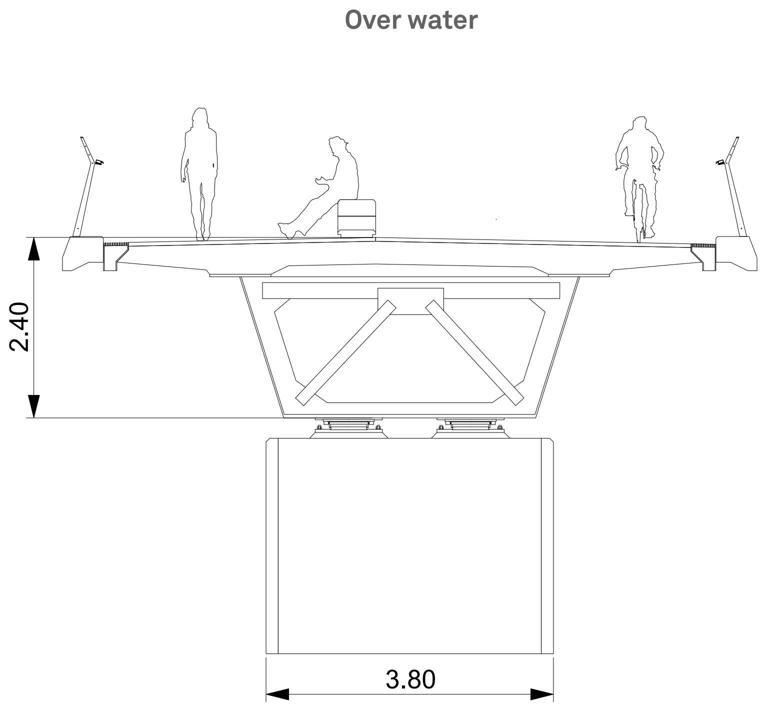
Prepared: [redacted]	**Name:** [redacted]	**Signed:** [redacted]

Proposal Implemented:	**Proposal is not appropriate for the current C2 Alignment.**	
Approved by:	**Name:**	**Signed:**
IMPLEMENTATION		
COMMENTS / ACTIONS		
To be completed by TfL		

C1 ALIGNMENT
On land / Over water

Cross section 1:100
On land / Over water





Thames path view

On land / Over water

JP Morgan Integration
On land / Over water

On land

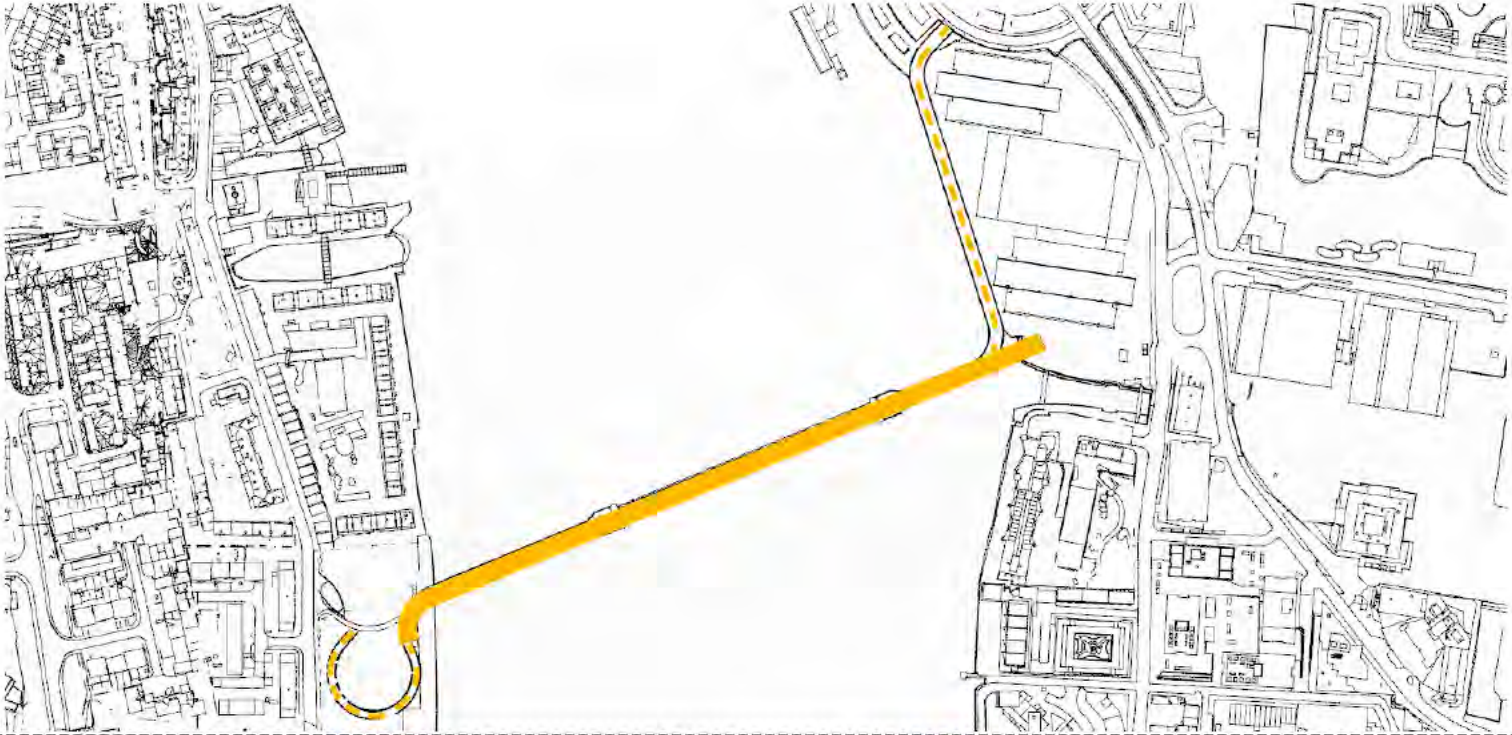
- Reduced visual impact to/from JP Morgan
- Future integration with JP Morgan facilitated by ligl
- Integration with river wall and tie backs nec-
- More but smaller foundations
- Over shadowing the Thames Path

Over water

- Future integration with JP Morgan unlikely
- Fewer but bigger foundations
- Over shadowing the foreshore

Bridge perception
On land / Over water

On land
Bridge + ramps

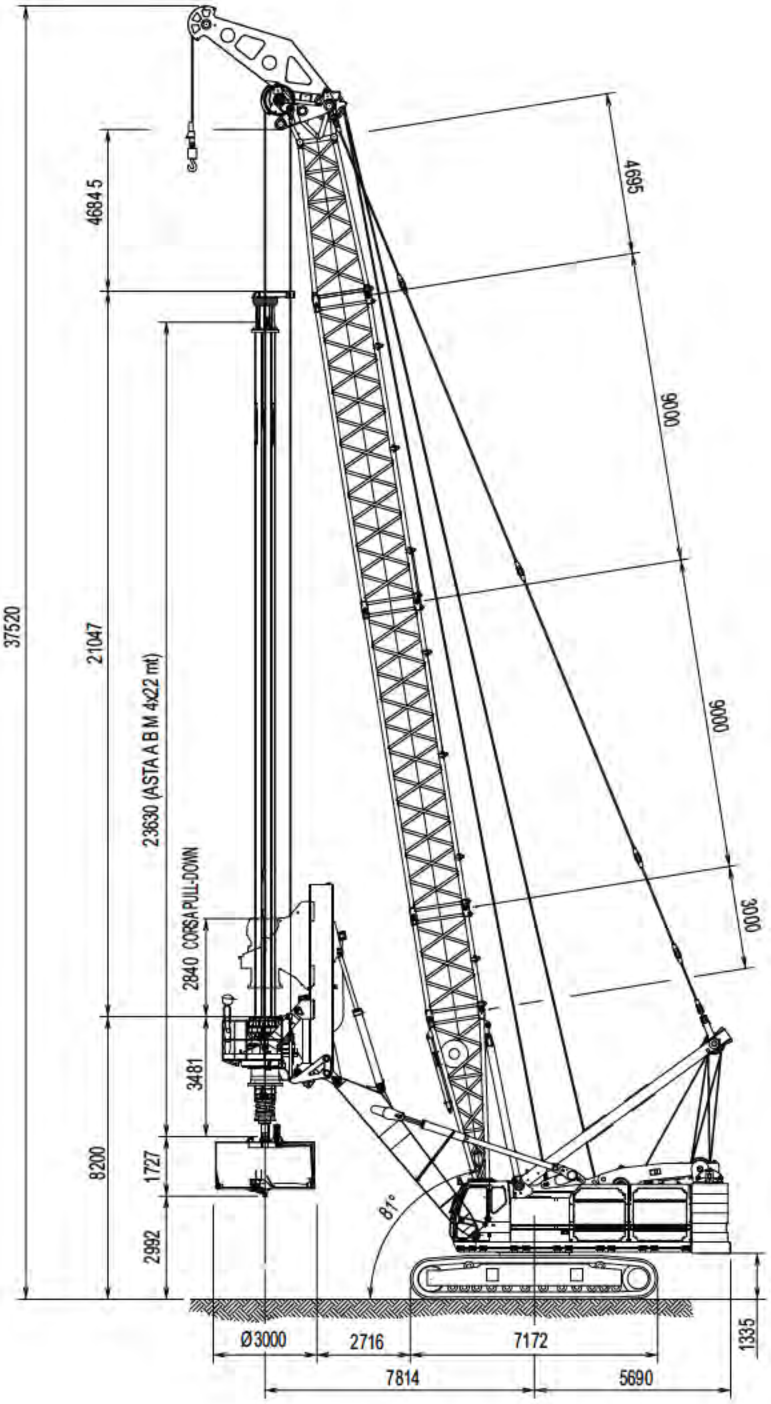


Over water
Bridge

Soilmec SA-40 system mounted to an SC120 crane

ITALIANO

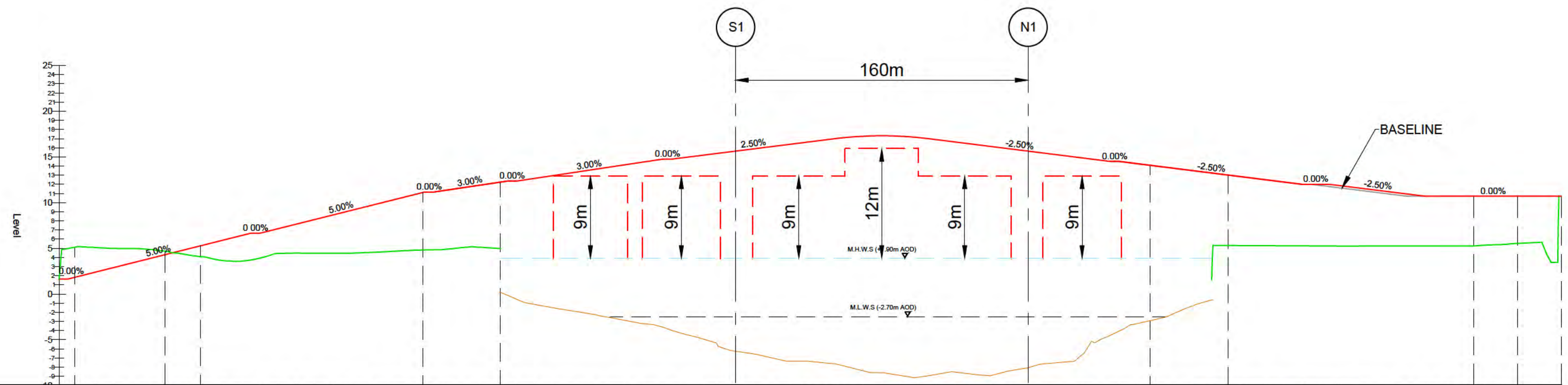
Dimensionale della macchina SC-120 con installata la SA-40.



DO NOT SCALE

PLAN

SCALE 1:2000



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380.000	-6.560	15.872
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550.000	-7.457	15.131
560.000	-6.621	14.881
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670.000	5.280	12.256
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710.000	5.246	11.627
720.000	5.255	11.377
730.000	5.258	11.127
740.000	5.258	10.877
750.000	5.258	10.689
760.000	5.258	10.689
770.000	5.259	10.689
780.000	5.333	10.689
790.000	5.413	10.689
800.000	5.545	10.689
810.000	5.647	10.689
821.934	10.689	10.689
820.000	3.446	10.689

Horizontal Geometry: L =8.764 | R: 22.000 L: 49.263 | L =19.320 | R: 28.000 L: 121.734 | R: 25.750 L: 42.543 | L =355.520 | R: 29.050 L: 42.692 | L =134.154 | R: 26.156 L: 23.937 | L =24.008

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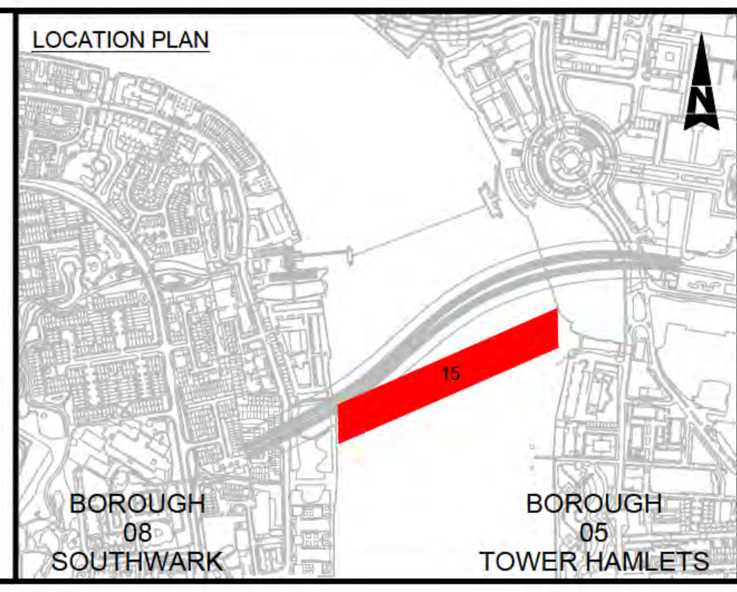
LOCATION PLAN



Description						
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
DRAWING CREATED						
S0	P01.1					00/05/18

Drawing Suitability: WORK IN PROGRESS — Status: S0

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Client: Transport for London

Project Title: Rotherhithe to Canary Wharf Crossing

Drawing Title: CENTRAL ALIGNMENT PLAN AND PROFILE ALIGNMENT OPTION C1 40m PIER CENTRES

Drawing Number: ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00014

Original Size: A1 | Scale: As Shown | Project Ref. No: 5162977 | Sheet: 1 of 1 | Rev: P01.1

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Rotherhithe to Canary Wharf River Crossing

VALUE ENGINEERING ASSESSMENT FORM	DATE: 21/09/18

- *Item Ref: VE03 – Reduce deck width from recommended to minimum values*

SUMMARY DESCRIPTION OF VE PROPOSAL

The width of the footway and cycleway is defined by several standards as shown in ST_PJ585C-ATK-ZZZ_25-REP-DR-00001. The minimum and recommended values are summarised below.

Footway:

- 2.00m minimum required (excludes buffers)
  - BD29/17
- 2.90m recommended (excludes buffers)
  - TfL Pedestrian Comfort Guidance for London (2010)

Cycleway:

- 3.00m minimum accepted (excludes buffers)
  - Suitable for 2 cyclists side by side
  - London Cycling Design minimum standards for two-way track
- 4.00m maximum recommended (excludes buffers)
  - Suitable for 3 cyclists side by side
  - Sustrans preferred

Buffers:

- 0.20m between footway and parapet minimum required
  - TfL Pedestrian Comfort Guidance for London (2010)
- 0.50m between cycleway and parapet
  - Ibid 17 (p11) and Ibid 18 (p47)
- 0.50m between pedestrians and cyclists
  - Cycling, Walking and Accessibility report

Baseline design allows for the clear width of the deck as 8.10m (Total deck width = 9.2m).
The VE03 proposes minimum acceptable clear width of the deck as 6.20m (=2.00+3.00+0.20+0.50+0.50 & total deck width = 7.3m). Refer Figure 1 for details. The comparison of the min. deck width with the original deck width is presented in sketch ST_PJ585C-ATK-BAS-ZZ_21-DIA-ST-00002.

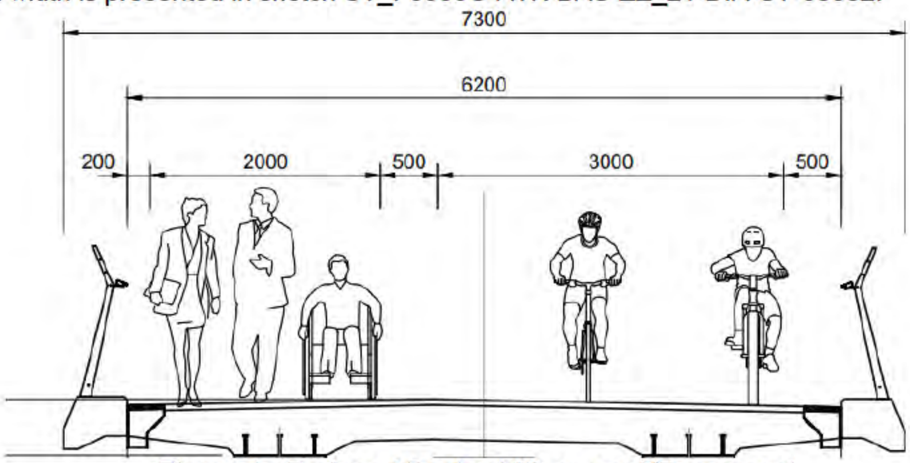


Figure 1 - Reduced Deck width as per VE proposal

By reducing the width of the deck in the main span, the horizontal stiffness is reduced, which affects the natural frequency of the structure. The horizontal natural frequency in the baseline design is 0.99Hz. By reducing the width of the deck by 1.9m to the minimum acceptable deck width and maintaining the other parameters of the deck, the horizontal natural frequency undesirably reduces to 0.82Hz. As a result, reducing the horizontal deck width requires an increase in the horizontal damping ratio (eg. mass tuned dampers). In accordance with NA to BS EN 1991-2:2003 NA2.44.7 approximately 5% horizontal damping ratio is required to achieve a minimum 0.8Hz natural frequency.

A drawing of the revised main span is included in ST_PJ585C-ATK-BAS-ZZ_09-DRG-ST-00006.

Cost savings have been calculated based on revised main span orthotropic deck width and pro-rata reduced approach span deck width.
Savings from reduced tower design requirements, counterweight, M+E and foundations have not been included.

ADVANTAGES:	**DISADVANTAGES:**
• Reduction in main span steel quantities and weight • Reduced counterweight weight (due to reduction in main span weight) • Reduced tower design requirements (reduced vertical load due to reduced main span and counterweight) • Reduced cost of approach span	• Reduced pedestrian comfort levels; however, still within TfL Pedestrian Comfort Guidance for London (2010) for 2041 forecast flows. • Increased accident risk – pedestrians migrating to cycle path and vice versa. • Limited space for stationary activities along the deck and for groups; unless dedicated areas are included in the design. • Reduced standing area when footway and cycle path is closed for opening.

LIST OF SUPPORTING DOCUMENTS:

- ST_PJ585C-ATK-ZZZ-ZZ_25-REP-DR-00001 (*Gradients and Widths Technical note*)
- ST_PJ585C-ATK-BAS-ZZ_09-DRG-ST-00006 (*Revised main span deck GA drawing with reduced deck width*)
- ST_PJ585C-ATK-BAS-ZZ_21-DIA-ST-00002 (Deck Width Comparison Concept Design & VE Proposals)

IMPACT EVALUATION

COST BENEFIT

The saving in Estimated Final Cost (EFC) of reducing the deck clear width to 6.2m as described above has been assessed and previously reported as being £16.2 million versus CB5-CA5 (Excluding Land and third-party compensation costs.) This assessment relates to the savings in the deck/superstructure costs only and further opportunity for reduction in the cost of the foundations may exist should their design also be simplified as a reduced of reduced dead load from the structure.

It should however be noted that the currently proposed C2 Concept design incorporates a significant reduction in the length of the approach ramps and therefore, there would be a commensurate reduction in the potential saving that this proposal would generate.

PROGRAMME BENEFIT

Negligible benefits anticipated.

RISK EVALUATION

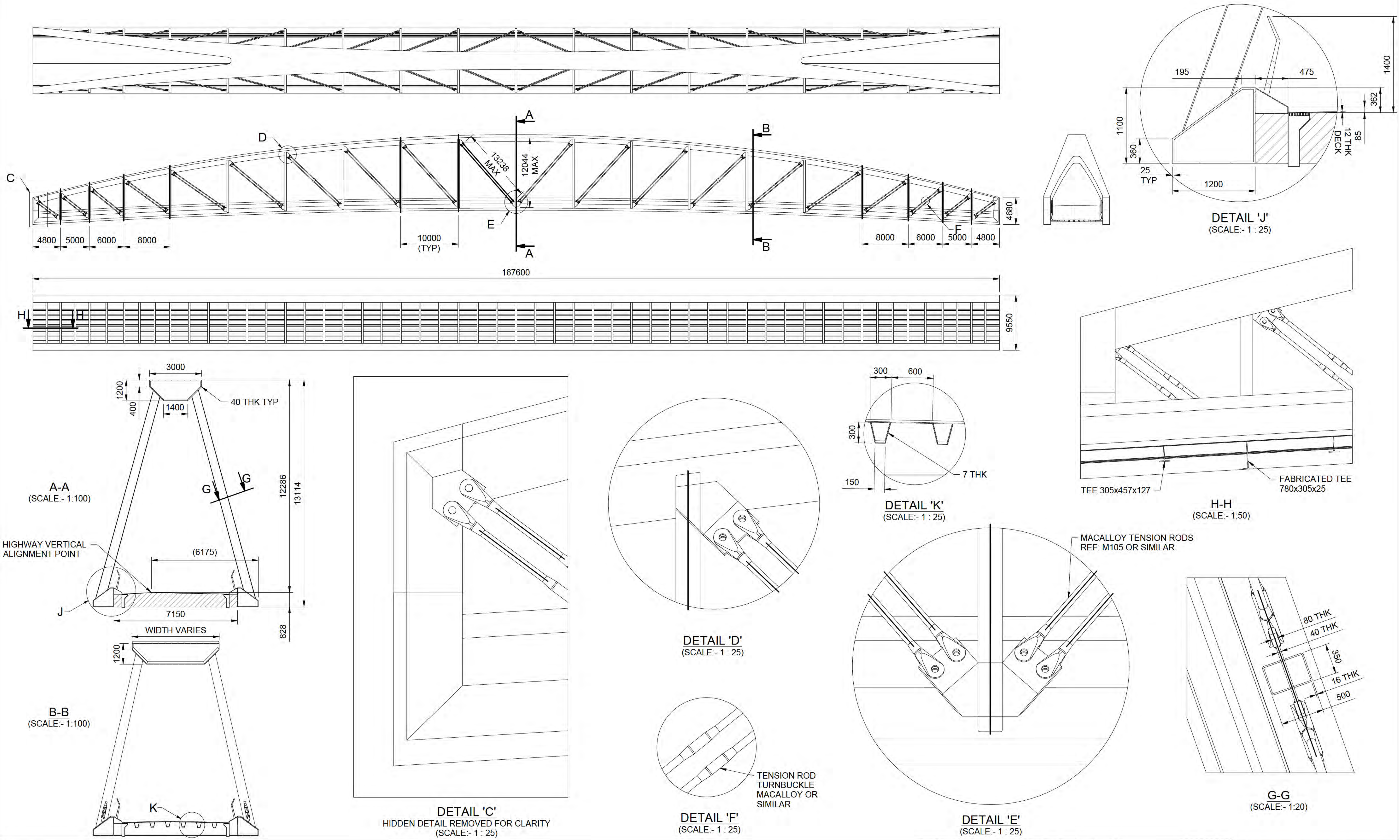
Stakeholder discussion: *Note:* Proposed would not meet the standards in published Sustrans guidance or TfL's own pedestrian comfort level guidance.

ENVIRONMENTAL

Reduced materials used.
BUILDABILITY
Same construction method expected. Small benefits anticipated as construction methodology would be the same, but lighter deck and smaller foundations.
SAFETY
Increased accident risk – pedestrians migrating to cycle path and vice versa. This is a risk highlighted in the TfL Pedestrian Comfort Guidance for London (2010) for over capacity footpaths/cycle paths.
OPERATIONS AND MAINTENANCE
Less area to repaint

ACCEPTANCE		
Prepared: [redacted]	**Name:** [redacted]	**Signed:** [redacted]
Proposal Implemented:	**Y / N**	**(Delete as appropriate)**
Approved by:	**Name:**	**Signed:**

IMPLEMENTATION
COMMENTS / ACTIONS
To be completed by TfL



NOTES

1. DO NOT SCALE.
2. ALL DIMENSION ARE IN MILLIMETERS U.N.O.
3. MAIN STRUCTURAL MEMBERS TO BE FROM STRUCTURAL STEEL WITH IMPROVED ATMOSPHERIC CORROSION RESISTANCE S355J2W, BS EN 10025-5 (WEATHERING STEEL), PAINTED ON EXTERNAL SURFACES.

rev	date	details	dm	chk	app

borough

scheme

ROTHERHITHE TO CANARY WHARF CROSSING
DETAILS OF MAIN SPAN

Transport for London
TfL Engineering

Traffic Design Engineering

Palestra
197 Blackfriars Road
London SE1 8NJ

DRAFT

date	scale	dm	chk	app	sheet no
21.08.18	1:300 @ A1		GM	PVH	1 OF 1

suitability: S0 WORK IN PROGRESS

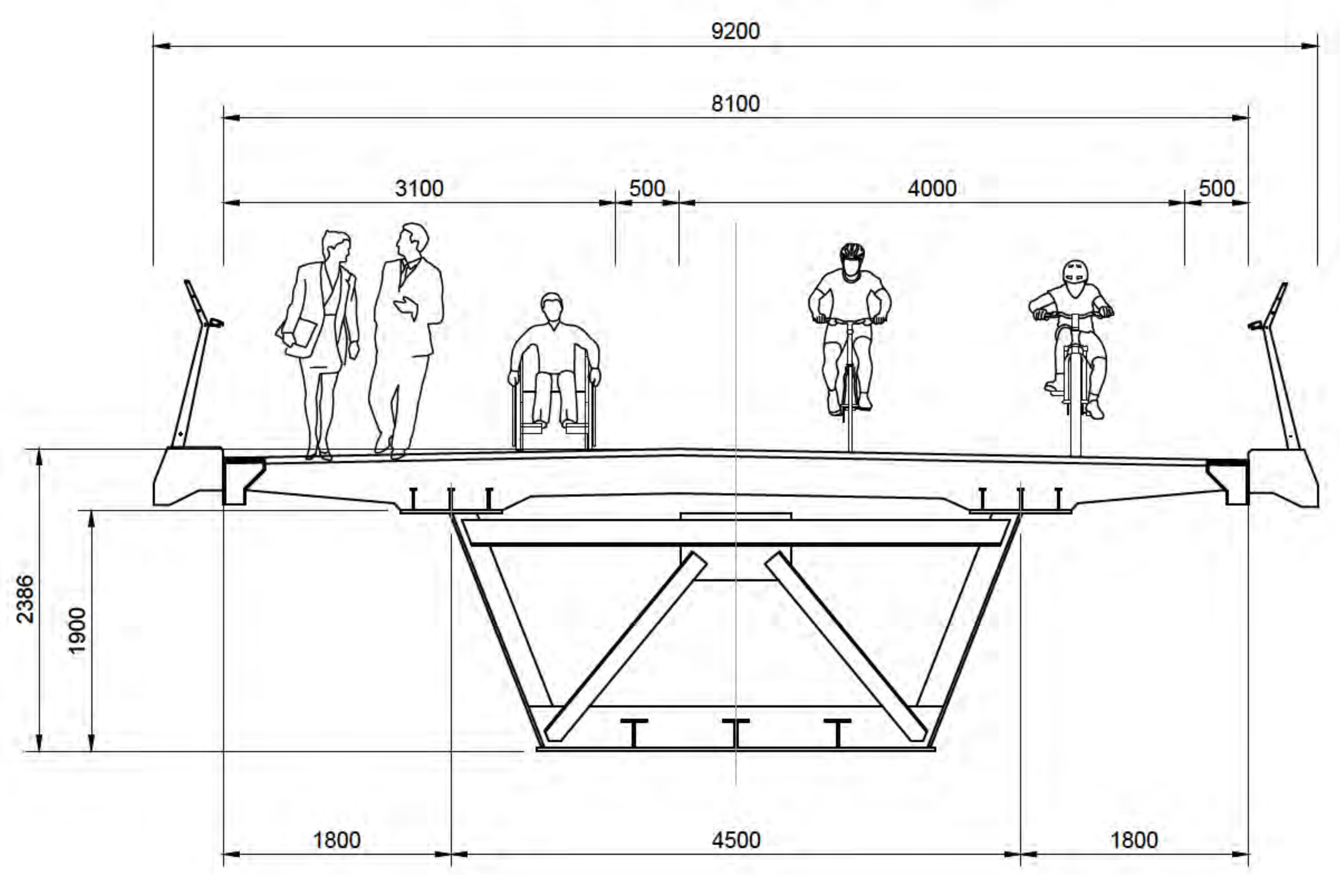
revision: P01.1

drawing No: ST_PJ585C-ATK-BAS-ZZ_09-DRG-ST-00004

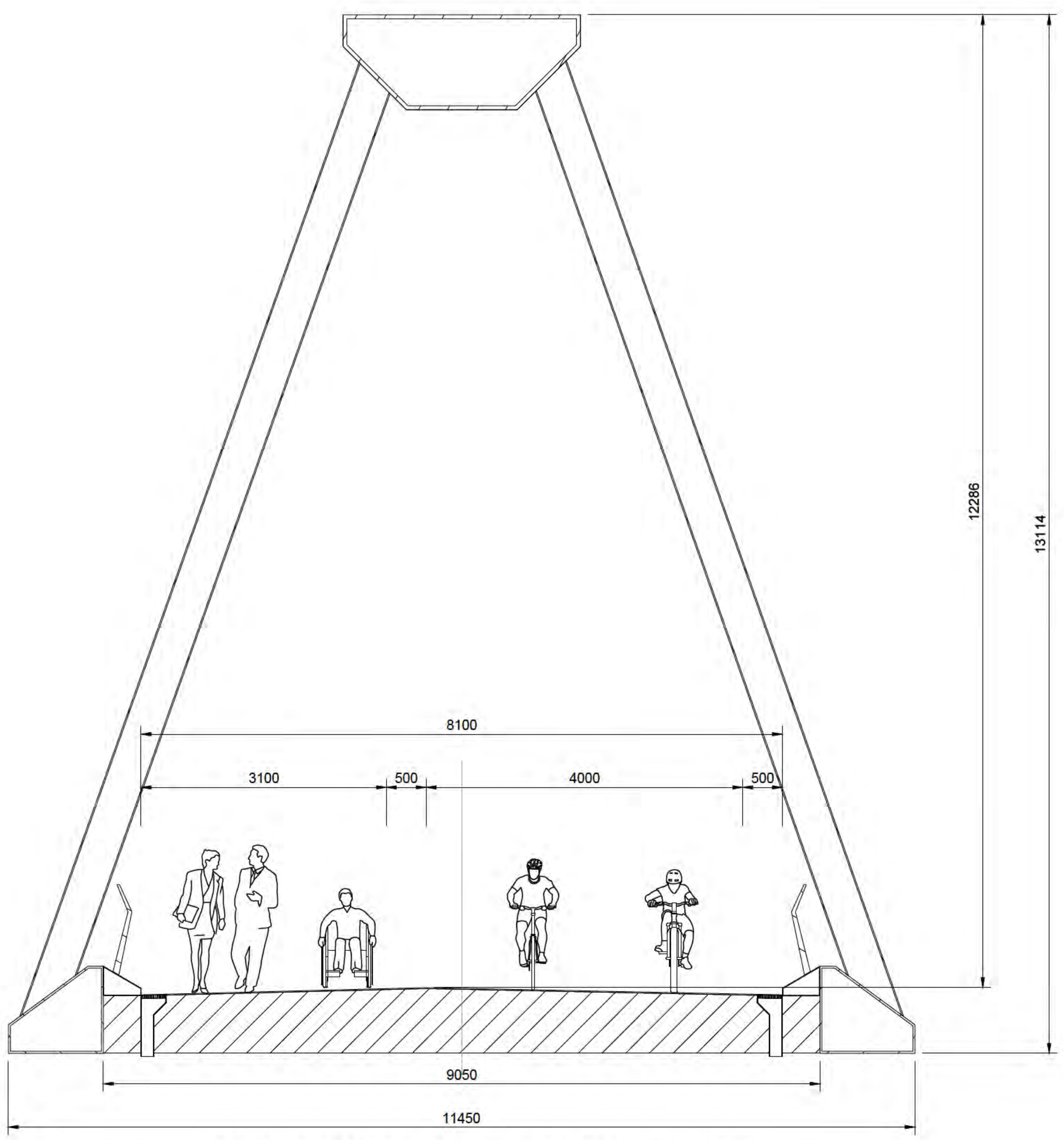
project | owner | asset | location | type | role | number

FILE REF: C:\projectwise\tfl\dms22908\ST_PJ585C-ATK-BAS-ZZ_09-DRG-ST-00006.dwg | USER: Ellis, James | DATE: 2018 Sep 17 10:20

CONCEPT DESIGNS

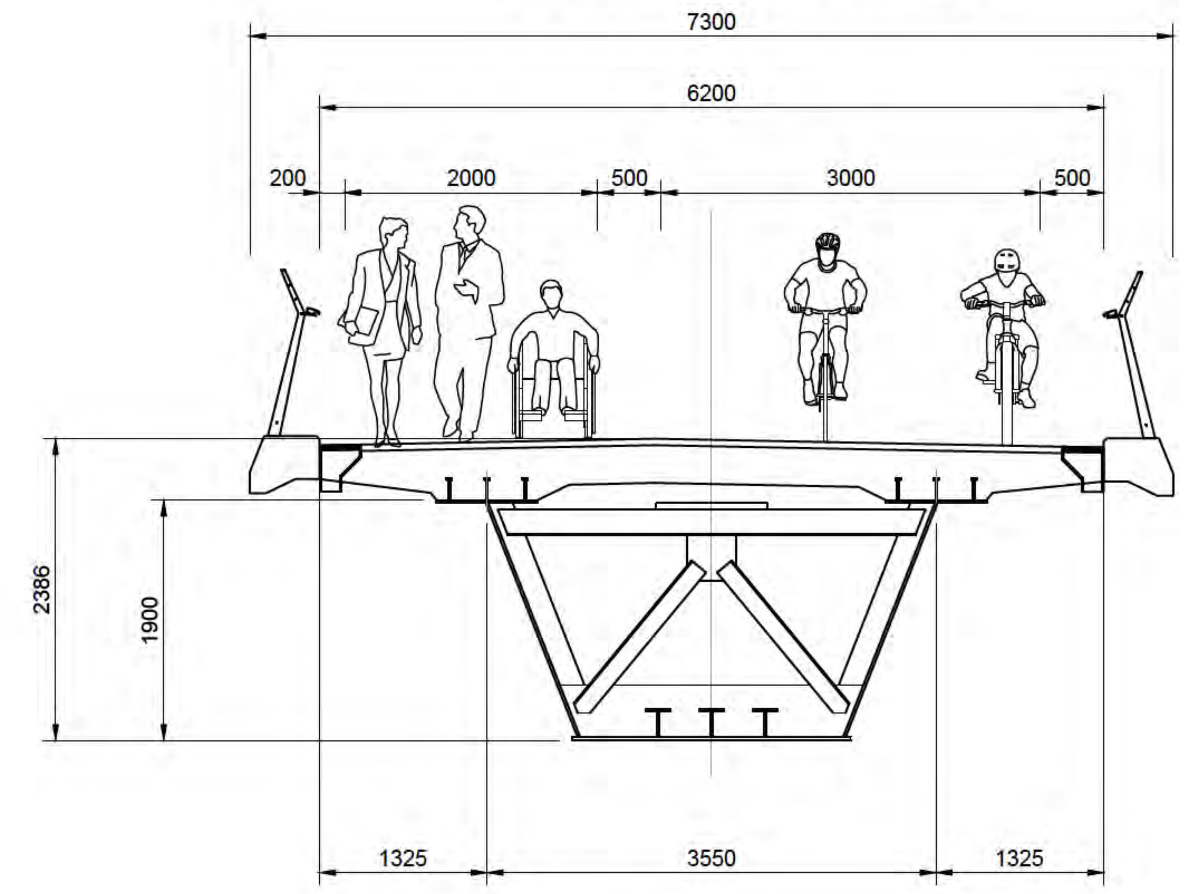


APPROACH SPANS ORIGINAL DECK WIDTH - 8.1m

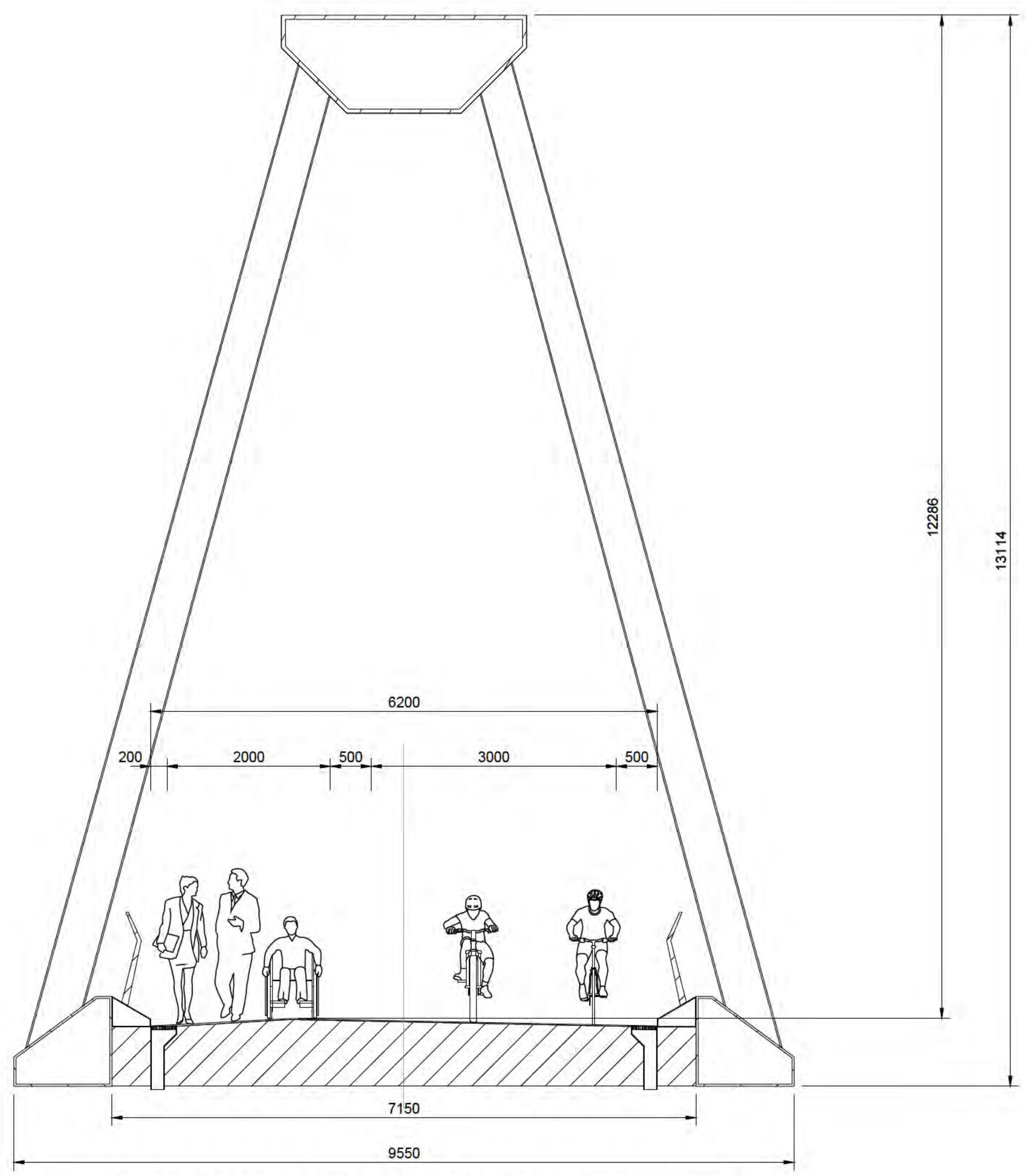


MAIN SPAN ORIGINAL DECK WIDTH - 8.1m

VE PROPOSALS



APPROACH SPANS REDUCED DECK WIDTH (VE03) - 6.2m



MAIN SPAN REDUCED DECK WIDTH (VE03) - 6.2m

NOTE:- REFER TO APPENDIX - A & B FOR DIMENSIONS, LEVELS & OTHER DETAILS.

rev	date	details	drn	chk	app
P01.1	—	FIRST ISSUE			

borough: Multiple Boroughs

scheme: R2CW RIVER CROSSING DECK WIDTH COMPARISON CONCEPT DESIGN & VE PROPOSALS

Transport for London
TfL Engineering
Surface Transport

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London SE1 8NJ

DRAFT

date	scale	drn	chk	app	sheet no
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suitability: S0 WORK IN PROGRESS

revision: P01.1

drawing No: ST_PJ585C-ATK-BAS-ZZ_21-DIA-ST-00002 (project | owner | asset | location | type | role | number)

DO NOT SCALE

Rotherhithe to Canary Wharf River Crossing

VALUE ENGINEERING ASSESSMENT FORM	DATE: 21/09/18

- *Item Ref: VE04 – Challenge Port of London Authority (PLA) on the required navigable headroom*

SUMMARY DESCRIPTION OF VE PROPOSAL

The baseline design considers 12m above MHWS for the central 40m of the main span and minimum 9m above MHWS for the entire main span. This has been calculated based on frequency of opening from Marico Marine shipping data.

On reviewing the Marico Marine shipping data, it was found that the river users or the bridges users are not significantly more inconvenienced by having the soffit at 10m above MHWS compared with 12m above MHWS. However, this is dependent on the opening management plan of the bridge, the review considers the following the management rules:

- Rule 1: Bridge must open within 1 hour of arrival of a vessel. Bridge is not required to open again for an hour after subsequent closure. Bridge opening time is assumed to be 30 minutes
- Rule 2: Bridge must be open within 2 hours of arrival of a vessel. Bridge is not required to open again for 2 hours after subsequent closure. Bridge opening time is assumed to be 30 minutes

The potential savings shown here are an estimate based on reduced ramp lengths (resulting from 10m above MHWS) from the baseline alignment. There needs to be an agreement of the opening management plan and PLA requirement to define the required navigable channel headroom.

Note: The value engineering design opportunities described below are for the preferable Durand's Wharf landing site alignment at the time. However, similar principles and savings can be applied for the other alignments.

Value Engineering Iteration 1

10m clearance has been fixed for the central 40m of the main span and as a first iteration an average longitudinal gradient of 3% is provided towards Rotherhithe approach and 2.5% towards Canary Wharf. 3% is a recommended value for best comfort level for cyclists and pedestrians based on current standards and case studies, refer to ST_PJ585C-ATK-ZZZ-ZZ_25-REP-DR-00001. However, this solution leads to reduction of only a few meters in total ramp length (when considering tie in at Durand's Wharf level, as opposed to Rotherhithe Street level), making the change not economically relevant.

Refer to ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00015 for revised highway alignment.

Value Engineering Iteration 2

10m clearance has been fixed for the central 40m of the main span and the longitudinal gradient limit was increased to 5%. This value represents the maximum generally accepted in accordance to BD29/17, IAN195/16 and other guidance, refer to ST_PJ585C-ATK-ZZZ-ZZ_25-REP-DR-00001. In summary the following restrictions have been considered:

- Gradient of 5% for maximum 30m long sections (IAN195/16 Table 2.2.9)
- Gradient of 2.5% for maximum 100m long sections (IAN195/16 Table 2.2.9)
- Landings for minimum 5m long sections (IAN195/16 2.2.9)
- Allowance of minimum 2.4m clearance over Thames Path at Durand's Wharf.

A reduction of approximately 130m in approach ramp length has been achieved.

Refer to ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00016 for revised highway alignment.

ADVANTAGES:	DISADVANTAGES:
• Reduces length of approach ramps/back spans at western end • Reduce impact on Durand's Wharf	• Increase amount of bridge openings – greater unavailability to pedestrians and cyclists • Approach ramp MHWS headroom clearance reduced. Reduced number of smaller vessels which could use the back spans. The clipper vessels may be restricted to certain tides in the back spans.

LIST OF SUPPORTING DOCUMENTS:

- 5169277-45-0137 P01 Analysis for Assessing Bridge Opening Frequency (Technical Note Assessing Bridge Opening Frequency)
- 5162977-45-0137 Addendum P01 Analysis for Assessing Bridge Opening Frequency (Addendum to Technical Note Above)
- ST_PJ585C-ATK-ZZZ-ZZ_25-REP-DR-00001 (Technical Note for Acceptable Gradients)
- ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00015 (Value Engineering Iteration 1 Highway Alignment)
- ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00016 (Value Engineering Iteration 2 Highway Alignment)

IMPACT EVALUATION

COST BENEFIT

An initial assessment of the impact on the Estimated Final Cost (EFC) of reducing the ramp length as described in Iteration 2 above has been made, and results in a potential saving of £12.5 million versus CB5-CA5 (Excluding Land and third party compensation costs.)

PROGRAMME BENEFIT

Benefits anticipated associated to reduction in earthwork ramp construction as Durand's Wharf; however, it is anticipated that the earthwork ramp construction at Durand's Wharf is a small component of the overall programme.

RISK EVALUATION

To be approved by the PLA, it may require moving the bridge to be on a straight section of the river. This is a less desirable connection on Canary Wharf side.

There needs to be an agreement with PLA regarding the opening management plan to assess the suitable clearance from MHWS.

Increased ramp gradients – Impact on PRM and cyclists scoring assessment; however, it is within the limits specified in the standards.

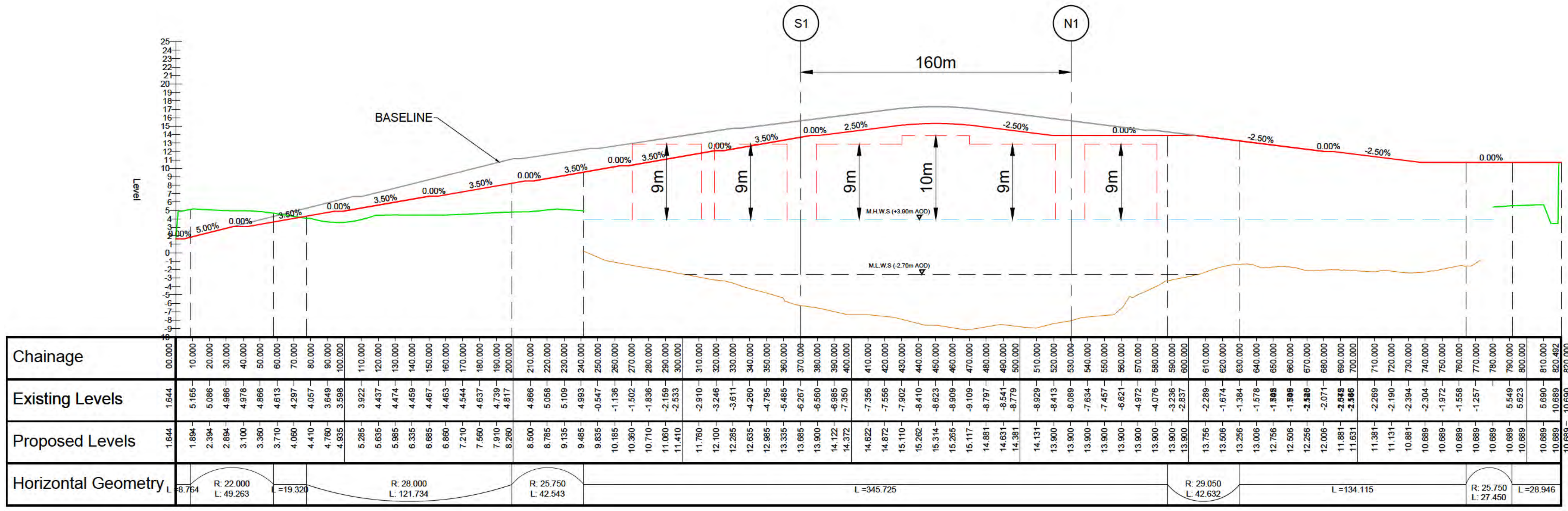
ENVIRONMENTAL

Reduction in headroom could result in significantly more openings; hence, increasing energy usage.

Reduction in approach ramp reduces materials used.

Less ramp in Durand's Wharf (Borough Open Land)

BUILDABILITY		
Construction method is similar to the one in base line design and no major changes are expected.		
SAFETY		
No changes, except reduced height while working in river.		
OPERATIONS AND MAINTENANCE		
Depending on the agreed opening management plan, it may result in an increase in the number of openings of the bridge; hence, increasing wear and maintenance required on the M+E.		
ACCEPTANCE		
Prepared: [redacted]	**Name:** [redacted]	**Signed:** [redacted]
Proposal Implemented:	**Y / N**	**(Delete as appropriate)**
Approved by:	**Name:**	**Signed:**
IMPLEMENTATION		
COMMENTS / ACTIONS		
To be completed by TfL		



VERTICAL PROFILE
SCALE 1:2000 HORIZONTAL 1:400 VERTICAL

NOTES:

1. THIS DRAWING IS FOR INFORMATION PURPOSES ONLY.
2. ALL DIMENSIONS AND DATUM LEVELS ARE IN METRES.
3. ALIGNMENT ON PLAN IS SHOWN OVER CYCLE PATH/FOOTPATH CENTRELINE. THE LONG SECTION IS BASED ON FINISHED LEVELS.

KEY:

- THE JUBILEE GREENWAY
- SOUTHWARK CYCLE ROUTES - COMMITED ROUTE
- SOUTHWARK CYCLE ROUTES - PROPOSED ROUTE
- SUSTRANS ROUTES - COMITTED ROUTE
- SUSTRANS ROUTES - PROPOSED ROUTE
- SUPPORT LOCATION
- BUS STOP
- SCHOOL
- JP MORGAN DEVELOPMENT SITE
- JUBILEE LINE TUNNEL (WITH 15m ZONE)
- GRADE II LISTED BUILDING
- GRADE II* LISTED BUILDING
- INDIVIDUAL TPO ZONES
- BOROUGH OPEN LAND
- METROPOLITAN OPEN LAND
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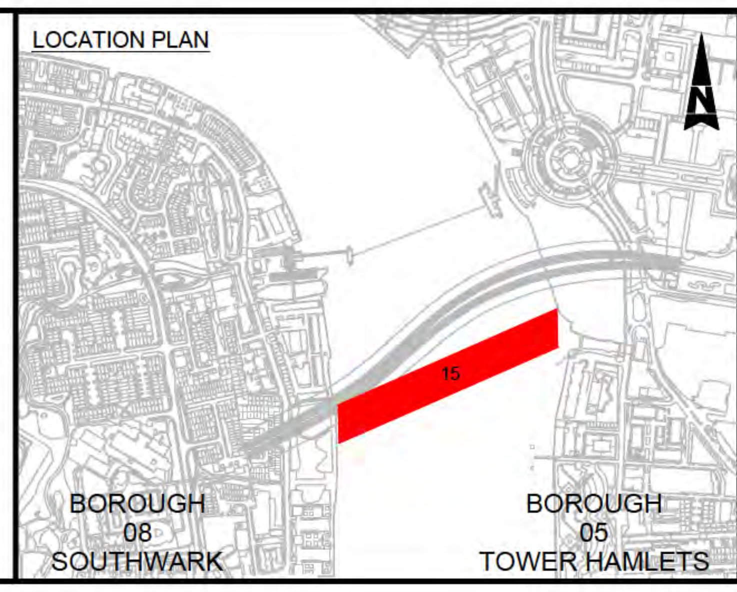
LOCATION PLAN



Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
Description: DRAWING CREATED						
S0	P01.1					00/05/18

Drawing Suitability: WORK IN PROGRESS
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Drawing Number: ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00015

Original Size: A1 | Scale: As Shown | Project Ref. No: 5162977 | Sheet: 1 of 1 | Rev: P01.1

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DO NOT SCALE

PLAN
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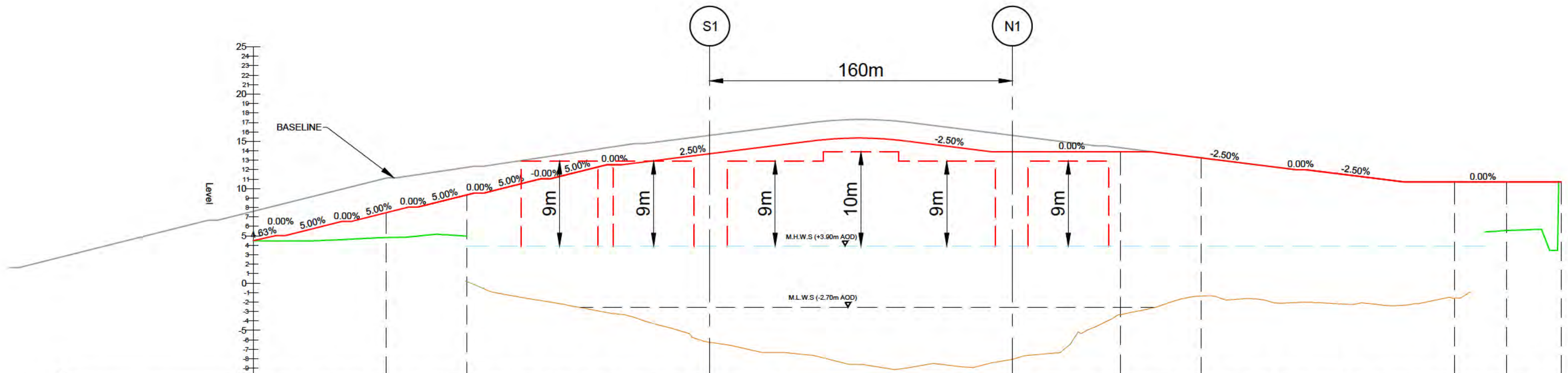

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50.000	4.623	6.529
60.000	4.728	6.928
70.000	4.809	7.428
80.000	4.856	7.928
90.000	5.035	8.178
100.000	5.126	8.678
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170.000	-2.493	11.675
180.000	-2.863	12.175
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VERTICAL PROFILE
SCALE 1:2000 HORIZONTAL 1:400 VERTICAL

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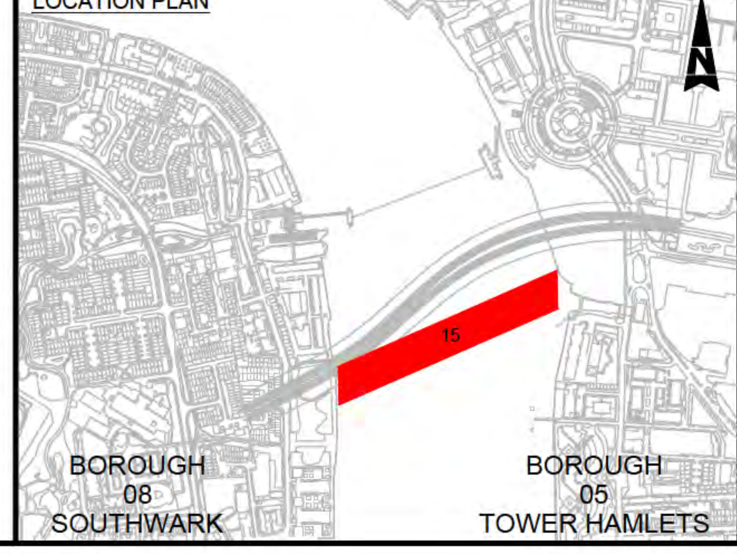

Description						
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
Description						
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Description: DRAWING CREATED						
Status	Revision	Drawn	Checked	Reviewed	Authorised	Issue Date
S0	P01.1					00/05/18

Drawing Suitability: WORK IN PROGRESS
Status: S0

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Client: Transport for London

Project Title: Rotherhithe to Canary Wharf Crossing

Drawing Title: CENTRAL ALIGNMENT PLAN AND PROFILE ALIGNMENT OPTION C1 40m PIER CENTRES

Drawing Number: ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00016

Original Size: A1 | Scale: As Shown | Project Ref. No: 5162977 | Sheet: 1 of 1 | Rev: P01.1

Rotherhithe to Canary Wharf River Crossing	
VALUE ENGINEERING ASSESSMENT FORM	**DATE: 01.10.18**

- *Item Ref: VE05 – Temporary Causeway or bridge to access main piers (half of the river at a time)*

SUMMARY DESCRIPTION OF VE PROPOSAL

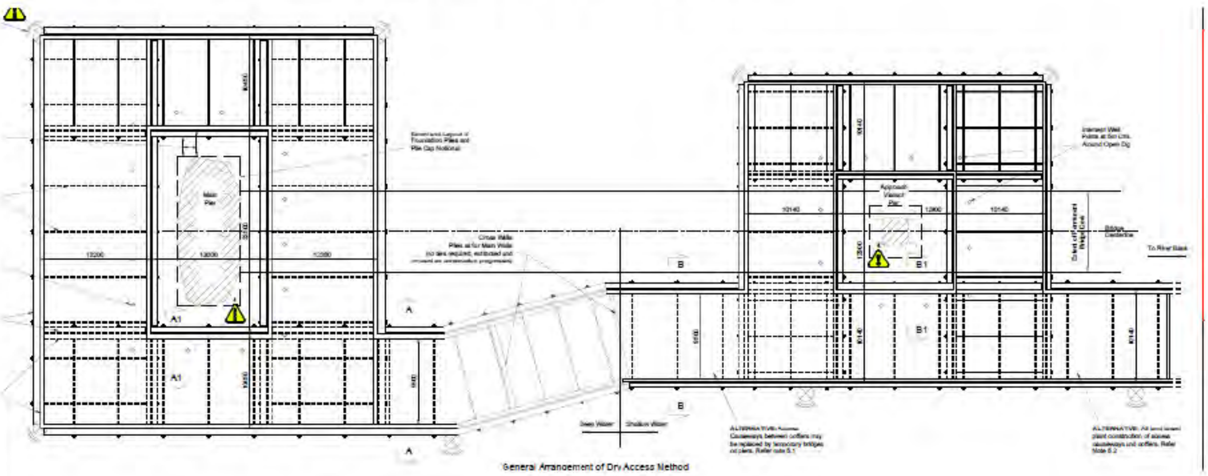
Access to, and operation at, workfaces within the river will require costly marine plant as well as additional allowances within the programme and the risk of availability for more specialist equipment.

Given the number of worksites within the river, and the need for continual access to these areas over an extended period, marine plant will be expensive, slow and potentially cause blockages in the river for extended durations.

2 options have been reviewed as an alternative to use of exclusively marine plant. These are evaluated below. Marine plant would still be required to install these structures initially.

Option 1:

Heavy duty, solid structure – extended double walled cofferdam (9-12m wide) infilled with ballast to link pier workfaces. This will require significant sheet piling with a Giken rig or similar. This will then require structural backfilling to enable heavy plant and equipment to traverse.



Disadvantages:

PLA and EA are likely to have significant concerns regarding completely blocking the side span to river traffic, river flow and flood risk. Works may need to happen consecutively to reduce the impact on the river.

Significant additional works and costs required to fabricate and construct which may counter the savings made by removing marine plant requirements.

Large quantity of sheet piles to be sourced.

Benefits reduced if back-spans not enclosed with double skin cofferdams requiring material infill.

Advantages:

Marine plant can be almost completely removed from works once the structure is in place.

Option 2:

Simply supported bridge sections spanning between adjacent pier construction worksites to provide operative access and to carry pumping lines for concrete. Temporary intermediate supports would be required between the permanent piers.

Image from Thames Cable Car

Advantages

River flow impact marginal.

Small vessels may still pass through the back spans (outside the navigation). Assume 9m above MHWS for span just behind primary piers then sloping downwards to shore level at embankments.

More likely to be approved for implementation concurrently on both banks

At this stage, it is proposed that the optimum option would be Option 2, where the bridge will carry just people, hand tools and concrete pipes. We believe this will deliver the majority of the benefits at a fraction of the cost.

ADVANTAGES:	**DISADVANTAGES:**
• This will provide safe access for personnel and material • Personnel will be able to access and egress the main tower and side spans at all times • As it is only designed for pedestrian and service pipe lines, security will be minimised • Does not block whole back span. • Removes need to ferry concrete to workface and avoids tidal limitations.	• It will not support vehicles / plant • Temporary supports piles will need to be installed in the river to carry the walkway.

LIST OF SUPPORTING DOCUMENTS:
Images within body of text.
IMPACT EVALUATION
COST BENEFIT
To be agreed with TfL estimating team
PROGRAMME BENEFIT
No programme savings quantifiable – saving on man access and concrete works. Man access saving could be assumed to be the period of time to wait for and embark the access tug, as well as travelling time, plus alighting – assume 0.5hrs per day = 15 man-days per year per operative.
RISK EVALUATION
Is an approx. 25m wide x 9m high clearance acceptable for marine traffic outside the navigation? Some level of impact would need to be considered if marine traffic would pass. Risk of concrete pipe burst to be managed. Eg regular inspection etc .. Marshalling may be required to permit small craft to navigate safely under access way.
ENVIRONMENTAL
Additional temporary piles needed in the river to support. Reduced risk of concrete and oil spills in the river e.g. washing out barge based agitators. However pumping lines will still need to be cleared at end of each shift. Reduced working on the river and associated fuel usage / carbon emissions. Avoids significant noise from agitators, pump and generator combined.
BUILDABILITY
As above
SAFETY
Reduced working on the river and avoids task based risk exposure. Access to workface will be via a bridge rather than embarking / alighting small river craft.

Provides a quick evacuation route to shore. Avoids storage of drilling support fluid on water.		
OPERATIONS AND MAINTENANCE		
N/A		
ACCEPTANCE		
Prepared: [redacted]	**Name: Costain**	**Signed:**
Proposal Implemented:	**Y / N**	**(Delete as appropriate)**
Approved by:	**Name:**	**Signed:**
IMPLEMENTATION		
COMMENTS / ACTIONS		
To be completed by TfL		

Rotherhithe to Canary Wharf River Crossing

VALUE ENGINEERING ASSESSMENT FORM	DATE: 18/09/18

- *Item Ref: VE6 - Auger tubular piles*

SUMMARY DESCRIPTION OF VE PROPOSAL

VE6 was raised to review the baseline design decision of caissons foundations. Initially piles driven to depth were being considered until the noise and vibration issues were highlighted. Costain suggested augered tubular piles at the VE workshop. Since then, further design development has taken place and other piling options explored in light of these changes. In the descriptions below the feasibility to use this option with either a single or double skinned cofferdam is stated.

<u>Option 1 Auger lead bored piles:</u>

Auger would lead with the sleeve following, being vibrated to the pile's full depth before being filled with concrete

This option will work with either a double or single skinned cofferdam.

Advantages:

- No need for a polymer / bentonite support fluid.
- Auger lead will be better dealing with any obstructions that are met.
- Reduction in noise vs driving to depth.

Disadvantages:

- Slower than option 2

<u>Photo of Hungerford Bridge</u>

Option 2 1200mm ID Ø option:

A 1200mm Ø (internal) cutting ring and sleeve is vibrated to a depth of approximately 9m. An auger then drives through this hollow tube, supported by polymer supporting fluid before being filled by reinforced concrete.

This option will work with either a double or single skinned cofferdam.

Advantages:

- Less vibrating required than option 1.
- Quicker than option 1.
- Less steel casing used that option 1
- At this ID an environmentally friendly polymer support fluid can be used instead of bentonite.

Disadvantages: Beyond 1.2m diameter, bentonite would need to be used with additional pollution prevention controls implemented. However, this can be managed with additional management controls.

Photo – Thames Cable Car

Option 3 Large Diameter "Offshore" Piling:

This option has the greatest upfront costs of all 3 options due to the size and specialism of the plant that is required. However, as the overall number of piles increases with design development, the cost per pile and associated programme savings of this option makes it a viable alternative. NB the current assumption is that 1 large diameter pile (3600mm Ø) is the equivalent to 6 no. 1200mm Ø piles.

These large diameter casings are bored and excavated (pushed) to depth before being filled with concrete to the required depth. 3.64m Ø – 20m depth = 203m^3 (300m^3 practical daily limit assumed). See risk evaluation for the feasibility risks associated with end bearing capacity in Thanet sands at Thames river.

This option will not work with the double skinned cofferdam option due to the sheer size of the workface (encroachment onto the navigable channel) and also the marine based nature of the specialist plant.

Advantages:

- Fewer manoeuvres between pile locations
- Fewer piles

Disadvantages:

- Significant upfront costs
- Marine based with no alternative option.
- Floating jetty would be required to supply concrete from end of backspan “ship to shore” bridge.

Photograph 3 – Casing installation lift

Photograph 5 – Drilling works underway

Photograph 9 – Second stage concrete pour completed and shuttering removed. Upper access platform in preparation of 3rd stage/final pour for the pile cap and bearing plate

Photograph 11 – Completed structure. Temporary casings now removed

Photos - Clackmannanshire Bridge

ADVANTAGES:	DISADVANTAGES:
• See above	• See above

LIST OF SUPPORTING DOCUMENTS:
NA
IMPACT EVALUATION
COST BENEFIT
To be agreed with TfL estimating team
PROGRAMME BENEFIT
Baseline costs / task timeline • Main Pier twin caisson baseline (Arcadis) = 10 months each (**+ uplift for impact protection required**) • Back span support construction not on critical path <u>Option 2 1.2m piles:</u> *Marine Based*: 2 shifts per pile Land based (cofferdam VE11): 1.33 shifts per pile Duration 1year + mobilisation (1 rig). Multiple rigs could be utilised <u>Option 3 Large Diameter “Offshore” Piling:</u> Duration 4 months + mobilisation (Assume x3 if 24hr working not permitted)
RISK EVALUATION
See above Option 2 - costs of additional impact protection piles around single skin cofferdam or in front of tubular wall. Option 3 – Capacity provided needs to be demonstrated / accepted by Designer. 24hour working would need to be agreed with stakeholders.
ENVIRONMENTAL
Less disturbance to river bed.
BUILDABILITY
See above
SAFETY
Avoids need for large scale open excavation into the river bed.
OPERATIONS AND MAINTENANCE

N/A		
ACCEPTANCE		
Prepared: [redacted]	**Name: Costain**	**Signed:**
Proposal Implemented:	**Y / N** (Delete as appropriate)	
Approved by:	**Name:**	**Signed:**
IMPLEMENTATION		
COMMENTS / ACTIONS		
To be completed by TfL		

Rotherhithe to Canary Wharf River Crossing

VALUE ENGINEERING ASSESSMENT FORM	DATE: 02/10/18

- *Item Ref: VE7 - Precast caissons in dry dock and floated into position*

SUMMARY DESCRIPTION OF VE PROPOSAL

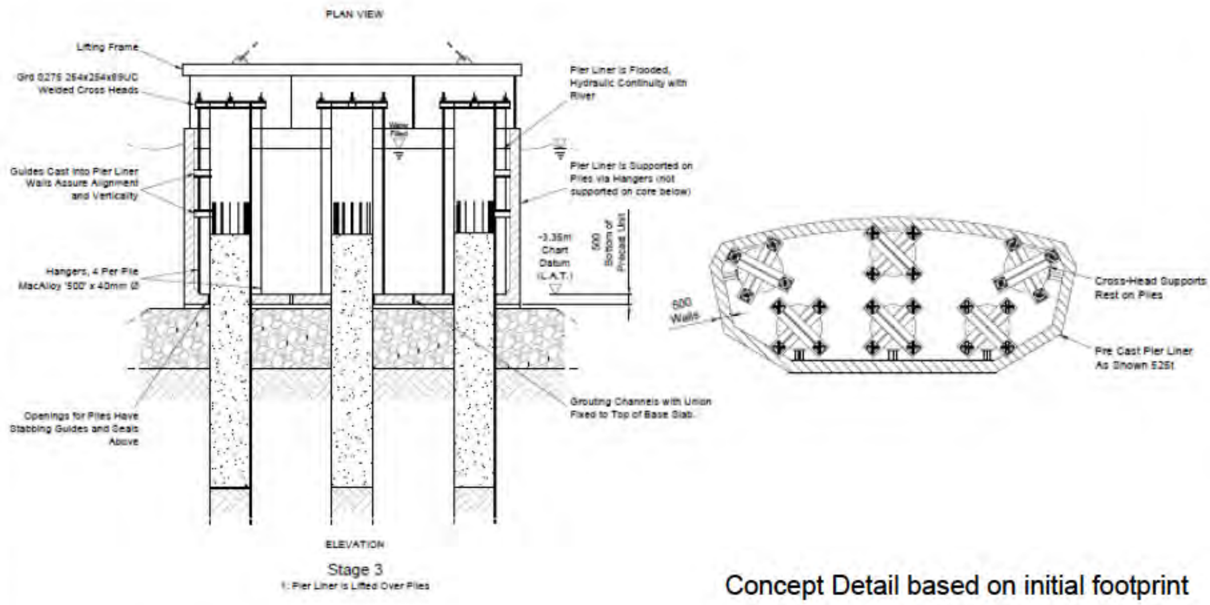
VE proposal was discussed during the workshop 04/07/18 to use precast caisson sections in dry dock, float them out on a barge and drop them into position. This is deemed as an unfavourable alternative to the baseline due to the difficulty in preparing and maintaining the river bed during installation.

Costain did develop an option that would support itself above the bed on the piles. However, as design developed, with ship impact requirements now accounted for, it is now envisaged that 70 no. 1.2m piles and a pile cap of 50mx19m will be required. It is therefore no longer considered practical (aligning 70 piles to fit through holes in a preformed shell will require high precision and steady installation which is complicated by working in a marine environment.

This option will therefore not be taken further.

ADVANTAGES:	DISADVANTAGES:
• Avoided the need for cofferdams • Developed solution avoided difficult bed preparations due to silt and flow.	• The developed / enlarged "pile cap" would be a large concrete mass above river bed and water level – not just a "slimline tower" visible.

LIST OF SUPPORTING DOCUMENTS:



Concept Detail based on initial footprint

IMPACT EVALUATION

COST BENEFIT

NA

PROGRAMME BENEFIT

NA
RISK EVALUATION
NA
ENVIRONMENTAL
NA
BUILDABILITY
NA
SAFETY
NA
OPERATIONS AND MAINTENANCE
NA

ACCEPTANCE		
Prepared: [redacted]	**Name: Costain**	**Signed:**
Proposal Implemented:	**Y / N**	**(Delete as appropriate)**
Approved by:	**Name:**	**Signed:**
IMPLEMENTATION		
COMMENTS / ACTIONS		
To be completed by TfL		

Rotherhithe to Canary Wharf River Crossing	
VALUE ENGINEERING ASSESSMENT FORM	**DATE: 18/09/18**
- *Item Ref: VE8 - Precast units used inside the cofferdam to form the caisson*	
SUMMARY DESCRIPTION OF VE PROPOSAL	
During the VE workshop, the option to precast caisson units to use within the confines of the cofferdam as the pile cap of the main towers was proposed. Since then, development of the design has meant that the bases of the main towers have become significantly larger; currently 70no. 1200mm Ø piles, with a 19 x 50m pile cap. Pre-cast caisson units are still feasible, however, they would now be most effective if used as the pier bases rather than the pile caps. It is proposed therefore that they are placed within the cofferdam (built to enable piling and pier cap construction) and once in place, filled with concrete. This is similar to the original baseline concept and therefore not seen as a VE opportunity.	
ADVANTAGES:	**DISADVANTAGES:**
• Reduce programme impact of pier base construction • Temporary cofferdam can be removed earlier due to programme savings, reducing the potential, perceived impact on the navigable channel • Reduction of working in water	• Heavy lifting equipment and marine plant required for lifting into place
LIST OF SUPPORTING DOCUMENTS:	
NA	
IMPACT EVALUATION	
COST BENEFIT	
NA.	
PROGRAMME BENEFIT	
NA Pre-casting forms off-site will reduce the time required on site.	
RISK EVALUATION	
NA	
ENVIRONMENTAL	
NA	

BUILDABILITY		
M&E could be pre-installed. Quality of finish can be ensured off-site (inspections may be necessary). Pre-cast formers will reduce the need for in-situ formwork.		
SAFETY		
The precast formers will be engineered to be stable in the temporary condition and will reduce the controls necessary on site to ensure stability of temporary formwork.		
OPERATIONS AND MAINTENANCE		
NA		
ACCEPTANCE		
Prepared: [redacted]	**Name:**	**Signed:**
Proposal Implemented:	**Y / N** **(Delete as appropriate)**	
Approved by:	**Name:**	**Signed:**
IMPLEMENTATION		
COMMENTS / ACTIONS		

Rotherhithe to Canary Wharf River Crossing

VALUE ENGINEERING ASSESSMENT FORM	DATE: 02/10/18

- *Item Ref: VE11 Construction noise. Potentially require double skin cofferdam to mitigate.*

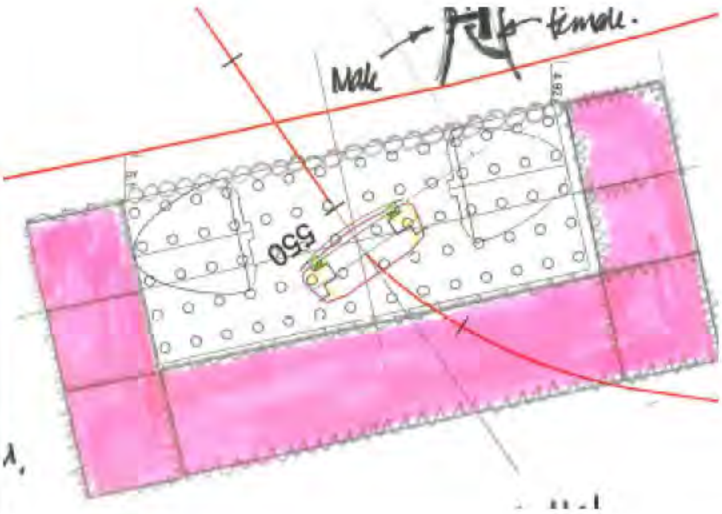
SUMMARY DESCRIPTION OF VE PROPOSAL

Construction of the Main Tower Base – Cofferdam

Construction of the main tower foundations requires a significant level of piling, excavation and construction or steel erection works (dependent on final design of towers). The baseline construction methodology requires a significant amount of marine plant which is costly, slows production manoeuvring and carries a level of risk based on plant availability.

To avoid such heavy reliance on marine based plant, a double skinned cofferdam is proposed. This will create the safe, dry conditions required for man access and efficient work, as well as temporary ship impact protection and a broad flat base for marine deliveries & storage.

High level calculations have been carried out which suggest the sheet piles will need to be AZ38-700 at 21.4m long forming a 12.2m wide base. The tubular piles will need to be supported with an additional propping frame.



ADVANTAGES:	DISADVANTAGES:
• Additional fender tubular piles to be installed along front edge to protect the workforce during construction of the tower as this will be designed for ship impact onto to protect the cofferdam • Double wall cofferdam, therefore no support frames required (wailings). So, it will be freestanding • The double wall construction is on the land side of the tower; this will minimise the noise impact to the public. This will give you the ability to erect sound screens to minimise the nuisance. • Double wall provides additional platform for the construction of the tower base. It will be designed for plant & material; it will also be an unloading facility that will reduce the requirements of marine spread (jack-up barges etc) • There are no requirements for base preparation that will be for caissons (The flow of the river and the silt will affect caisson preparation)	• Increased temporary footprint vs single skin

• More likely to permit works to continue on both main towers concurrently (remaining outside of the navigable channel for the duration of works). • If main area is filled with ballast, then the marine spread for the 1.2m piling could be avoided.	

LIST OF SUPPORTING DOCUMENTS:
IMPACT EVALUATION
COST BENEFIT
To be agreed with TfL estimating team
PROGRAMME BENEFIT
Configuration should permit concurrent working on both piers.
RISK EVALUATION
May require temporary marine plant access for installation of the tubular piles from the shipping lane – PLA agreement req. But this is true of all construction methods. Ship impact capabilities to be resolved to practical level. Cofferdam operatives will need to be evacuated to shore before largest vessels pass through. Risk item to be included in Project Risk register in case of impact leading to damage (similar for caisson options). Costs of additional impact protection piles around single skin cofferdam or in front of tubular wall.
ENVIRONMENTAL
Noise and potential marine pollutants confined within cofferdam.
BUILDABILITY
SAFETY

OPERATIONS AND MAINTENANCE		
ACCEPTANCE		
Prepared: [redacted]	**Name: Costain**	**Signed:**
Proposal Implemented:	**Y / N**	**(Delete as appropriate)**
Approved by:	**Name:**	**Signed:**
IMPLEMENTATION		
COMMENTS / ACTIONS		
To be completed by TfL		

Rotherhithe to Canary Wharf River Crossing

VALUE ENGINEERING ASSESSMENT FORM	DATE: 21/09/18

- *Item Ref: VE17 – Reduce main span length to minimum navigable channel width*

SUMMARY DESCRIPTION OF VE PROPOSAL

The navigation channel defined by Port of London Authority (PLA) is approximately 135m wide at the proposed location of Rotherhithe Bridge. Currently it is unknown if the channel width is determined to account for passage of particular set of vessel movements.

The baseline design locates the main span towers outside and at a skew to the navigation channel. The baseline tower locations result in approximately 169m lifting main span length.

The clear span (or navigable width) of the other significant structures on the River Thames for reference are:

- Thames Barrier – 61m
- Tower Bridge – 61m

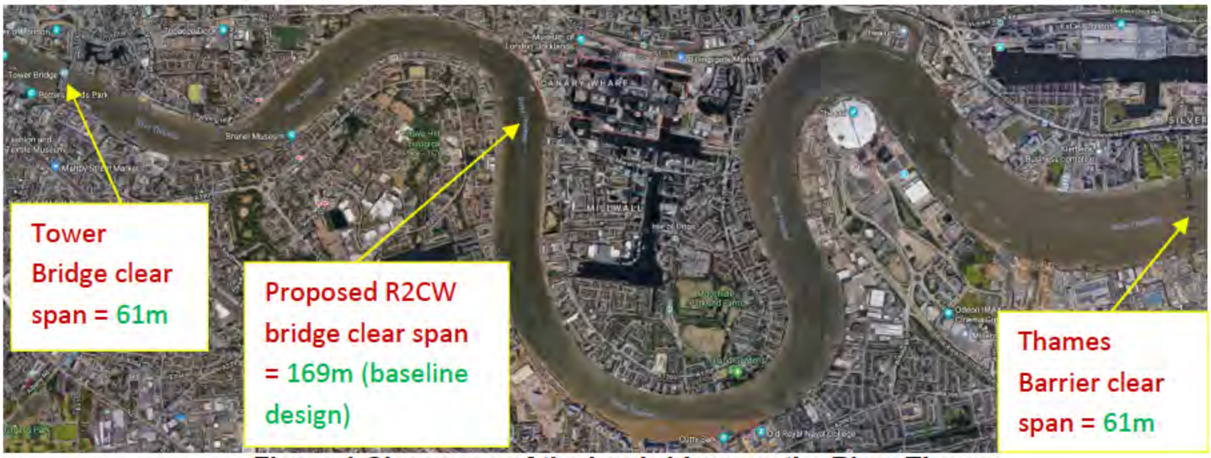


Figure 1 Clear span of the key bridges on the River Thames

BS6349-1-1:2013 *Maritime Works – Code of Practice for Planning and Design for Operations* refers to PIANC guidance for the navigation channels. PIANC *Report no* 121 – 2014 – *Harbour Approach Channels Design Guidelines* sets out guidelines and recommendations for the design of vertical and horizontal dimensions of harbour approach channels. The design aspects are mostly centred on the ship and environmental factors: its manoeuvring behaviour under influence of wind, currents and waves, its vertical motions in waves and the horizontal and vertical motions at berth. The outlined design methodology considers a two-stage process consisting of Concept Design, where empirically based methods are used, and Detailed Design, where a more elaborate process may utilise simulation models and risk analysis.

A high-level assessment has been conducted based on the PIANC concept design approach to investigate the potential of reducing the navigational channel width, allowing a reduction in the proposed bridges main span. The concept design undertake is based the assumptions listed. To pursue this further will require a detailed design to be undertaken in consultation with PLA, which is aligned with PIANC report No. 121 and is likely to be a significant undertaking.

Following concept design assumptions:

- Moderate vessel speed – It is intended to ask Marico Marine to identify the typical speed of transit that each of these vessels uses when it passes the site.

- Moderate prevailing cross wind – Built up area, therefore, unlikely to have significant cross winds.
- No prevailing cross current – River.
- Strong prevailing longitudinal current – Significant fresh and tidal current anticipated.
- Small beam and stern quartering wave height
- Moderate Aids to Navigation

Assuming a one-way channel where the ships would not be able to pass under the bridge together for the largest ship specified in the Marico Marine Data (Hamburg) results in a navigable channel width of **121m** (**14m decrease from current navigable channel width**). In accordance with the baseline design assumptions for temporary works and pier protection this reduces the main span length to approximately 155m. However, the concept design assumptions have been refined from the baseline and is currently work in progress; hence, this value should be revisited when additional allowances from navigable width are confirmed in the concept design.

Refer to drawing ST_PJ585C-ATK-BAS-ZZ_21-DIA-ST-00005 for reference with baseline design.

For situations with two-way channels (vessels passing side-by-side), PIANC advise the channel is increased using the most onerous vessel the to accommodate an additional basic manoeuvring lane/width and a safe passing distance. Adopting the approach stated in the PIANC report the design channel width is greater than what is currently defined. It is unlikely that a large ship would not be allowed to leave HMS Belfast to travel east when a large ship is travelling west towards HMS Belfast. Due to the type and recorded frequency of the most onerous vessels in practice it is unlikely vessels of this size would be in the same vicinity to pass each other. Some optimisation was considered that assumes a large cruise ship and cargo vessel are passing, however this still results in a design channel width greater than is currently defined. As the Thames only has one access point an allowance for multi-vessel passing is required and requirements would need to be agreed with PLA.

It is important to understand from PLA their operational methodology as to what ships can pass together (this might potentially be a three-way channel or more for smaller ships). This then needs to be supported by an assessment of whether those ships can pass under the approach spans or are required to pass under the main span. This assessment should be coordinated with the bridge opening operational methodology. From this the combination of ships to pass under the main span can be understood; hence, the broad concept design required for the main span length calculated.

This value engineering item has only calculated potential reductions in navigable channel as specified above. The potential savings to the structure has not been calculated as it would require a wholesale change in design. Should a reduction in navigable channel be pursued and agreed with PLA then a change in design should be undertaken. There will be a saving through a reduction of the components described above. It is worth noting that the approach spans will increase to accommodate the reduction in main span; however, the cost of the approach span is significantly less than the components described above.

ADVANTAGES:	**DISADVANTAGES:**
By reducing the main span length by 8%, the following can be reduced: • Main span cost as steel weight and fabrication required is reduced • M+E bridge lift equipment due to reduction in main span weight • Main span counterweights due to reduction in main span weight	• Reduction in length of two-way channel, i.e. ship passing points, along the River Thames • Increase in approach ramp lengths to account for the reduction in main span length • Piers will be located in a deeper part of the Thames; hence, increase in pier height and temporary works construction • Permanently reduces navigable channel width of Thames River. It is important to note that the

• Tower axial loading is reduced two-fold as the main span and counterweights are reduced; hence, reducing the thickness of the costly steel sections	navigable width of the Thames Barrier and Tower Bridge is 61m.

LIST OF SUPPORTING DOCUMENTS:

- 5169277-45-0137 P01 Analysis for Assessing Bridge Opening Frequency (Technical Note Assessing Bridge Opening Frequency)
- 5162977-45-0137 Addendum P01 Analysis for Assessing Bridge Opening Frequency (Addendum to Technical Note Above)
- 180804 Addition Ship Analysis 1.0 (Technical Note Outlining Dimensions of Marico Marine Shipping Data)
- PIANC Report No 121: 2014 – Harbour Approach Channels Design Guidelines
- ST_PJ585C-ATK-BAS-ZZ_21-DIA-ST-00005 (VE17 - Reduced Navigable Width)
- Lower Pool to Limehouse Reach River Thames Admiralty Chart, courtesy of PLA

IMPACT EVALUATION

COST BENEFIT

Reducing the main span length would reduce the cost of that element of the structure due to the reasons listed in “Advantages”, although these would be tempered by the need for corresponding increases in the length of the back spans and/or approach ramps. An initial assessment of the cost benefit of the reduction has been calculated and suggests a potential saving of £0.5 million could be achieved. This is based purely on a pro-rata basis to the deck length but there may be potential for greater savings to be achieved if the reduction in lifting span length resulted in a change to the deck design itself, which if it reduced the deck mass may also facilitate savings associated with the lifting mechanism and foundations. Without a firm design proposal however, it is not possible to accurately estimate what these may be, but they could offer further VE opportunities. There are however also additional risks to the cost, should there be a need for increased vessel impact protection measures and additional cost of constructing foundations in a deeper part of the Thames.

Should a reduction in main span length be pursued further then the proposed design can be reviewed and costed appropriately.

PROGRAMME BENEFIT

None anticipated as the same plant will have to be mobilised.

RISK EVALUATION

To date PLA have not provided any specific issues nor rational to their objection to reducing the navigable width. Current consultation suggests they would prefer to maintain current navigable width and only allow for any temporary works that can be removed within 24hrs.

Further consultation is required to understand PLA’s root cause for this position and if there are any other stakeholders influenced by this proposal.

Reduced main span length increases the risk of ship impact. It is important to note, however, that it has no influence on the ship impact design loading.

ENVIRONMENTAL

No environmental changes anticipated.
BUILDABILITY
Construction in deeper part of the River Thames.
SAFETY
The challenges are similar to that in the baseline design: • Working directly in/around/over water • Working next to navigable channel • Ship impact on piers • Maintenance inspections
OPERATIONS AND MAINTENANCE
There is a chance of increase in number of openings (vertical lift operations) of the bridge and will increase the operating energy costs.

ACCEPTANCE		
Prepared: [redacted]	**Name:** [redacted]	**Signed:** [redacted]
Proposal Implemented:	**Y / N**	**(Delete as appropriate)**
Approved by:	**Name:**	**Signed:**

IMPLEMENTATION
COMMENTS / ACTIONS
To be completed by TfL

rev	date	details	drn	chk	app
P01.1	---	FIRST ISSUE			

borough: Multiple Boroughs

scheme: R2CW RIVER CROSSING VE17 REDUCED NAVIGABLE WIDTH

Transport for London
TfL Engineering
Surface Transport

Palestra
197 Blackfriars Road
London SE1 8NJ

DRAFT

date	scale	drn	chk	app	sheet no
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suitability: S0 WORK IN PROGRESS

revision: P01.1

drawing No: ST_PJ585C-ATK-BAS-ZZ_21-DIA-ST-00005

project | owner | asset | location | type | role | number

FILE REF: C:\projectwise\tfl\dms22911\ST_PJ585C-ATK-BAS-ZZ_21-DIA-ST-00005.dwg | USER: Ellis, James | DATE: 2018 Oct 02 11:48

SENSITIVE INFORMATION

DO NOT SCALE

Rotherhithe to Canary Wharf River Crossing	
VALUE ENGINEERING ASSESSMENT FORM	**DATE: 07/09/2018**
- *Item Ref: VE18 – Architectural Truss Form & VE19 – Standard Truss Form*	

SUMMARY DESCRIPTION OF VE PROPOSAL

The Arcadis baseline design for the main movable span consisted of a slender tied arch, where the arch splits at the towers and converges at midspan.

At the value engineering workshop, a Pratt Truss structure was presented. VE18 recognises the desire to proceed with this option. The structure consists of a weathering steel orthotropic deck with flat plate stiffeners welded to the underside of the deck plate in the longitudinal and transverse directions. Above the deck will be a varying steel hollow section arch section, where the arch splits at the towers and converges at midspan. The arch will form the top chord of the Pratt truss. The vertical elements will be bespoke steel hollow sections and the diagonals will be formed by architectural tension struts.

This is significantly simpler to construct, than the Arcadis baseline design. whilst maintaining a lot of the architectural qualities of the Arcadis baseline design. This has been incorporated into the core team's concept design.

However, for the structure to maintain its desirable architectural qualities it requires many bespoke sections that come with it high fabrication costs.

VE19 consists of eliminating as many of the bespoke sections as possible. The structure consists of weathering steel orthotropic deck with flat plate stiffeners welded to the underside of the deck plate in the longitudinal and transverse directions. Above the deck will be two separate standard section steel arches. The arch will form the top chord of the truss. The vertical and diagonal elements will be formed of standard steel sections. The arches will be braced together by standard steel sections.

Painted structural steel has been assumed to achieve the maximum benefit from using standard steel sections (it is assumed these are not available in weathering steel).

Refer to ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00004 for a General Arrangement Drawing for VE19.

ADVANTAGES:	DISADVANTAGES:
• Potential for significant savings in deck fabrication & material costs • Standard sections (off-the shelf products) and connections. • Simpler connection details. • Stiffer structure.	• Bracing required between the separated top chord. • Increase in total weight of the deck and counterweight needs to be altered accordingly. • Less aesthetic while viewing from sideways compared to baseline design due to replacing the architectural tension struts with standard steel sections. • The thicker vertical bracing members and separated top chord makes the deck feel more enclosed – negatively influencing experience on the bridge deck.

LIST OF SUPPORTING DOCUMENTS:

- Main span AIP 3.12
- ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00004 (Standard truss main span GA drawing)
- VE18 & 19 - Standard truss bridge deck with the original steel towers (from concept design) - Rendered Views
- Reference: 3D visuals

Figure 1 3D visualisation of standard truss bridge deck

IMPACT EVALUATION

COST BENEFIT

The procurement and fabrication costs will reduce due to standard sections being used with simpler connections against that of the bespoke fabricated steel sections proposed for the baseline design.

The overall mass of the structure is assessed as being approximately 1100t versus the 1200t allowed in the baseline design for CB5-CA5.

Advice has been received from the American Bridge Company in respect of supply and fabrication rates as follows.

1. The top and bottom chord prices would remain essentially the same as they have a significantly higher degree of complexity. For reference the figures previously quoted are included below.

2. For the truss fabrication the price would come down as per the figures below. The reason for the drop is the use of standard rolled sections and the simpler fabrication and erection. Other elements like QC, painting and delivery would remain the same.

Truss Sections

Element	Cost per kilo in £
Material	1.90
Fabrication	1.40

QC & testing	0.11
Painting	0.44
Delivery	0.11
Overhead & profit	0.44

Top and Bottom Chord Sections

The base price of £5.54 per kilo (converted from $ and Lbs) would cover material cost, shop fabrication, quality control & testing, painting, and delivery to site. The breakdown would be material 40%, fabrication 40% QC & testing 2%, painting 8% delivery 2% overhead & profit 8%.

Element	Cost per kilo in £
Material	2.22
Fabrication	2.22
QC & testing	0.11
Painting	0.44
Delivery	0.11
Overhead & profit	0.44

Applying these rates to the revised structure weights generates a saving in EFC of £19.9 million.

It should be noted that in order to assess this proposal on a like for like basis a main span length of 169m has been utilised. The current C2 Concept design assumes a 181m main span. This could potentially increase the level of saving slightly but only if that increase in span had no material effect on the sizing of any of the standard sections proposed.

PROGRAMME BENEFIT

The programme duration will significantly reduce for fabrication of the steel sections due to usage of standard sections (off the shelf products) against bespoke steel sections in the baseline & concept design.

RISK EVALUATION

- Local Authority consents required. There is a concern that the deck may not fit in with surrounding environment.
- Transport and Work Acts Order (TWAO) consent

ENVIRONMENTAL

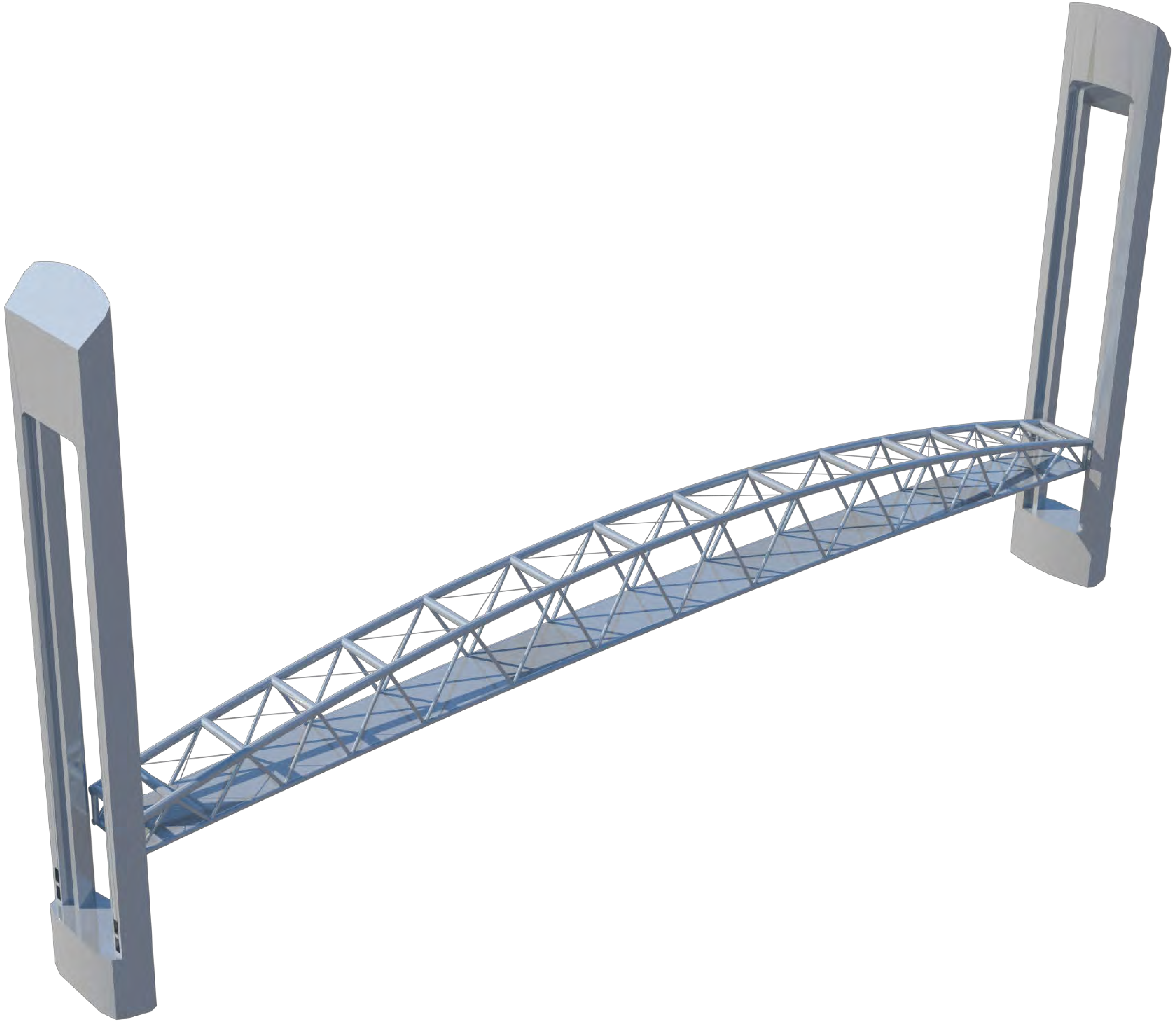
Reducing the construction period would be beneficial to the environment.

The painting of deck during future maintenance may have a little impact over the river water body.

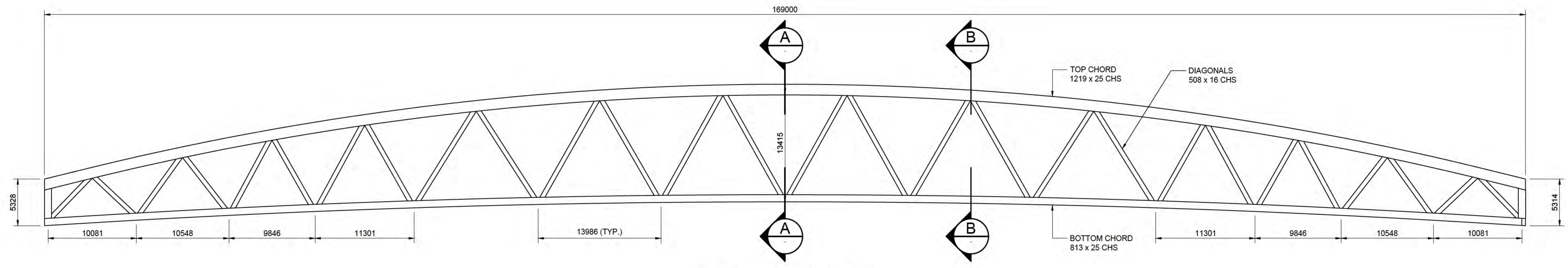
BUILDABILITY		
Construction of long span steel truss deck can be achieved by fabricating the truss elements in the factory, transporting to site in the form of segments / panels, assembling the segments near the site and installing it using incremental launch method from land (with temporary towers in the river with the help of barges / anchors). Alternate option is to erect the truss deck at site in segments with the help of barges and assembling it using HSFG bolts.		
SAFETY		
Possible elimination of site welding. There is a possibility of single lift erection of the deck using heavy lift jacks through the temporary barges in the river, as it will reduce work hours at site and associated HSE issues.		
OPERATIONS AND MAINTENANCE		
Steel truss tower requires periodical maintenance and needs painting or corrosion protection measures due to closer proximity to river. There is sufficient space for the inspection and maintenance of the deck.		
ACCEPTANCE		
Prepared: [redacted]	**Name:** [redacted]	**Signed:** [redacted]
Proposal Implemented:	**Y / N** **(Delete as**	
Approved by:	**Name:**	**Signed:**
IMPLEMENTATION		
COMMENTS / ACTIONS		
To be completed by TfL		

VE18 & 19 - Standard truss bridge deck with the original steel towers (from concept design) - Rendered Views

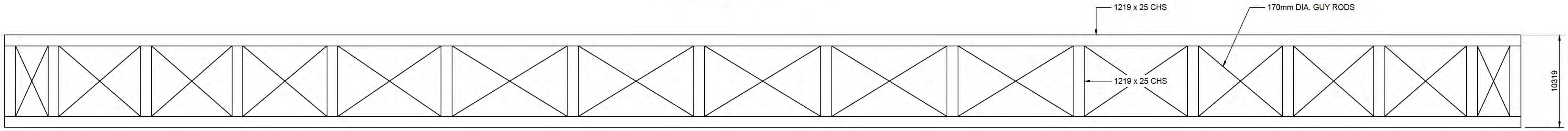
VE18 & 19 - Standard truss bridge deck with the original steel towers (from concept design) - Rendered Views



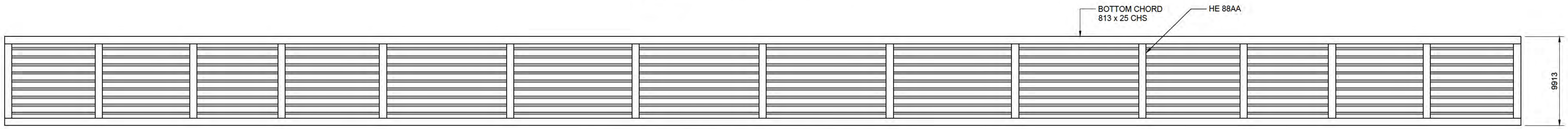
VE18 & 19 - Standard truss bridge deck with the original steel towers (from concept design) - Rendered Views



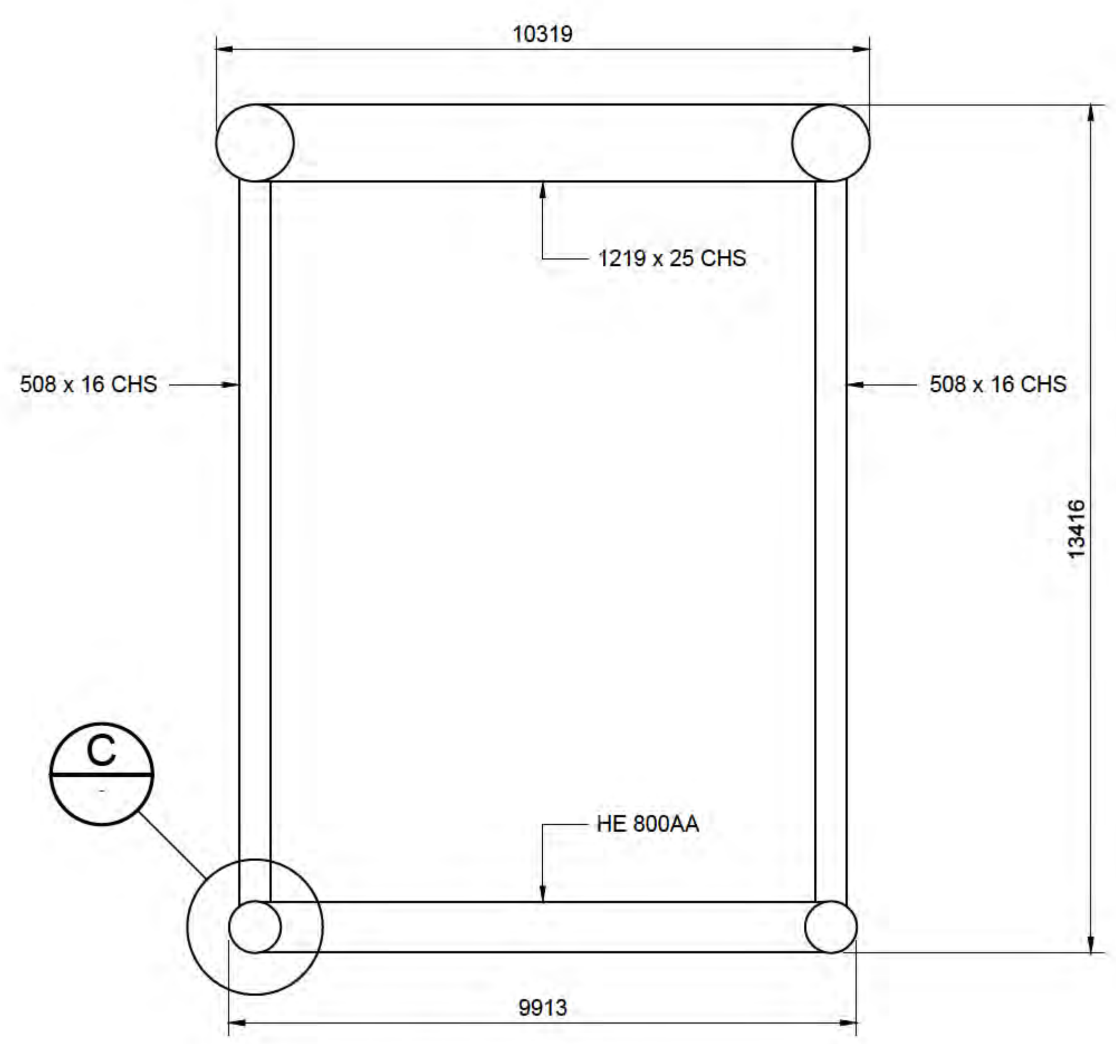
ELEVATION ON TRUSS
SCALE 1:250



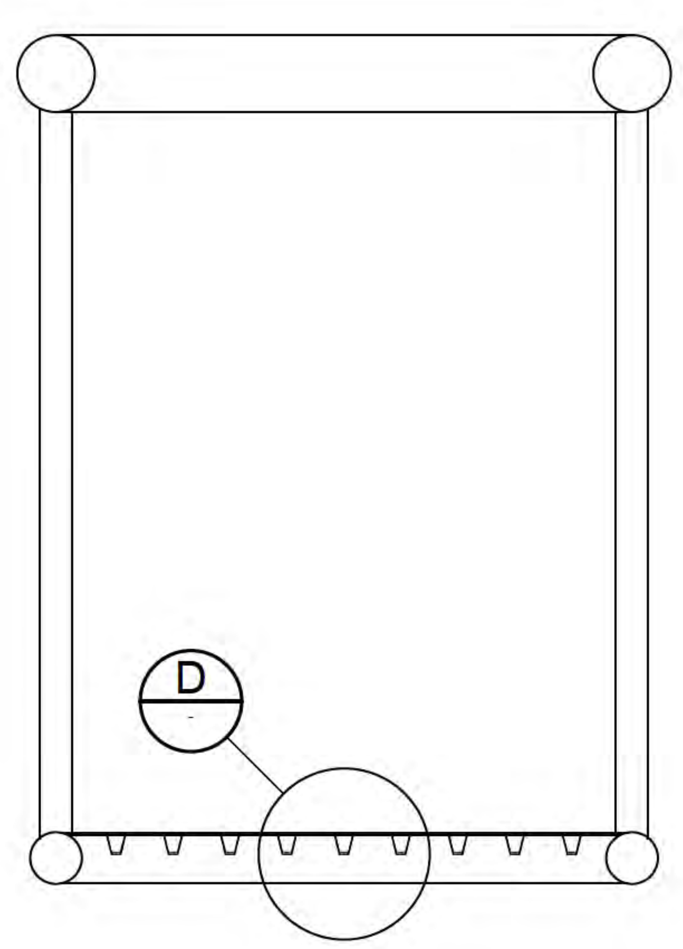
PLAN ON TOP STRING OF TRUSS
SCALE 1:250



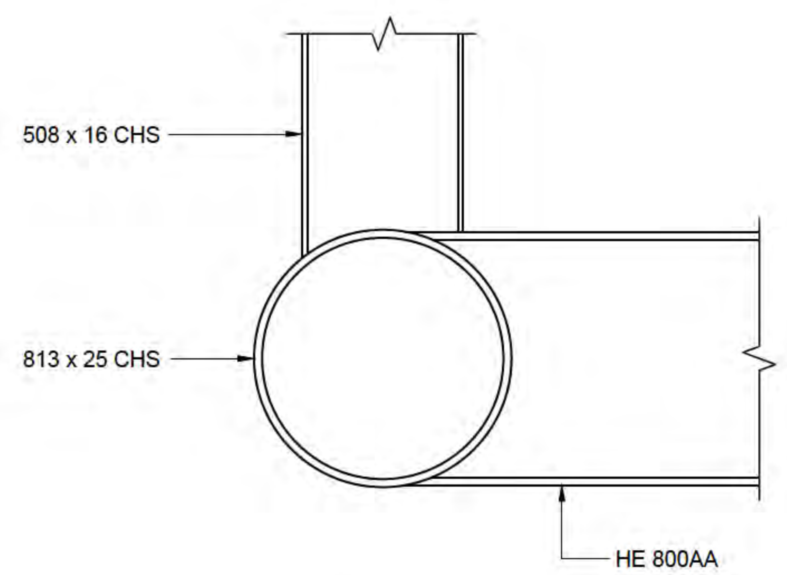
PLAN ON BOTTOM STRING OF TRUSS
SCALE 1:250



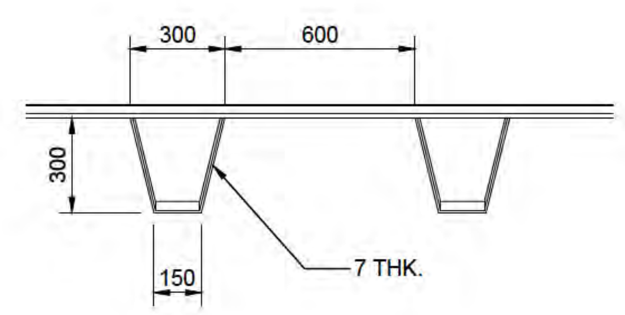
A SECTION
SCALE 1: 100



B SECTION
SCALE 1: 100



C DETAIL
SCALE 1: 20



D DETAIL
SCALE 1: 20
(ORTHOTROPIC DECK PLATE)

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION			
In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following:			
CONSTRUCTION	MAINTENANCE/CLEANING	OPERATION	DEMOLITION
NONE	NONE	NONE	NONE
It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement			

rev	date	details	drn	chk	app
P01.1	—	FIRST ISSUE			

borough: Multiple Boroughs

scheme: R2CW RIVER CROSSING
VE19 - MAIN SPAN
STANDARD TRUSS FORM

Transport for London
TfL Engineering
Traffic Design Engineering

Palestra
197 Blackfriars Road
London SE1 8NJ

DRAFT

date	scale	drn	chk	app	sheet no
—	AS SHOWN	—	—	—	3 OF 3

suitability: S0 WORK IN PROGRESS

revision: P01.1

drawing No: ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00004
(project | owner | asset | location | type | role | number)

FILE REF: C:\projectwise\tfl\dms22908\ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00004.dwg | USER: Ellis, James | DATE: 2018 Oct 03 2:52

SENSITIVE INFORMATION

DO NOT SCALE

Rotherhithe to Canary Wharf River Crossing

VALUE ENGINEERING ASSESSMENT FORM	DATE: 21/08/18

- *Item Ref: VE21* – Fibre-reinforced Plastic (FRP) deck

SUMMARY DESCRIPTION OF VE PROPOSAL

The baseline bridge main span design consists of a Pratt Truss Structure with towers and piers located in the River Thames as close as possible to the navigable channel without encroaching on it.

In VE21, it is proposed to construct the superstructure using FRP components. This assessment separately details differences associated to using an FRP deck and full FRP superstructure.

FRP Deck

FRP composites are primarily made up of fibres aligned within a resin material in such a way to make a very strong and very customizable material. The most common fibre choices are glass and carbon fibres. In the use of bridge decking, FRP have been moulded into cellular panels that can be installed as full-depth deck panels. An example of an FRP deck panel is provided in Figure 1.

Figure 1 – Example of conventional adhesively bonded composite decks *(Source: ZellComp Inc.)*

Constructability: To connect the panels to one another, the panels are design to interlock with male-female shear keys. Another option for connecting the panels is the use of high quality epoxy adhesives. To connect the panels to the steel framing, pockets are formed over the beams to allow for welded stud shear connectors and non-shrink grout. Bolts can also be used to connect the panels to the steel framing.

Evaluation: FRP products have the benefits of having high strength, low weight, high stiffness to weight ratio, and corrosion resistance. The deck being prepared in panels, transporting the deck to the jobsite and placing the deck panels is efficient.

Given the increased fabrication costs compared to conventional materials, it is anticipated this would increase capital costs; however, it is anticipated whole life costs will reduce as there are less maintenance requirements. Furthermore, it can be an option to be considered in detailed design to make weight reductions where required.

ST_PJ585C-ATK-BAS-ZZ_21-DIA-ST-00004 outlines potential structural layout changes.

FRP Superstructure

Secondly, it is proposed to construct the superstructure using an FRP deck. This would reduce the overall deck weight and thereby reduce the size of the machinery required to operate the lifting mechanism. Furthermore, using a lightweight deck could increase the overall span of the structure, eliminating the need for piers within the river. This would have significant construction and programme benefits.

Figure 2 Example of a FRP Truss bridge (*Reference: E.T. Techtonics*)

Figure 3 Example of connections used in FRP truss bridge (*Reference: E.T. Techtonics*)

However, this proposal is well beyond what has been achieved to date in terms of span length. Initial studies completed by others have suggested this could be technically feasible. The proposal has a number of technical risks from a design perspective and fabrication perspective.

There have been numerous pedestrian bridges built within Europe with spans of up to **40m**. The longest span FRP pedestrian footbridge constructed currently is a **63m** span (Aberfeldy Footbridge, constructed in 1992). Further FRP structures have been constructed for vehicle loading up to 400kN in a two-span arrangement covering a total deck length of 52m. (Ascione, et. al. 2016).

Further theoretical proposals suggest a 300m span footbridge could be built as a single span. The deck depth would vary from 6m deep to 11m deep and be delivered to site using 6 preformed sections. The depth of the deck section would require increasing the level of the bridge to meet the navigable channel headroom requirements, and in turn increasing the approach ramp lengths.

The proposal suggested the costs were competitive with other landmark bridges. The competitiveness was a result of reduced substructure costs, offsetting the increased superstructure costs. (Kendall, 2016) However, this piece of literature did not provide evidence of a peer review. Therefore, the assumptions, limitations and exclusions were not clear. Further work would be required to determine how much of this proposal is aspirational and how much is feasible.

Using a theoretical bridge based upon the Millennium Bridge and Hungerford Bridge, it is claimed that a 300m single span FRP bridge could cost 12,500 €/m². The Millennium Bridge and Hungerford Bridge had a total cost of 22,000 €/m² and 16,000 €/m² respectively. (Kendall, 2010) This is a significant potential saving. It is important to note this cost saving is suggested to be from a reducing in substructure costs, offsetting the increased superstructure costs. Again, there is limited evidence of an independent technical review. Further work would be required to determine how much of this proposal is aspirational and how much is feasible.

The single span FRP proposal would require major changes in the design to achieve the single span. The substructure arrangement and lifting arrangement would require significant modification.

To conclude, a single span structure represents an opportunity to eliminate river working. There is possibly capability to deliver an FRP structure in multiple prefabricated sections, but a single span structure would be significantly larger than other bridges or components to date. Consequently, the increase in span length will present significant design, procurement and fabrication risk. There is no available data to facilitate a justifiable cost estimate for the superstructure as nothing of this scale has been constructed in the past. Engagement with potential fabricators would have to be made to ascertain potential superstructure costs; however, it is envisaged that there will be high costs associated to the bespoke requirements of the bridge.

ADVANTAGES:	**DISADVANTAGES:**
• Potential to eliminate river pier construction and associated Health and Safety Risks, operational risks and costs.	• Feasibility unknown as the structure would span five times further than any existing FRP deck • Large design risk as there is minimal design standards and guidance. • Large fabrication risk • Procurement risk • The theoretical proposal suggests a 6m construction depth is required; hence, increasing the level of the structure, in turn increasing the length of the approach ramps. • Significantly increased deck clearance time.

LIST OF SUPPORTING DOCUMENTS:

References

ST_PJ585C-ATK-BAS-ZZ_21-DIA-ST-00004 (VE21 – Deck plate types comparison)

(Aerospace Engineering blog, 2013) Composite Materials and Renewables: Wind Energy on AUGUST 21, 2013 · in Composite Materials, Manufacturing, Novel Materials/Tailored Structures, Renewables. https://aerospaceengineeringblog.com/composite-materials-wind-energy/ retrieved 22/08/18

(Ascione et al 2016) - Prospect for New Guidance in the Design of FRP. Luigi Ascione, Jean-François Caron, Patrice Godonou,Kees van IJselmuijden, Jan Knippers, Toby Mottram, Matthias Oppe, Morten Gantriis Sorensen, Jon Taby, Liesbeth Tromp

(Cairns et. al., 2011) Cairns, D., Nelson, J., & Riddle, T. (2011). Wind Turbine Composite Blade Manufacturing: The Need for Understanding Defect Origins, Prevalence, Implications and Reliability. Montana State University, Department of Mechanical and Industrial Engineering. Albuquerque, NM: Sandia Corporation

(Gamesa Corporation, 2011) Gamesa Corporación Tecnológica. Gamesa Corporation. Viewed on 04. 12 2011 from Wind Turbines: http://www.gamesacorp.com/en/products-and-services/wind-turbines/productos-y-servicios-aerogeneradores-2catalo.html

(Kendall 2010) Technical and Economic Viability of FRP Bridges

(Kendall 2016) Future Potential for FRP composites

(Scenta, 2007) "How to make an elephant fly". Scenta. 31 July 2007. Archived from the original on 20 July 2011

IMPACT EVALUATION

COST BENEFIT

Item	Comments	Effect on CAPEX	Effect on OPEX
Design costs	The design cost of the structure would increase as a result of the unconventional material	Increase	No effect
Substructure cost	A single river span could negate the need for river piers. This would reduce materials and allow land-based construction	Decrease	Decrease
Superstructure cost	The cost of the proposed superstructure is not known. There is no known manufacturer of these FRP deck this size based in the UK. Therefore, costs may significantly increase.	Increase	Unknown

PROGRAMME BENEFIT

Item	Description	Effect on programme
Design	The design programme duration the structure would increase because of the unconventional material	Increase
Substructure	A single river span could negate the need for river piers. This would mean faster land-based construction could be adopted	Decrease
Superstructure	The effect of using an FRP superstructure on the programme is unknown. There is a significant programme risk for procuring the unconventional material and fabrication.	Unknown.

RISK EVALUATION

Item	Description	Effect on risk
Design	The design is more complex using unconventional materials with limited standards and guidance and as a result there are more risks of delays and unforeseen events during the design period	Increase
Substructure	Eliminating the river piers is a significant reduces programme risk during construction	Decrease
Superstructure	Using a material that is used significantly less in bridge construction than concrete and steel increases risk. A single span here would represent a fivefold increase in the current maximum FRP span.	Increase

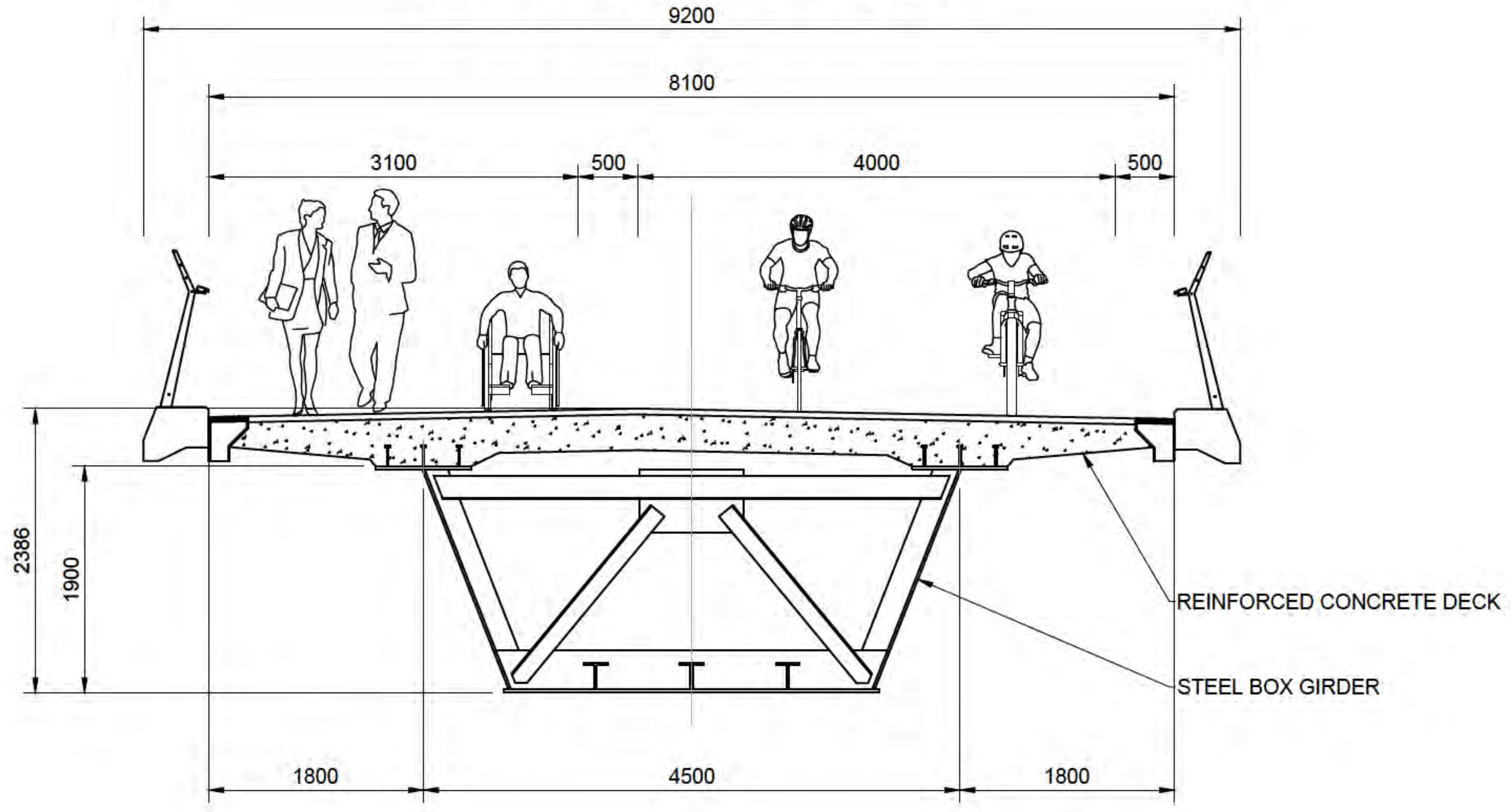
ENVIRONMENTAL

Item	Description	Effect on the environment
Construction	The programme impact evaluation conclusion is unknown. Reducing the construction period would be beneficial to the environment.	Unknown
Substructure	Reducing the deck weight and number of piers will reduce the quantity of substructure materials, decreasing the carbon footprint of the substructure.	Beneficial
Superstructure	The total embedded carbon of the superstructure is unknown.	Unknown
BUILDABILITY		
Substructure	Removal of the river piers significantly increases the buildability of the structure	Beneficial
Superstructure	A single span, precast deck, could be easier to build. However, the use of unconventional materials may add complexity.	Unknown
SAFETY		
Item	Description	Effect
River impact	Removal of piers in river eliminates risk of pier impact	Beneficial
Maintenance	Refer to section below	N/A
Construction	Refer to buildability section	N/A
OPERATIONS AND MAINTENANCE		
Item	Description	Effect
Lifting bridge	A single lifting span would be operationally different to lifting only the central 160m.	Unknown
Lifting mechanism replacement	If the deck is lighter, a smaller lifting mechanism would be adopted, reducing cost.	Unknown
Inspection	The bridge could be inspected from an underbridge unit located on the superstructure, eliminating the need for river-based inspection	Beneficial
Bearing replacement	Bearings would be replaced from land increasing safety and reducing cost	Beneficial
Painting	An FRP deck theoretically would not need repainting. However, other methods of repair may be required instead	Unknown

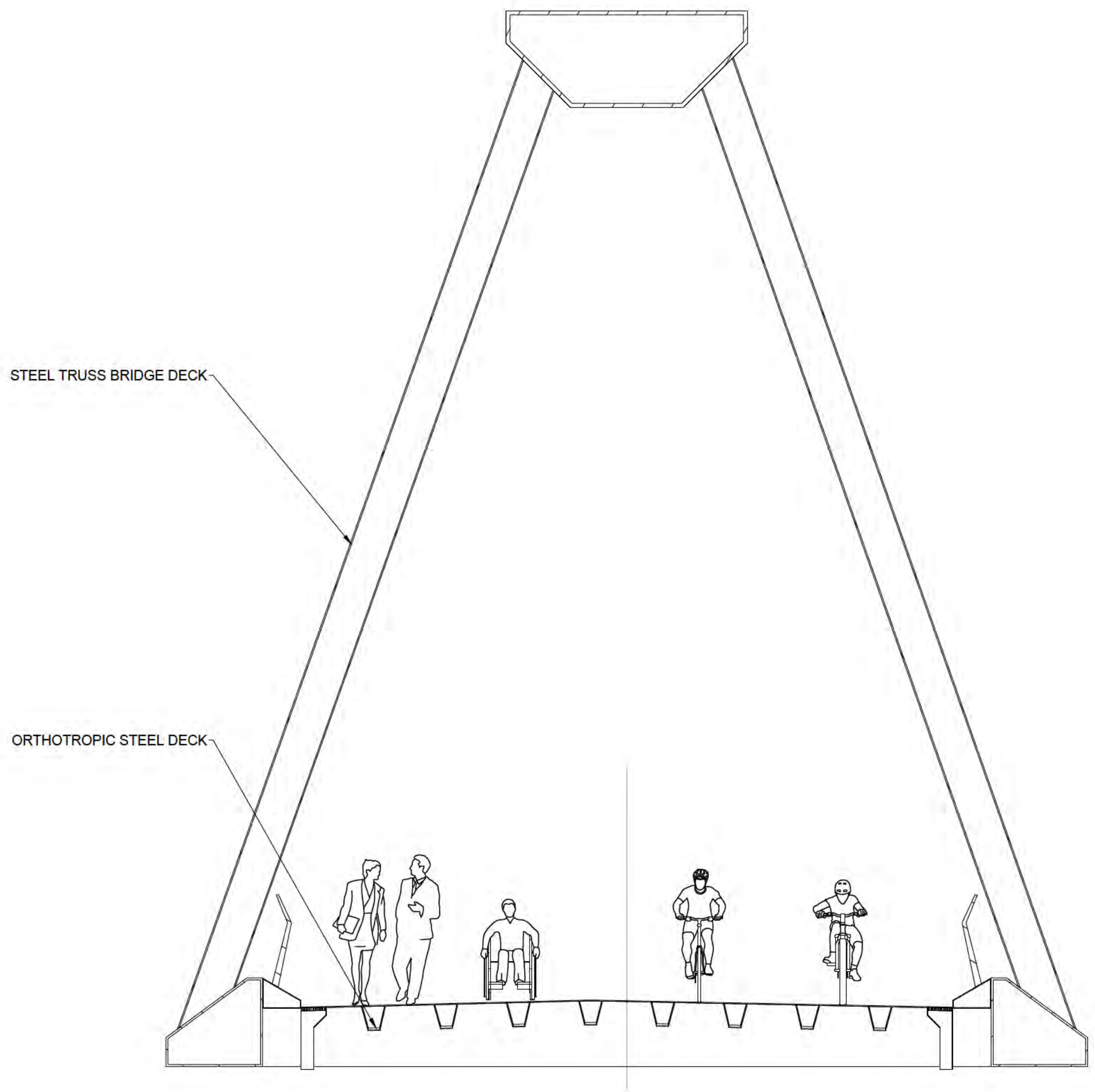
ACCEPTANCE		
Prepared: [redacted]	**Name:** [redacted]	**Signed:** [redacted]
Proposal Implemented:	**Further investigation required**	
Approved by:	**Name:**	**Signed:**
IMPLEMENTATION		
COMMENTS / ACTIONS		

To be completed by TfL

CONCEPT DESIGNS

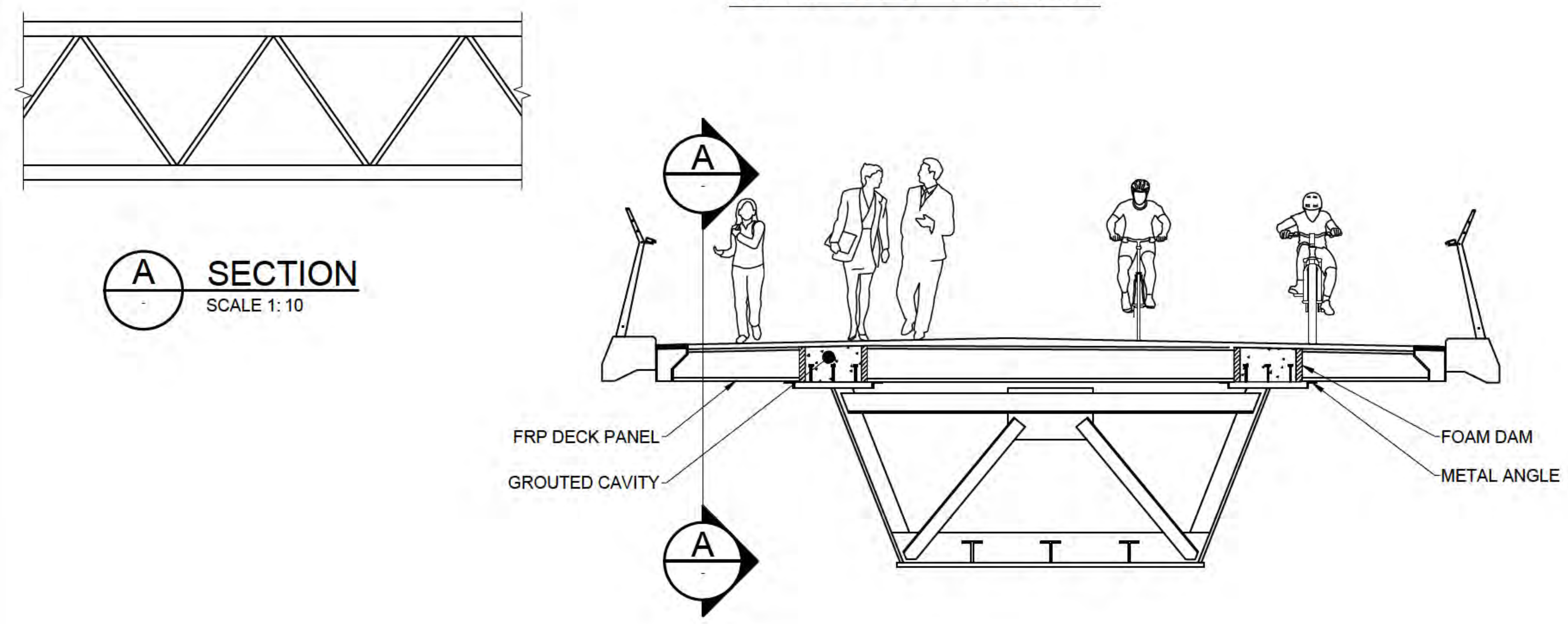


APPROACH SPANS STEEL/CONCRETE COMPOSITE DECK

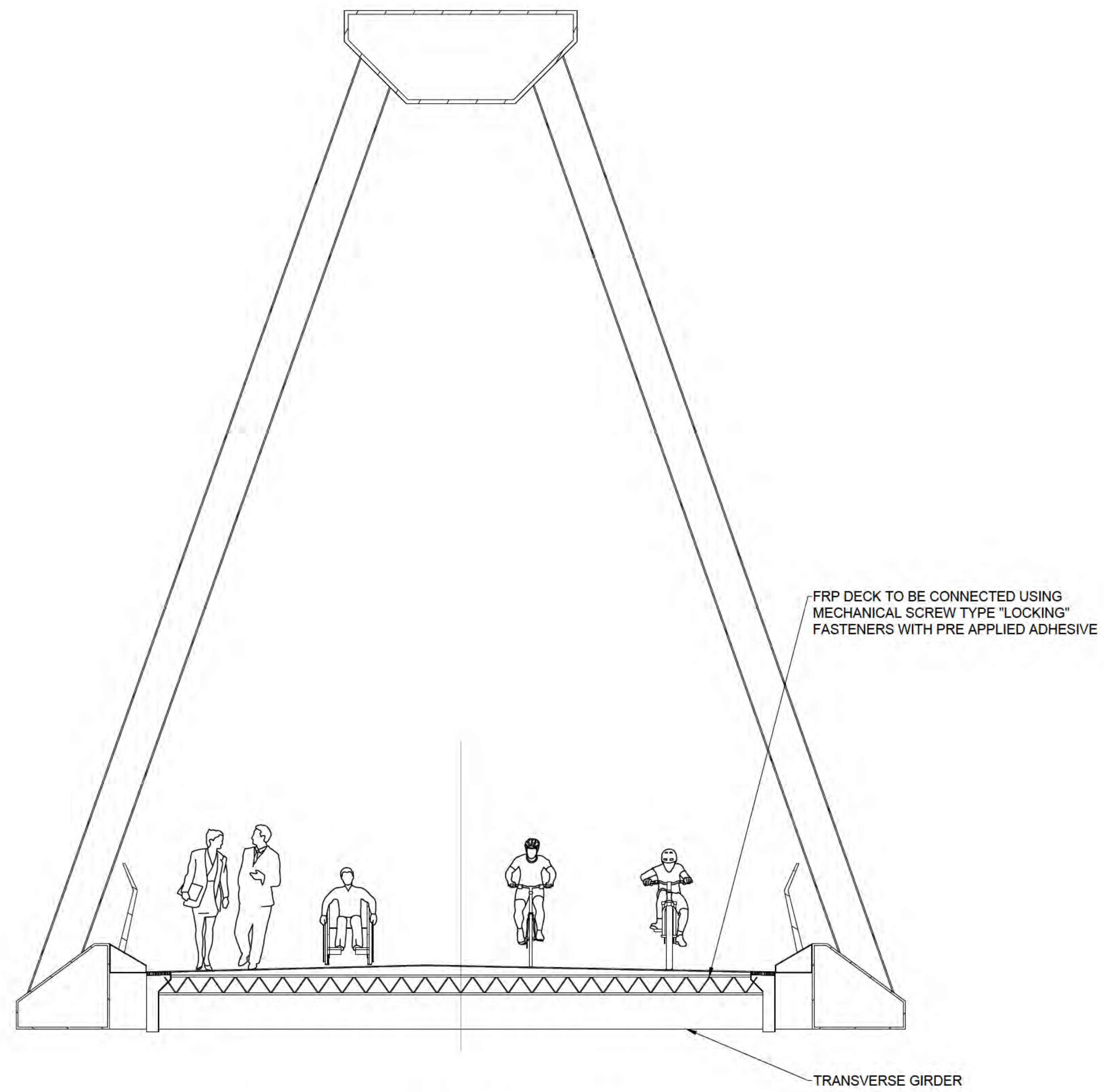


MAIN SPAN STEEL ORTHOTROPIC DECK PLATE

VE PROPOSALS



APPROACH SPANS FRP DECK PLATE



MAIN SPAN FRP DECK PLATE

NOTE:- REFER TO APPENDIX - A & B FOR DIMENSIONS, LEVELS & OTHER DETAILS.

rev	date	details	drn	chk	app
P01.1	—	FIRST ISSUE			

borough: Multiple Boroughs

scheme: R2CW RIVER CROSSING VE21 DECK PLATE TYPES COMPARISON

Transport for London
TfL Engineering
Surface Transport

Palestra
197 Blackfriars Road
London SE1 8NJ

DRAFT

date	scale	drn	chk	app	sheet no
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suitability: S0 WORK IN PROGRESS

revision: P01.1

drawing No: ST_PJ585C-ATK-BAS-ZZ_21-DIA-ST-00004
(project | owner | asset | location | type | role | number)

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SENSITIVE INFORMATION

DO NOT SCALE

Rotherhithe to Canary Wharf River Crossing

VALUE ENGINEERING ASSESSMENT FORM	DATE: 22/08/2018

- *Item Ref: VE23 – Steel truss-type tower*
- *Reference: ST_PJ585C-ATK-BAS-ZZ_12-REP-ZZ-00001*

SUMMARY DESCRIPTION OF VE PROPOSAL

The baseline design considers steel sections for the 80m tall tower proposed for the vertical lift of the bridge deck. The steel plate of 80mm thick is considered in the baseline design for the towers (Ref.: ST_PJ585C-ATK-BAS-ZZ_09-DRG-ST-00003). It will be fabricated to the desired shape and installed with significant stiffener rings/diaphragms at the intermediate floors of the stairs, approx. 4m to control buckling. The provision of intermediate stiffeners rings/diaphragms in one of the tower will be complex to allow space proofing for the lift shaft. Painting of tower is required for maintenance and for better aesthetics. The current concept design for the towers has refined and it is currently 55mm thick section at the bottom and the section thickness varies gradually till the top of the tower (Refer Figure 1). The weight of the tower is approx. 900 tonnes of steel.

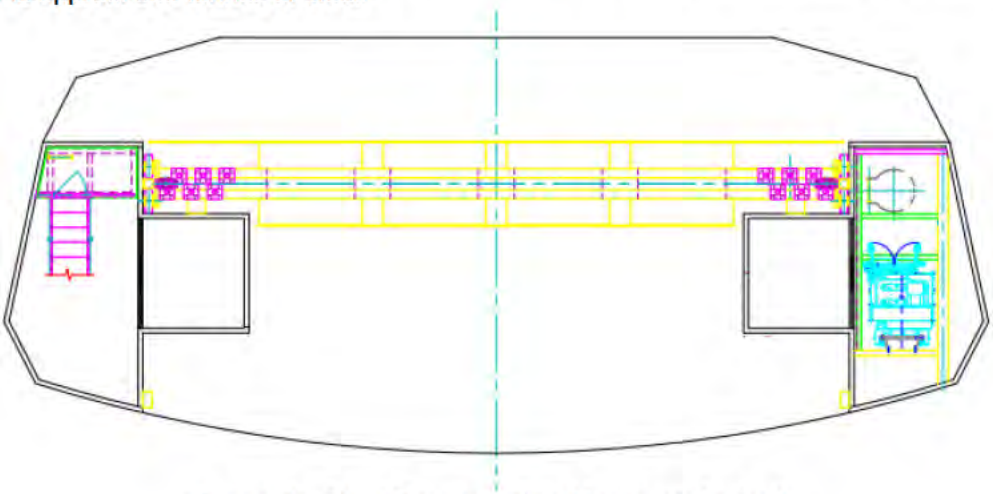


Figure 1 - Steel Tower option (Concept design)

The VE23 is to propose the steel truss tower for the 75m height and the top 5m will comprise of rotors, M&E equipments with a service floor deck. The current proposal of the truss tower comprises uniform CHS sections with bracings and can potentially be reduced along the height during the detailed design stage. For the steel truss option, the lift shaft & staircase are not considered as it is uneconomical and require higher space inside the truss. Ladders (to be attached at the rear side of the truss) separated by floors at various levels is considered for maintenance operations. The counterweights at either side will be split in two and will be located inside the truss tower with cable hangers & sheaves at top. The weight of the truss tower is approx. 250 tonnes of steel and is comparatively lesser than the steel plate tower.

For the VE proposal, CHS 600 x 25 section is considered for the main truss chords to satisfy the design checks, which can be optimised during the detailed design stage. Drawings with estimated section sizes can be seen in ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST00005 and ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST00006.

Note: This VE proposal requires a significant M+E redesign and rework on operational mechanism. Outstanding M+E design includes relocating spragging beams and balancing main span lift forces caused from separate counterweights.

ADVANTAGES:	DISADVANTAGES:
• Potential for significant savings in Tower construction & material costs • Significantly simpler fabrication than steel towers • Comparatively reduced wind load impact on the tower and on the foundation. • Total weight of the tower is reduced by 4.5 times in calculation of foundation loads.	• Increase in overall size of the tower will impact the aesthetics and is visually intrusive to the surroundings. • The truss form of the tower is not fitting with the Canary Wharf environment. • Two separate counter-weights are required on each side and needs to balance during deck lift operation. • Lift shaft or stairs inside the tower is not possible as it obstructs counterweight movement. They are to be replaced with ladders separated by floors at various levels.

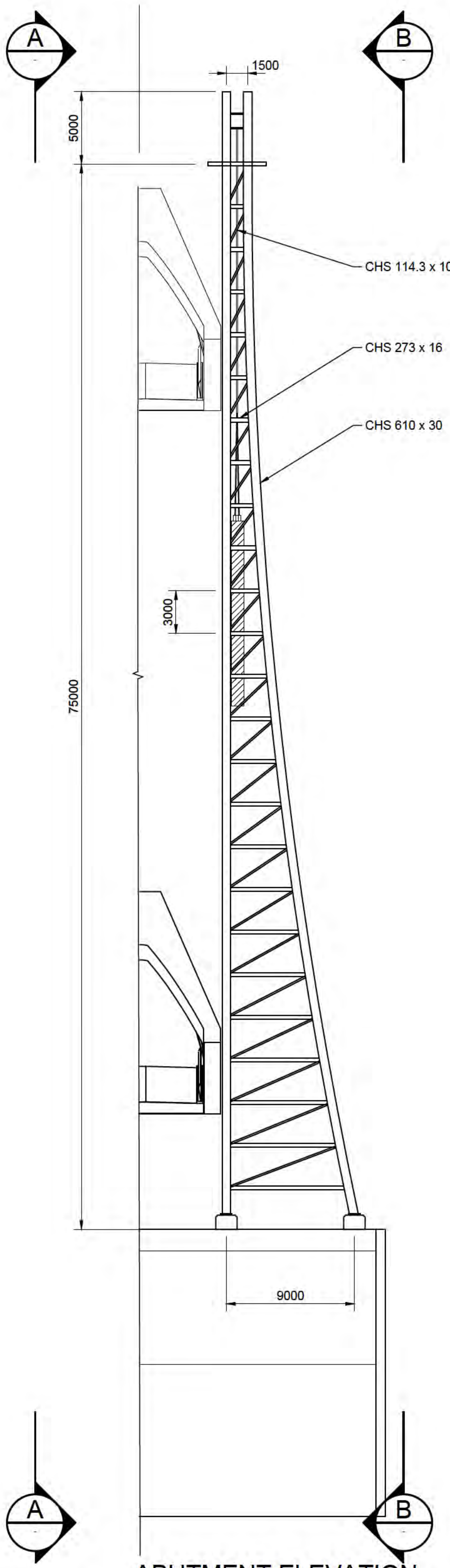
LIST OF SUPPORTING DOCUMENTS:

- ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00005 (Steel truss towers GA drawing 1 of 2)
- ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00006 (Steel truss towers GA drawing 2 of 2)

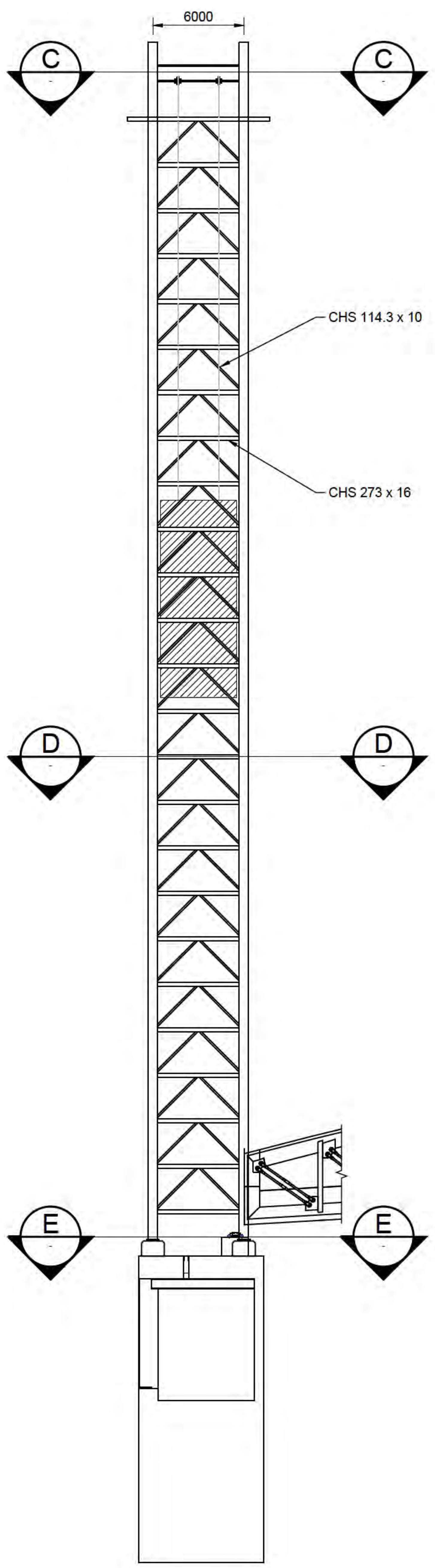
Reference: Salford Quay bridge truss towers

IMPACT EVALUATION
COST BENEFIT
An initial assessment has been made of the impact of reducing the overall mass of the materials and the impact on fabrication costs by adopting standard steel sections and allowing land-based construction. An additional allowance has been made for the provision of four rotatory motor drums to lift the bridge compared to two in the baseline design. It should be noted however that as has been identified above, this proposal will require a significant M+E redesign and operational concept rework, and it is not clear therefore what other impacts this may have on the costs of those elements. It is also possible that the reduction in wind load impact upon the foundations may result in a simplified foundation/pier design but at present no saving has been included for this. This exercise has currently generated an anticipated saving in EFC of £9.1 million but a significant amount of additional design development would need to be undertaken before a more informed and robust estimate of potential savings could be generated.
PROGRAMME BENEFIT
The steel truss could be constructed off site while the foundation is being cast at site, thus reducing the programme. Erection of tower in a single lift using heavy cranes will reduce the site possession time.
RISK EVALUATION
• Imbalance in appearance – large truss towers carrying a small deck. • Canary Wharf local authority consents require - does not fit in with surrounding environment. • TWAO consent risk. • Counterweight needs special buffer material at sides to avoid getting clash / pounding with main structural members during high winds.
ENVIRONMENTAL
Reducing the construction period would be beneficial to the environment. The reduction in the steel quantity of the substructure will reduce the carbon footprint. The painting of towers during future maintenance may have a little impact over the river water body.
BUILDABILITY
Construction of tall steel truss tower can be achieved by fabricating the truss elements in the factory, transporting to site in the form of segments / panels, assembling the segments near the site and erecting the tower in a single lift (either from land or from river using barges). Alternate option is to erect the truss tower at site in segments and assembling it using HSFG bolts.
SAFETY
Appropriate safety measures to be implemented at site for the installation of steel truss towers. There is a possibility of single lift erection using heavy cranes, as it will reduce work hours at site, site related HSE issues as well as to save possession time. Maintenance access to the top of the tower is achieved by ladders separated by floors at various levels. This is not preferable; however, Salford Quays Bridge Truss Tower adopts a similar methodology.
OPERATIONS AND MAINTENANCE

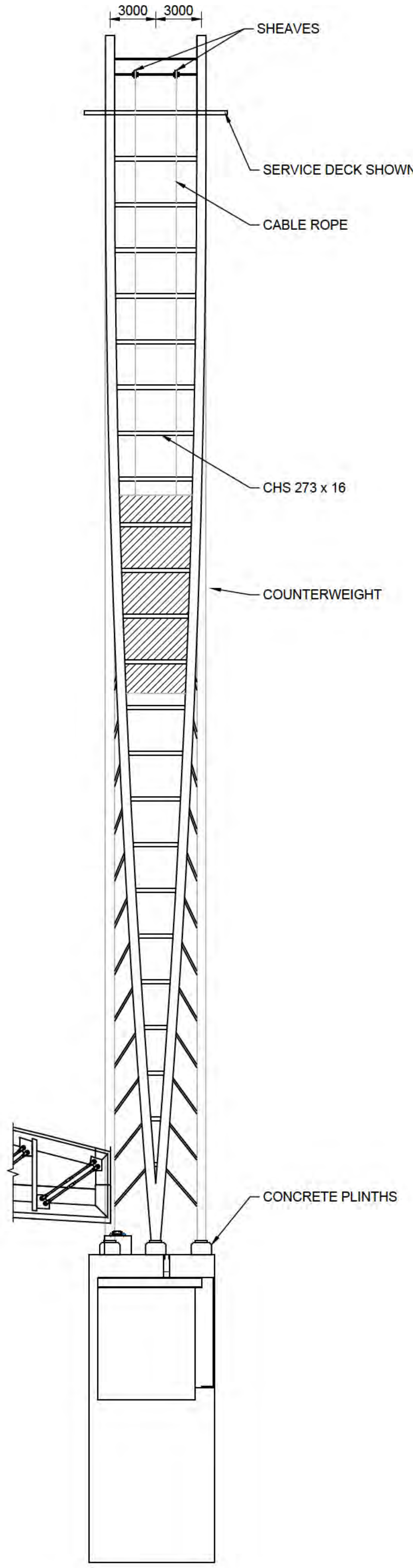
Steel truss tower requires periodical maintenance and needs painting or extensive corrosion protection measures. There is well enough space for inspection and maintenance and no issues with respect to ventilation. Maintenance access to the top of the tower is achieved by ladders separated by floors at various levels.		
ACCEPTANCE		
Prepared: [redacted]	**Name:** [redacted]	**Signed** [redacted]
Proposal Implemented:	**Y / N**	**(Delete as appropriate)**
Approved by:	**Name:**	**Signed:**
IMPLEMENTATION		
COMMENTS / ACTIONS		
To be completed by TfL		



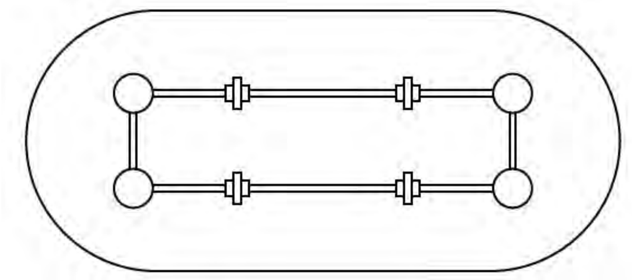
ABUTMENT ELEVATION
SCALE 1:250



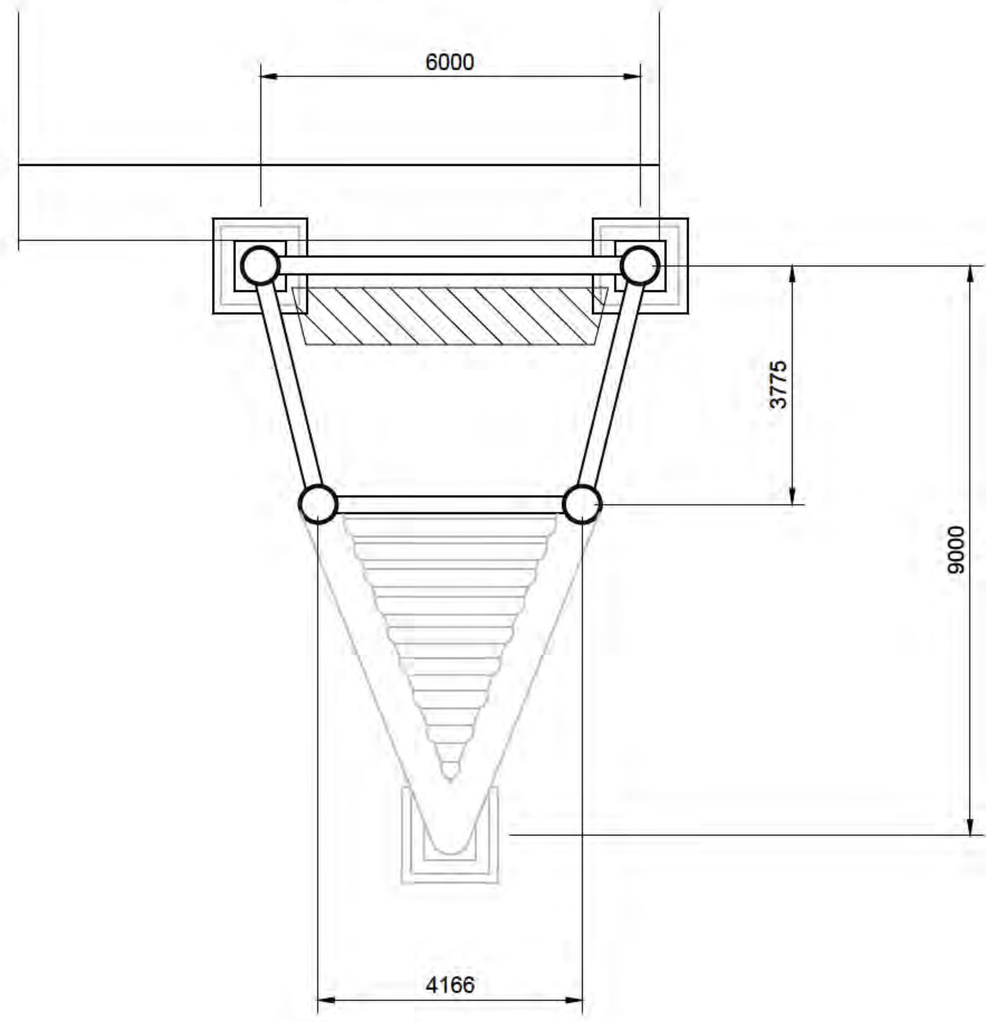
A ELEVATION
SCALE 1: 250



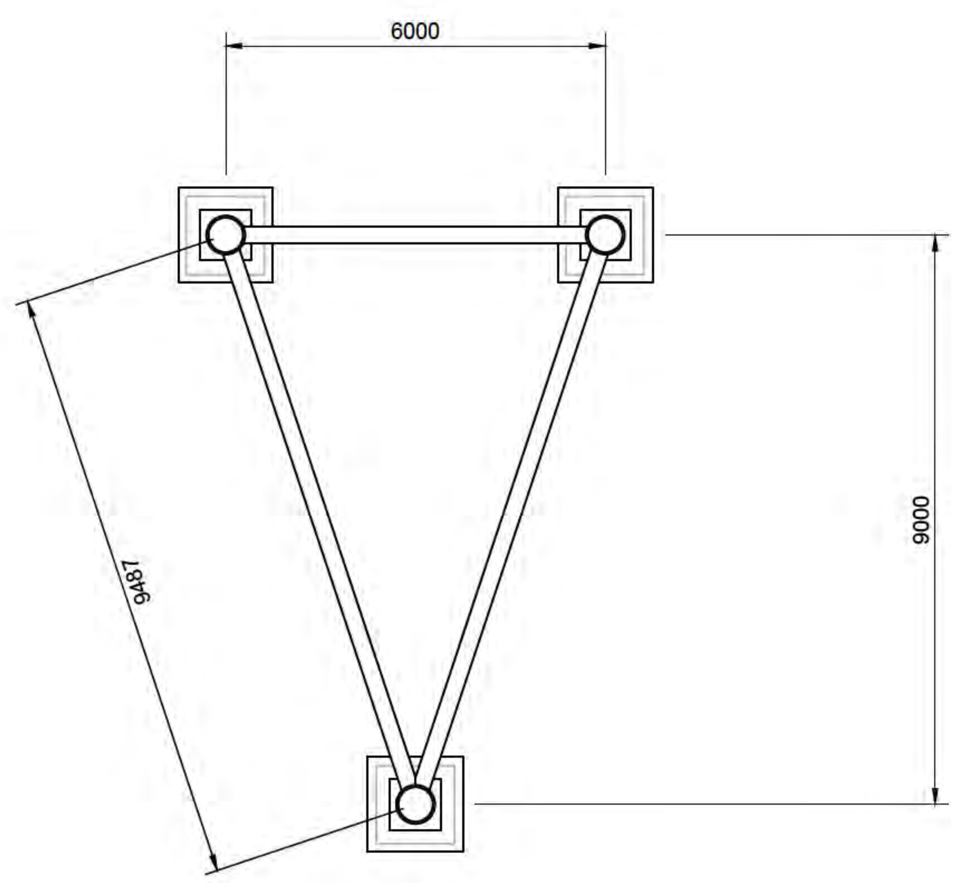
B ELEVATION
SCALE 1: 250



C SECTION
SCALE 1: 250



D SECTION
SCALE 1: 250



E SECTION
SCALE 1: 250

NOTES:
1. SERVICE LADDER AND M & E DETAILS NOT SHOWN.
2. WELDED CONNECTIONS PREFERRED.

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following:

CONSTRUCTION	MAINTENANCE/CLEANING	OPERATION	DEMOLITION
NONE	NONE	NONE	NONE

It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement

rev	date	details	drn	chk	app
P01.2	—	FIRST ISSUE			

borough: Multiple Boroughs

scheme: R2CW RIVER CROSSING
STEEL TRUSS TOWER

Transport for London
TfL Engineering

Traffic Design Engineering

Palestra
197 Blackfriars Road
London SE1 8NJ

DRAFT

date	scale	drn	chk	app	sheet no
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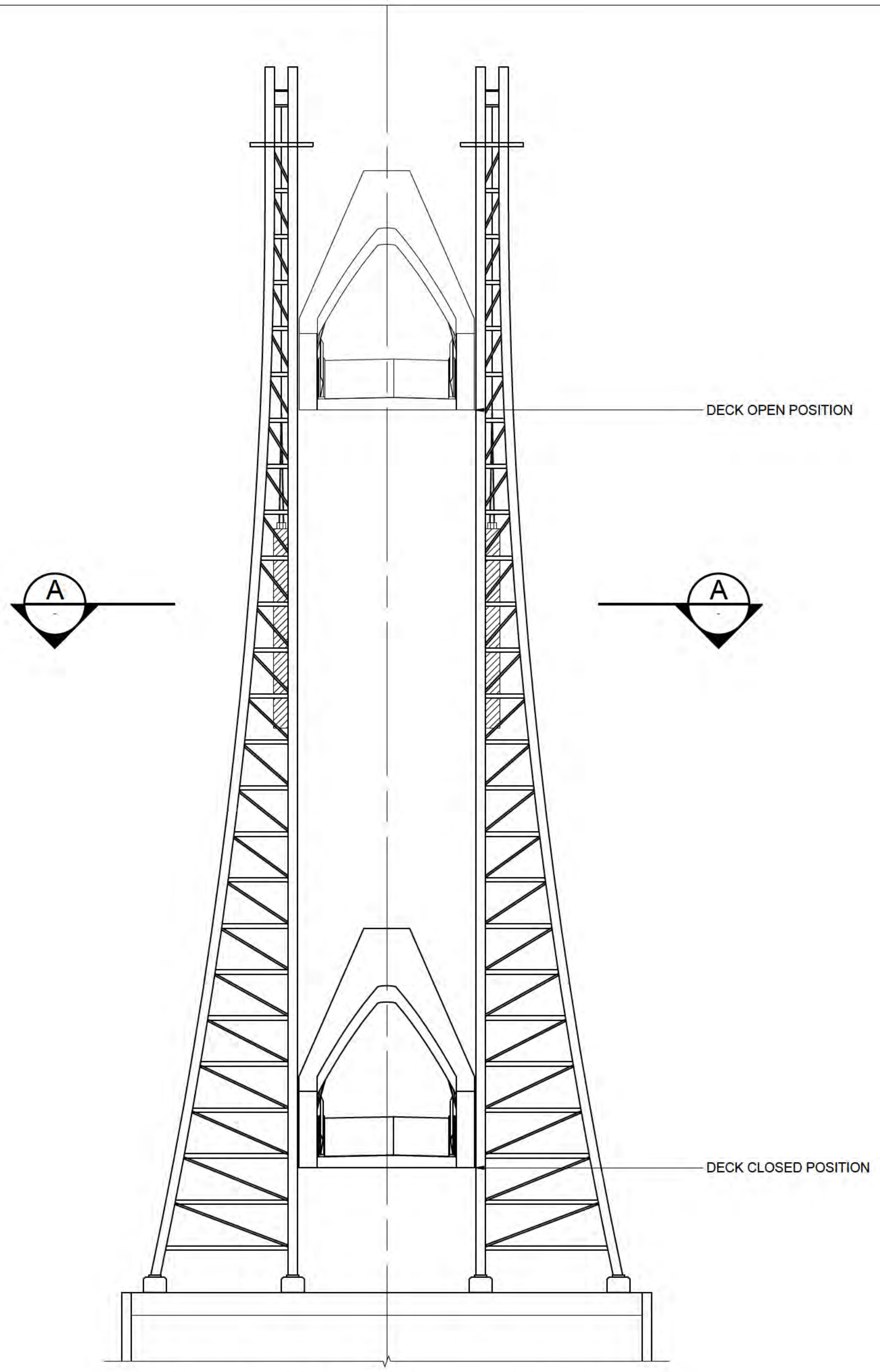
suitability: S0 WORK IN PROGRESS

revision: P01.2

drawing No: ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00005
(project - owner - asset - location - type - role - number)

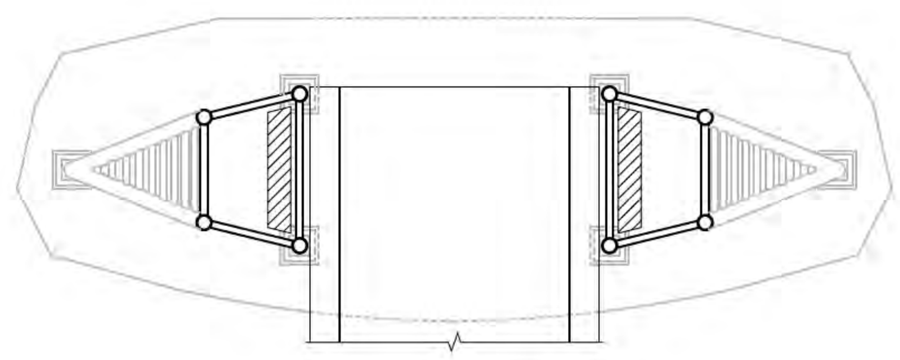
FILE REF: C:\projectwise\tfl\dms22908\ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00005.dwg ¦ USER: Sinfield, Chris ¦ DATE: 2018 Oct 03 5:25

DO NOT SCALE



ELEVATION OF TOWER FROM WALKWAY

SCALE 1:250



A SECTION

SCALE 1: 250

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION			
In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following:			
CONSTRUCTION	MAINTENANCE/CLEANING	OPERATION	DEMOLITION
NONE	NONE	NONE	NONE
It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement			

rev	date	details	drn	chk	app
P01.2	—	FIRST ISSUE			

Transport for London
TfL Engineering
Traffic Design Engineering

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197 Blackfriars Road
London SE1 8NJ

DRAFT

borough: Multiple Boroughs

scheme: R2CW RIVER CROSSING STEEL TRUSS TOWER

date	scale	drn	chk	app	sheet no
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suitability: S0 WORK IN PROGRESS

revision: P01.2

drawing No: ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00006
(project | owner | asset | location | type | role | number)

FILE REF: C:\projectwise\tfl\dms22908\ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00006.dwg ¦ USER: Sinfield, Chris ¦ DATE: 2018 Oct 03 5:27

SENSITIVE INFORMATION

DO NOT SCALE

Rotherhithe to Canary Wharf River Crossing

VALUE ENGINEERING ASSESSMENT FORM	DATE: 22/08/2018

- *Item Ref: VE24 – Concrete tower – jump form, slip form or precast construction*

SUMMARY DESCRIPTION OF VE PROPOSAL

The baseline design considers steel sections for the 80m tall tower proposed for the vertical lift of the bridge deck. The steel plate of 80mm thick is considered in the baseline design for the towers (Ref.: ST_PJ585C-ATK-BAS-ZZ_09-DRG-ST-00003). It will be fabricated to the desired shape and installed with significant stiffener rings/diaphragms at the intermediate floors of the stairs, approx. 4m to control buckling. The provision of intermediate stiffeners rings/diaphragms in one of the tower will be complex to allow space proofing for the lift shaft. Painting of tower is required for maintenance and for better aesthetics.

The current concept design for the towers has refined and it is currently 55mm thick section at the bottom and the section varies gradually till the top of the tower (Refer Figure 1). The weight of the tower is approx. 900 tonnes of steel.

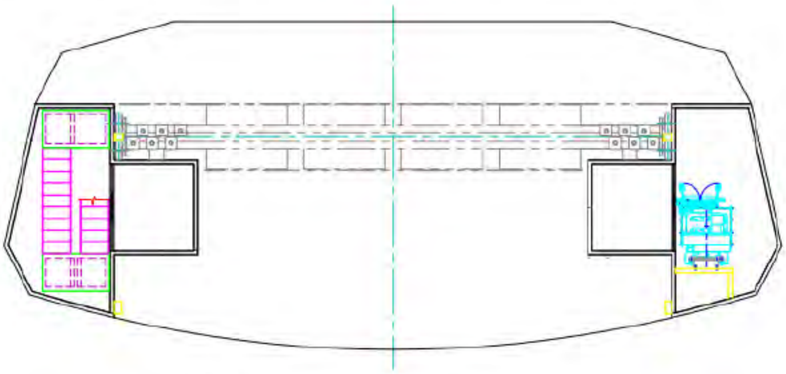


Figure 1 Steel Tower option (Concept design)

The VE24 is to propose the concrete tower for the 75m height and the top 5m (an aesthetic requirement) will comprise of steel frames with cladding arrangement (possibly aluminium cladding for longer shelf life) and do not carry any bridge loads. The concrete tower is currently assumed as 600mm thick uniform section and can potentially be reduced along the height during the detailed design stage. For the concrete option, the width & length of the pier must be increased to satisfy the M&E spacing requirements, stairs and lift shaft. The total weight of the reinforced concrete tower is approx. 2500 tonnes, which is nearly 2.8 times heavier than steel tower option.

For the VE proposal, HYSD (High Yield Strength Deformed) bars of 40mm diameter bars at 150mm c/c spacing in 2 layers (reduced to single layer at top 25m height of the tower) is considered to satisfy the design checks, which can be optimised during the detailed design stage.

For concrete towers, small openings are required at top of the tower (Refer Figure 2) to install M&E items such as spragging beams, lift pins / locks and needs access from inside of the tower for inspection and maintenance.

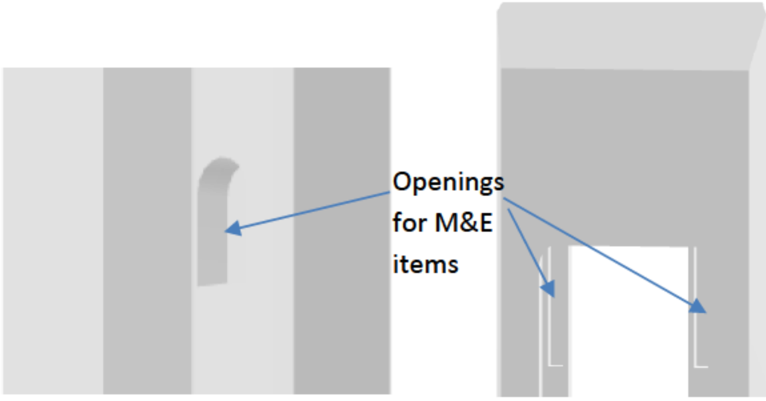


Figure 2 Minor openings at top of the tower for M&E items

The General Arrangement drawings for the concrete tower can be seen in ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00001, ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00002 and ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00003

For the Post-tensioned concrete options, the concrete tower can be built using precast segments (fabricated at precast yard) with post-tensioning strands / PT threaded bars with a similar cross-section. The precast option will reduce the programme time and reduced working hours at site leads to improved health and safety.

ADVANTAGES:	**DISADVANTAGES:**
• Potential for significant savings in Pier construction & material costs • Potential in reducing operational risks and maintenance costs. • The steel tower design requires intermediate bracing/stiffener rings/diaphragm at 4m (approx.). In the concrete tower design no intermediate bracings/stiffener rings/diaphragms are required. • Considering higher mass & stiffness, the concrete tower will be subjected to reduced lateral deflection than the steel towers due to wind loads.	• Marginal increase in main span by 1.36m • Construction time may be comparatively higher than steel tower in case of in situ construction • Increase in size of the tower will impact the aesthetics • Openings required for spragging beams and M&E access, depending on construction methodology this could require additional formwork at height to create minor opening in the face of the concrete towers. • Total weight of the tower increases by nearly 2.8 times in calculation of foundation loads. Increase in foundation loads would lead to significantly larger foundations.

LIST OF SUPPORTING DOCUMENTS:

- ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00001 (Concrete tower GA drawing sheet 1 of 3)
- ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00002 (Concrete tower GA drawing sheet 2 of 3)
- ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00003 (Concrete tower GA drawing sheet 3 of 3)
- VE24 - Concrete towers with the current truss bridge deck (from concept design) - Rendered Views

IMPACT EVALUATION

COST BENEFIT

An initial assessment has been made of the impact of implementing the proposals described above.

This exercise has currently generated a potential saving in EFC of £21.2 million.

However, in the absence of any identified proposals, no allowance has currently been included for potential additional works required to the foundation/pier design arising from the additional dead load imposed by the 2.5 times heavier tower structures. This cost could be extremely significant and there are other "knock-on" effects that could potentially add further costs and reduce that saving. It is to note that the mentioned saving would be potentially reduced by the increase in foundation requirements.

It should also be noted that this assessment is made against the CB5-CA5 baseline estimate which retained the steelwork masses of the original Arcadis design (700t per tower). Ongoing development of the design has resulted in an increase in that weight which could theoretically mean that the substitution of concrete towers versus the Concept Design proposals could generate a greater saving, although a significant amount of additional design development would need to be undertaken before a more informed and robust estimate of potential savings could be generated.

PROGRAMME BENEFIT

Based on the Arcadis baseline programme the steel towers would take 6 months to erect per pair. The towers could be completed by jump forming within this same duration.

RISK EVALUATION

- Has the potential to make foundations very wide, although this is likely to be governed by ship impact requirements.
- Increase in tower weight.
- Imbalance in appearance – large piers carrying a small deck.
- Canary wharf local authority consents require - does not fit in with surrounding environment.
- TWAO consent risk.
- Increase in foundation size due to concrete tower weight may potentially impact on the Jubilee Line Tunnels.
- Open space available for inspection access will have to be carefully considered; however, it is envisaged that the same as the steel tower can be achieved.

ENVIRONMENTAL

Cast in place construction option of concrete towers and associated temporary works in the Thames river needs concordance from the Environmental agency & water body. However, it is anticipated the high-risk item is in the foundation construction, which remains the same.

As painting of towers is not required for the concrete option, it reduced the impact on the river water body.

BUILDABILITY

Construction of tall concrete tower can be achieved by cast in place construction using jump / climbing formwork (involves significant amount of time) or precast segments (comparatively lesser duration) attached using epoxy grout.

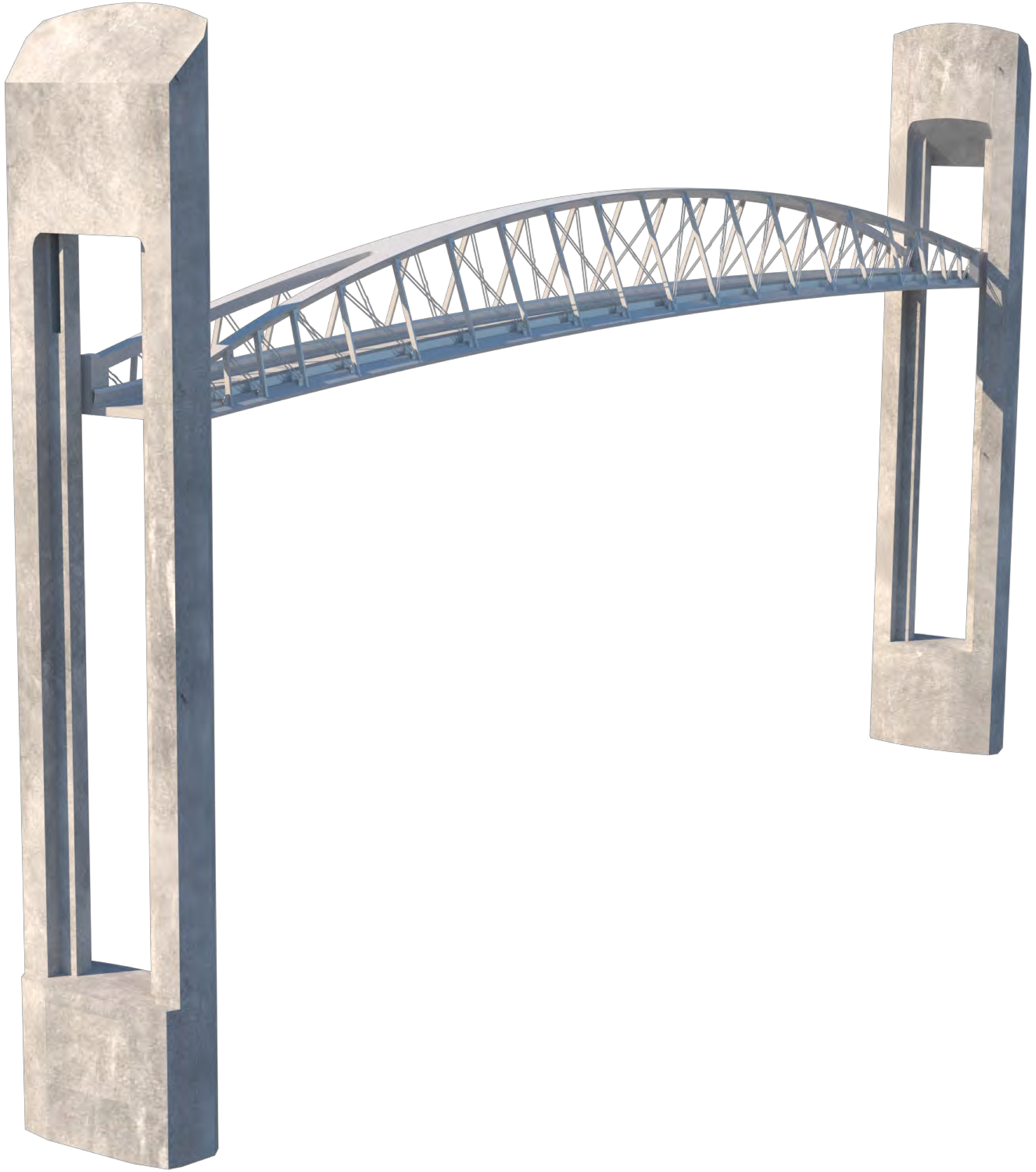
SAFETY

Necessary safety measures to be implemented at site for jump formwork construction of tower.

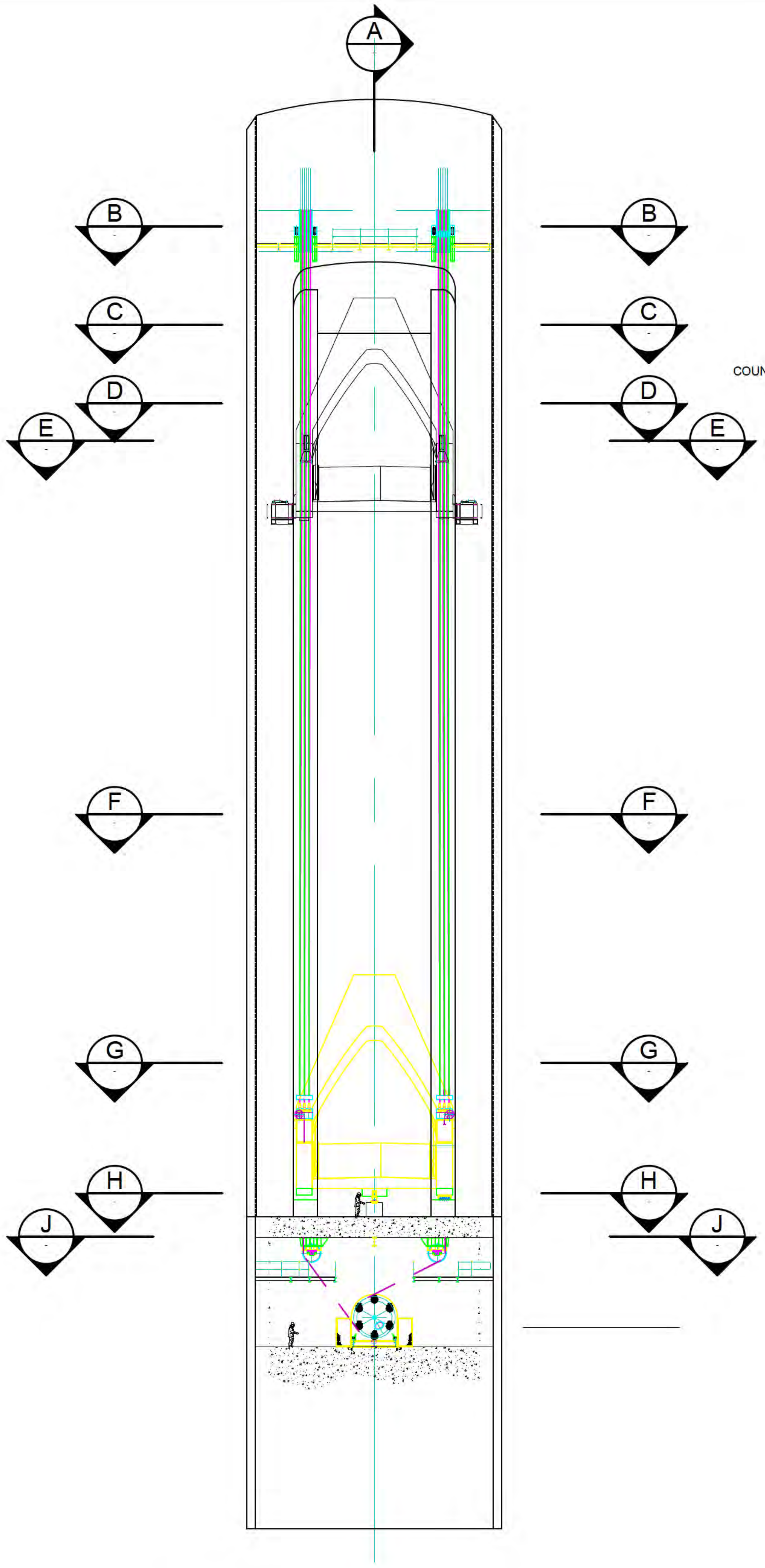
The additional form work to create minor openings at the face of the concrete towers (refer Figure 2) is applicable for cast in place construction method (disadvantage concerns about assembling & dismantling of form work at 60 ~ 65m height) and may not be an issue for precast solutions. Costain have suggested that there are equal challenges and risks associated to steel tower construction. And that all foreseen risks can be mitigated on both steel and concrete tower construction.		
OPERATIONS AND MAINTENANCE		
Concrete tower requires less maintenance than steel towers and did not require painting or extensive corrosion protection measures. However, this advantage is lost if any architectural cladding is required and the proposal currently considers aluminium cladding at the top of the tower.		
ACCEPTANCE		
Prepared: [redacted]	**Name:** [redacted] **A**	**Signed:** [redacted]
Proposal Implemented:	**Y / N** **(Delete as a**[redacted]	
Approved by:	**Name:**	**Signed:**
IMPLEMENTATION		
COMMENTS / ACTIONS		
To be completed by TfL		

VE24 - Concrete towers with the current truss bridge deck (from concept design) - Rendered Views

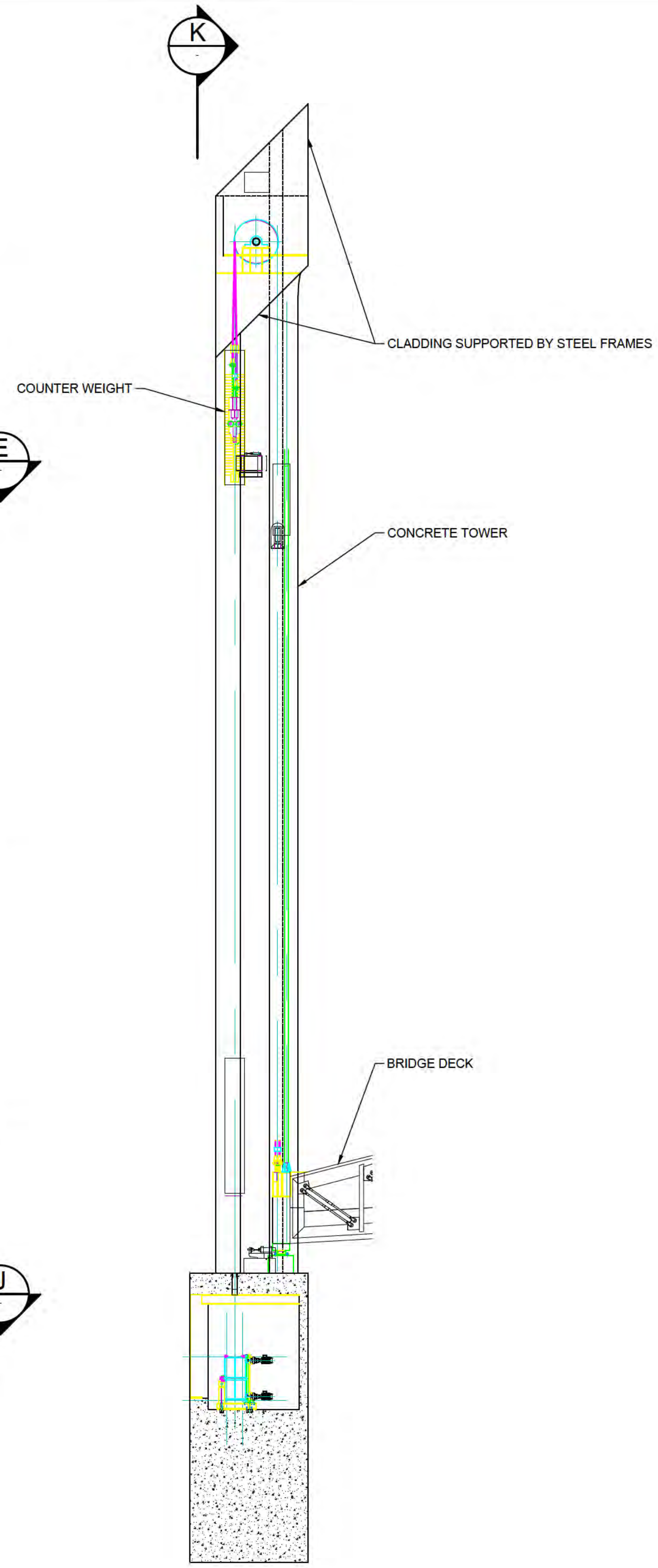
VE24 - Concrete towers with the current truss bridge deck (from concept design) - Rendered Views



VE24 - Concrete towers with the current truss bridge deck (from concept design) - Rendered Views



FRONT ELEVATION OF TOWER
SCALE: 1:250



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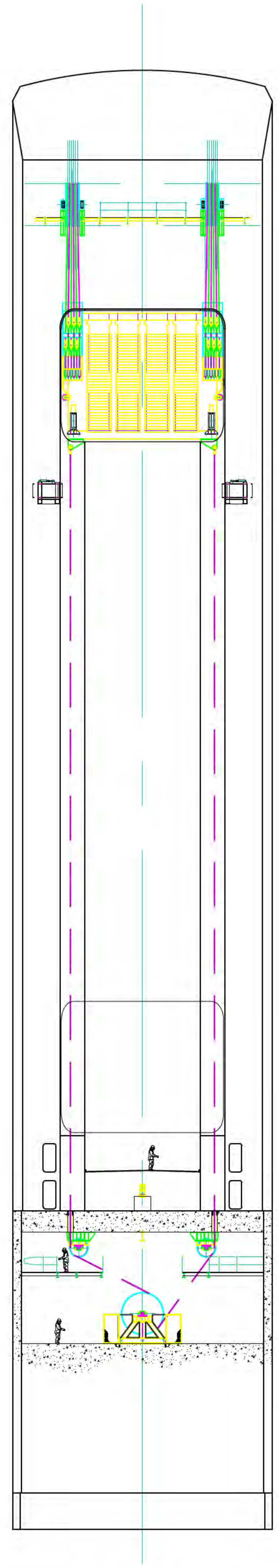

K SECTION
SCALE 1: 250

SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION			
In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following:			
CONSTRUCTION	MAINTENANCE/CLEANING	OPERATION	DEMOLITION
NONE	NONE	NONE	NONE
It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement			

rev	date	details	drn	chk	app
P01.1	—	FIRST ISSUE			

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DRAFT

borough: Multiple Boroughs

scheme: ROTHERHITHE TO CANARY WHARF CROSSING CONCRETE TOWER ELEVATIONS

date	scale	drn	chk	app	sheet no
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suitability: S0 WORK IN PROGRESS

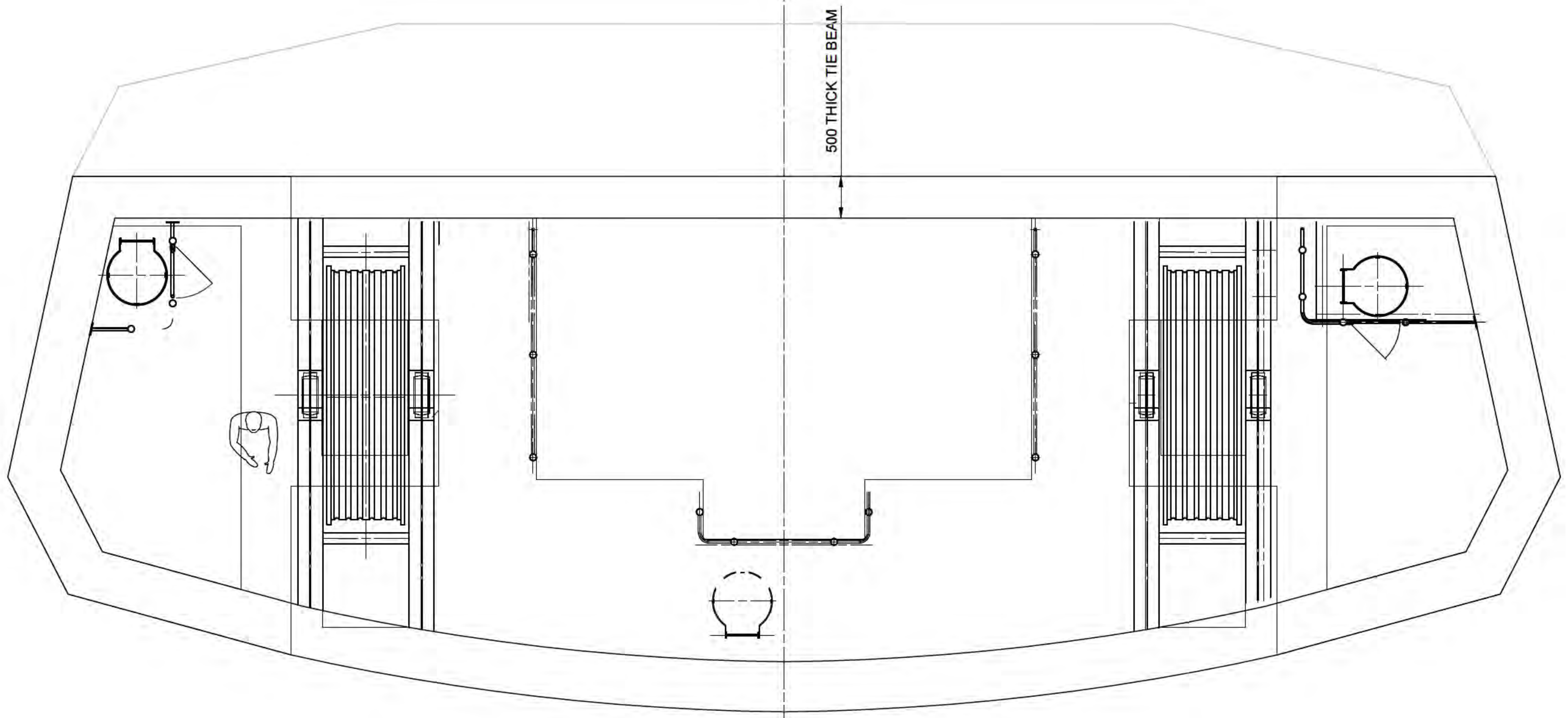
revision: P01.1

drawing No: ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00001 (project / owner / asset / location / type / role / number)

FILE REF: C:\projectwise\tfl\dms22908\ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00001.dwg | USER: Ellis, James | DATE: 2018 Aug 24 4:16

SENSITIVE INFORMATION

DO NOT SCALE



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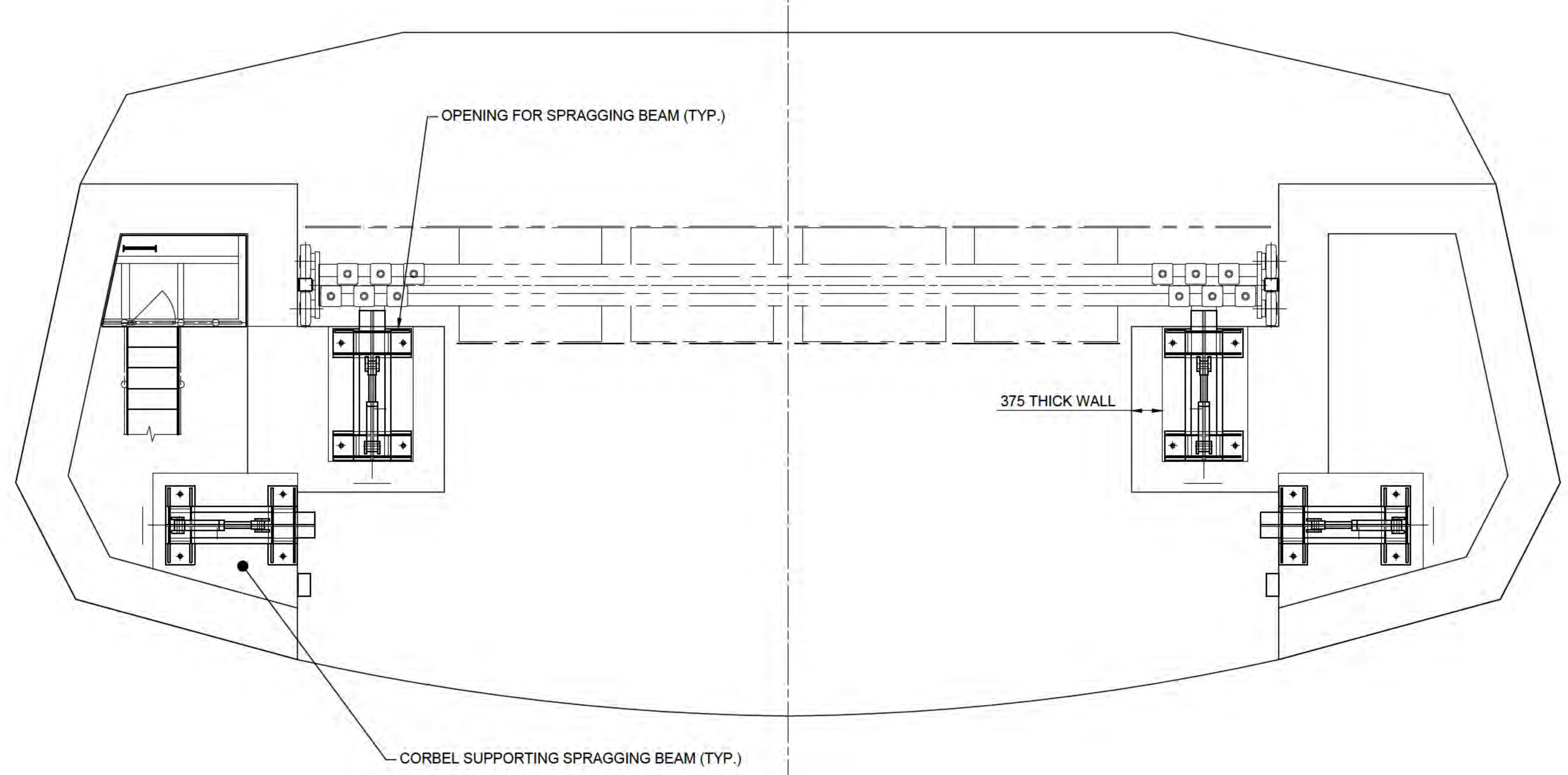

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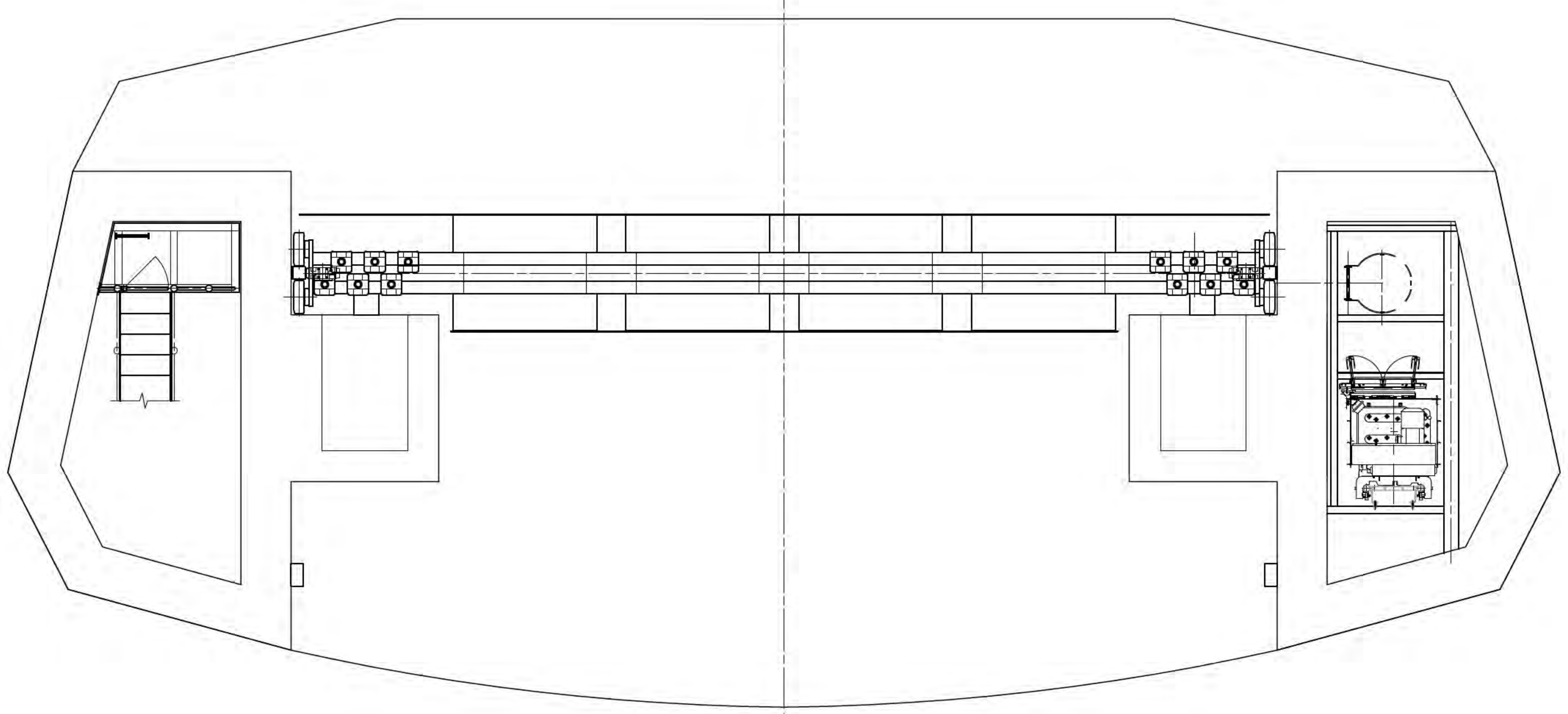

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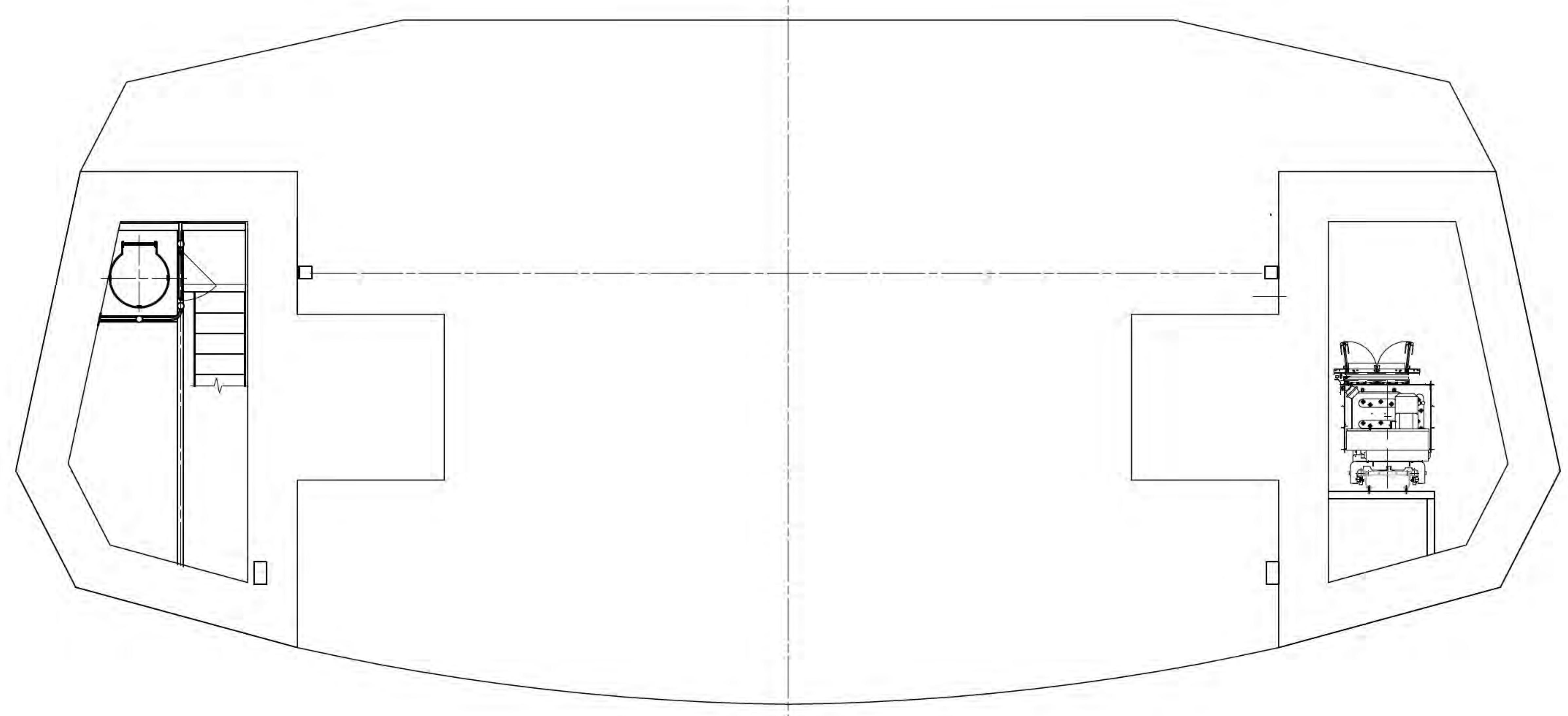

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SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following:

CONSTRUCTION	MAINTENANCE/CLEANING	OPERATION	DEMOLITION
NONE	NONE	NONE	NONE

It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement

rev	date	details	drn	chk	app
P01.1		FIRST ISSUE			

borough: Multiple Boroughs

scheme: ROTHERHITHE TO CANARY WHARF CROSSING CONCRETE TOWER SECTIONS

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date	scale	drn	chk	app	sheet no
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suitability: S0 WORK IN PROGRESS

revision: P01.1

drawing No: ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00002
(project - owner - asset - location - type - role - number)

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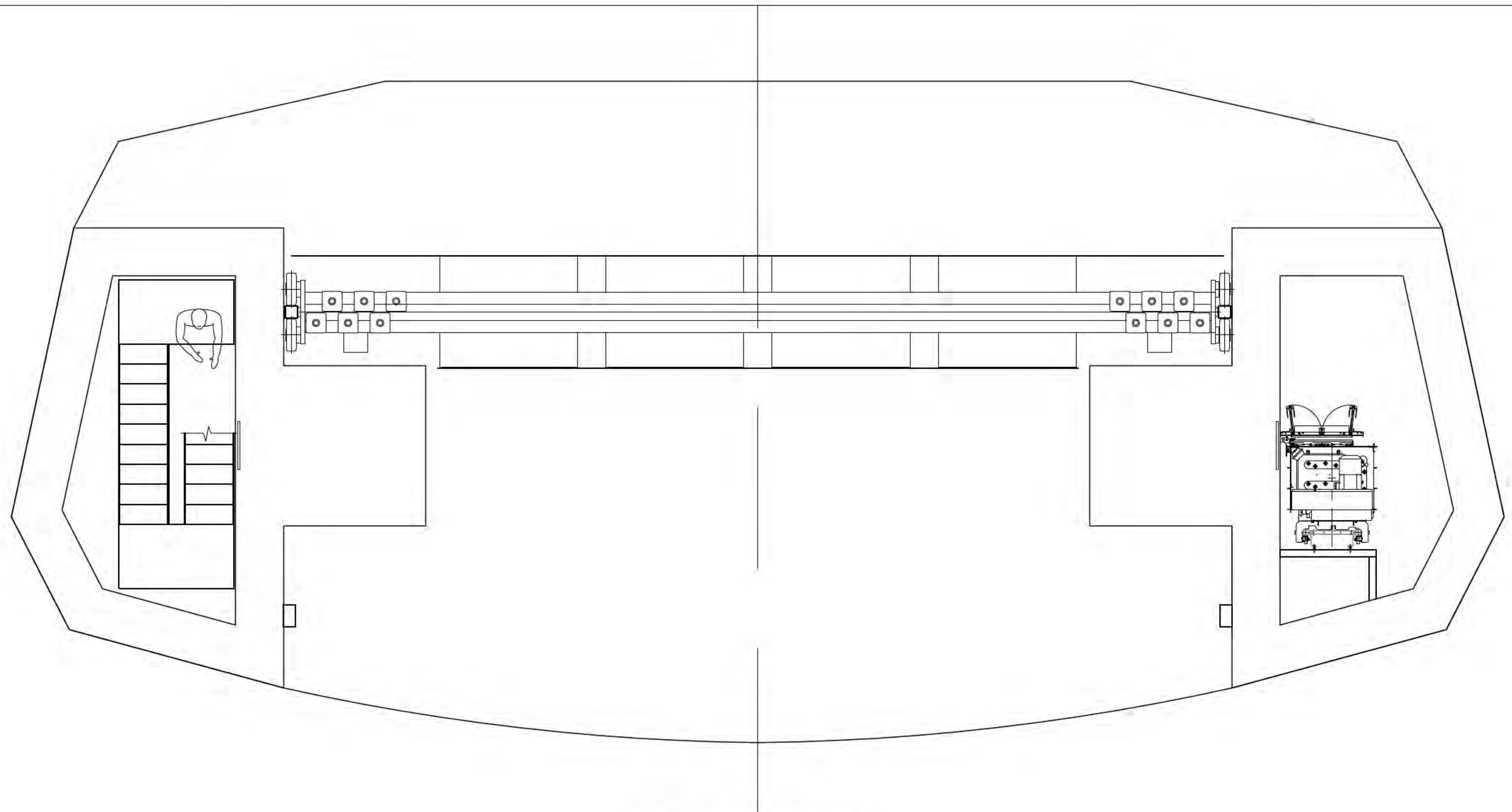

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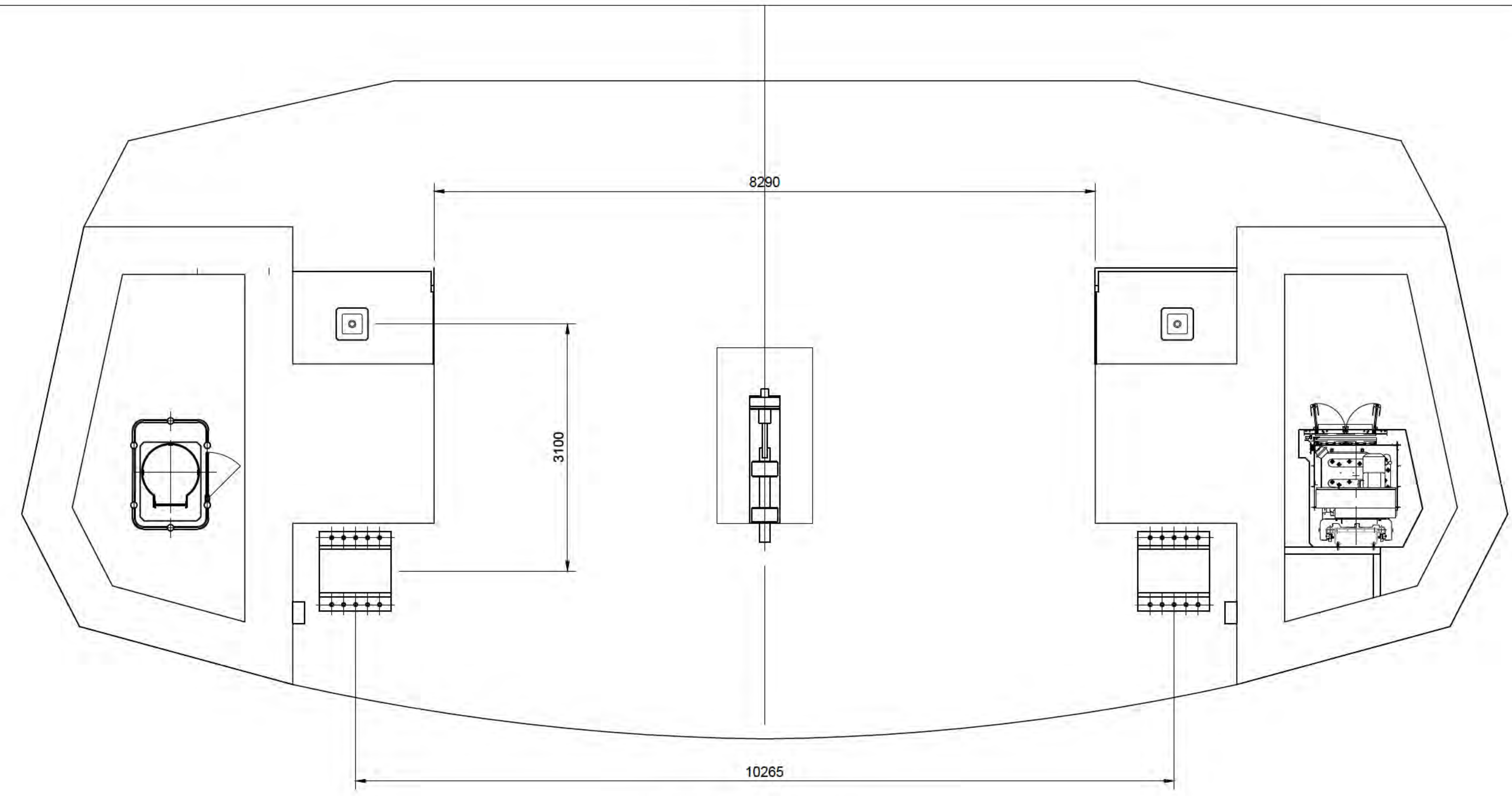

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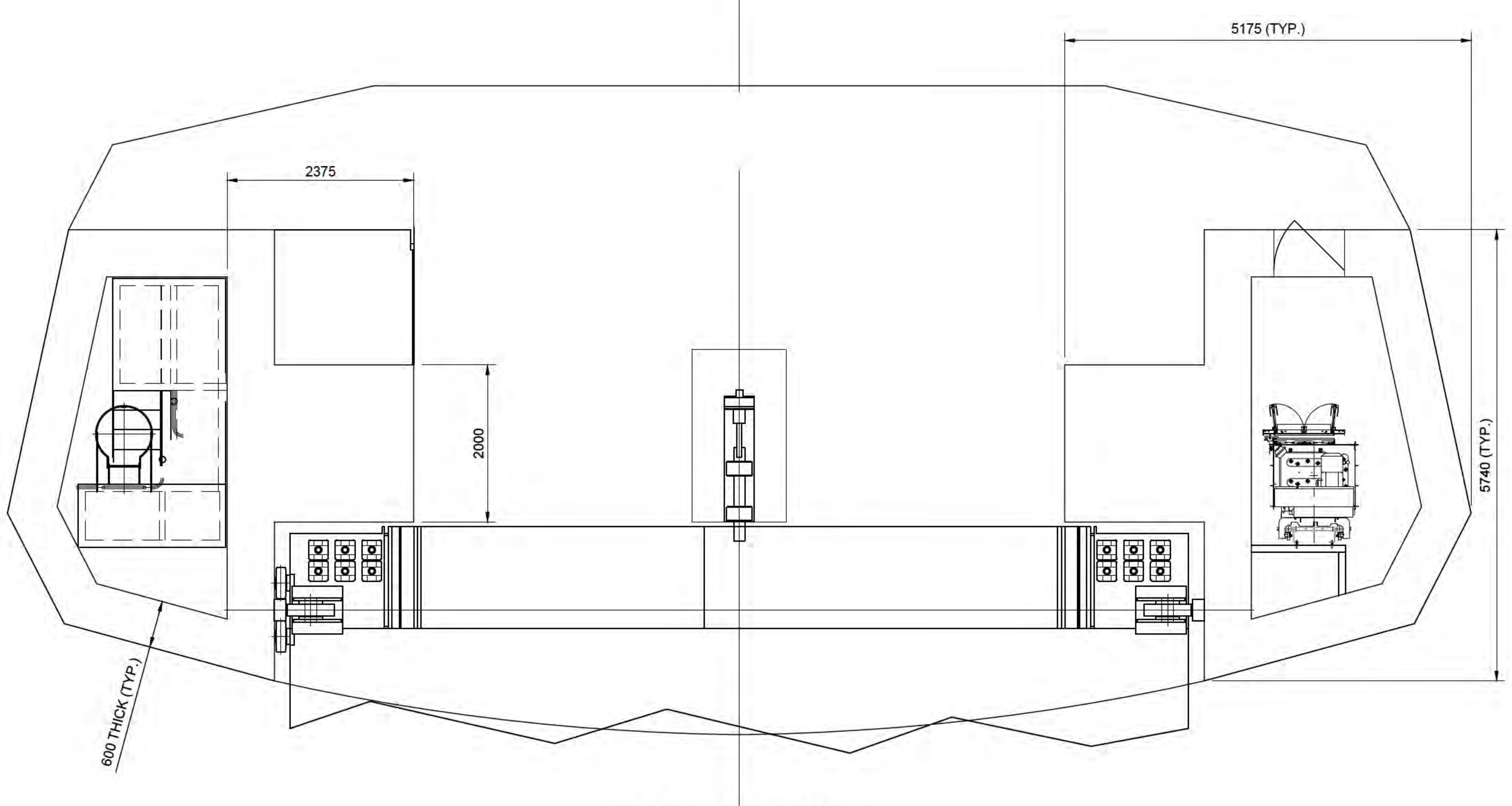

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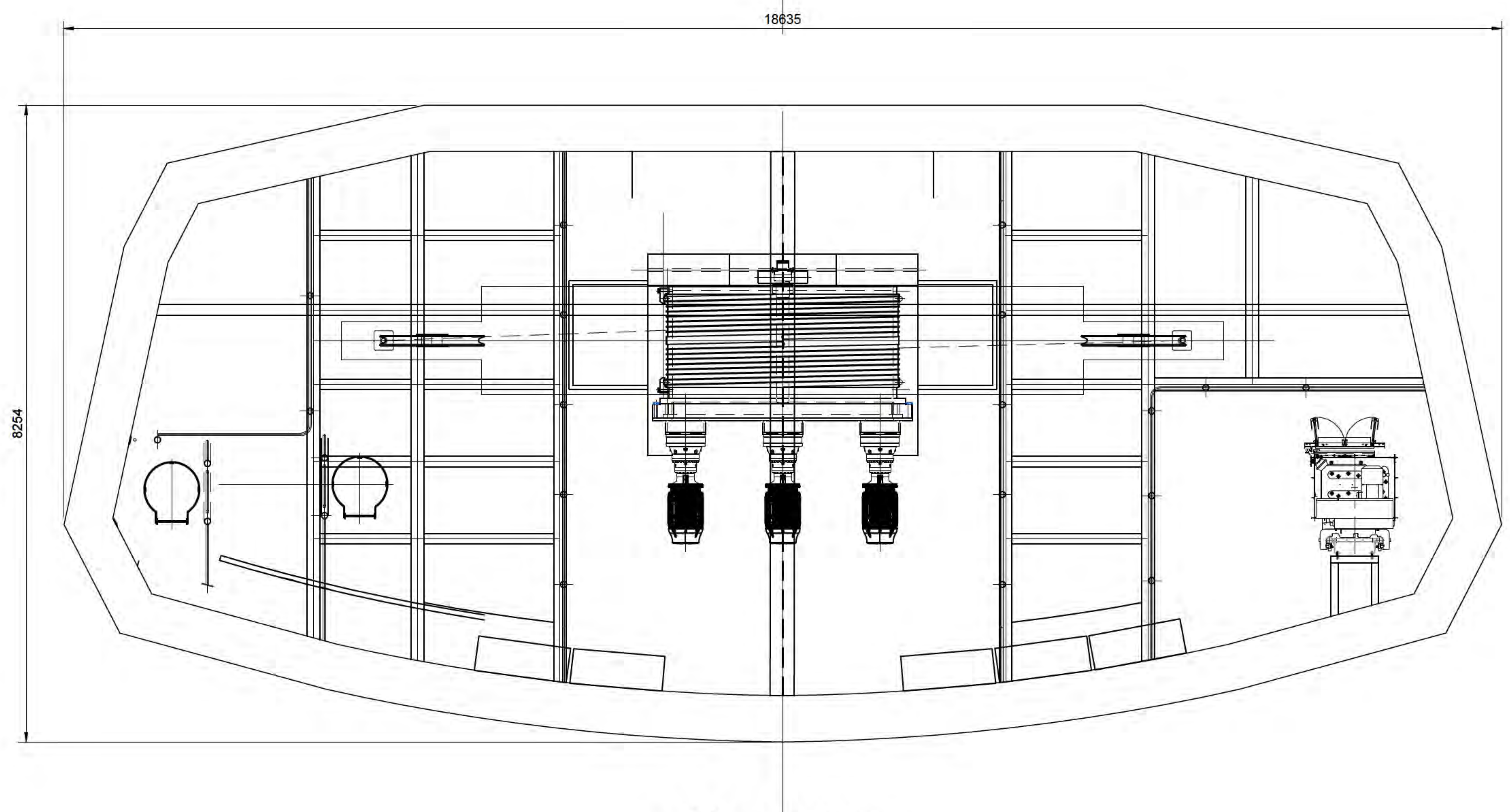

J SECTION
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SAFETY, HEALTH AND ENVIRONMENTAL INFORMATION

In addition to the hazards/risks normally associated with the types of work detailed on this drawing, note the following:

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NONE	NONE	NONE	NONE

It is assumed that all works will be carried out by a competent contractor working, where appropriate, to an approved method statement

rev	date	details	drn	chk	app
P01.1	—	FIRST ISSUE			

borough: Multiple Boroughs

scheme: ROTHERHITHE TO CANARY WHARF CROSSING CONCRETE TOWER SECTIONS

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date	scale	drn	chk	app	sheet no
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suitability: S0 WORK IN PROGRESS

revision: P01.1

drawing No: ST_PJ585C-ATK-BAS-ZZ_21-DRG-ST-00003
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SENSITIVE INFORMATION

DO NOT SCALE

Rotherhithe to Canary Wharf River Crossing

VALUE ENGINEERING ASSESSMENT FORM	DATE: 21/09/2018

- *Item Ref: VE25 – Main span lift counterweight – concrete with steel casing or other infill materials*

SUMMARY DESCRIPTION OF VE PROPOSAL

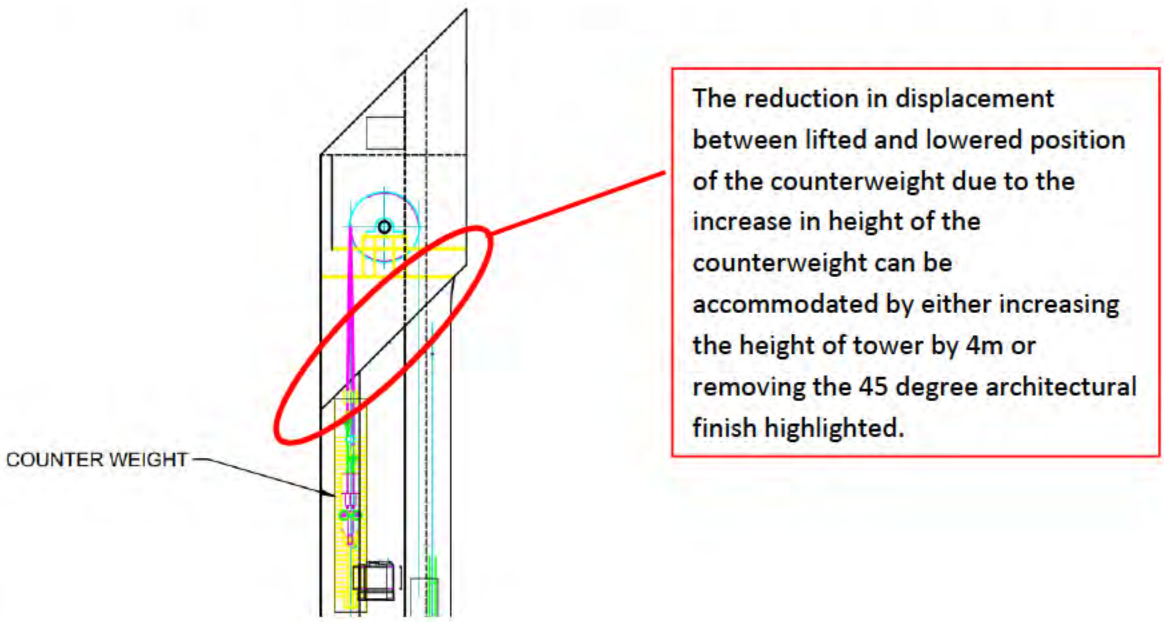
The baseline design of the lift counterweights considers solid steel billets supported by steel frame. The counterweight dimensions (approximate) considered in the design are **8m wide x 9.4m high x 1.4m thick**, which weighs approx. 826tonnes considering steel billets as infill. The counterweight will be designed as 90% of the total bridge weight to balance the deck during operation. The fabrication involves the steel frames to be transported to site and infilled with steel billets stacking over each other. Painting is required for maintenance and better aesthetics.

The VE25 is to propose the alternate cheaper options for the counterweight. The total weight of the 169m span bridge deck is approximately 1290t and considering 90% it will be 1161t. The counterweight on each end should weigh 581t. Considering the flexibility in available space, two options for the infill been considered.

Normal grade concrete: - is not considered in the VE proposals, as it requires the height of the counterweight to be increased by 3 times (due to restriction in plan dimensions). Increasing the height of the counterweight reduces the displacement between lifted and lowered position of counterweight. Increasing the height of the counterweight by 3 times requires the height of the tower to increase to achieve the required displacement for the lifting span.

Heavy weight concrete infill: - Concrete's density can be improved by adding dense aggregates such as limonite, hematite, or magnetite, or metal bits and scraps into the concrete mix. For example: MagnaDense (*LKAB Minerals*) in concrete can provide a density of typically 4.0 t/m3. When mixed with other iron-based materials, concrete including MagnaDense can achieve a density up to 5.0 t/m3.

Heavy weight concrete infill counterweight estimated size – **8m wide x 13m high x 1.4m thick**.



Cast iron billets infill: is indeed stronger and harder than concrete which automatically makes counterweights more resistant to impact and strains and guarantees longer fatigue life against cyclic stress. Usually counterweights need screws for fastening or mounting additional equipment.

The mass for cast iron is the same as that of steel; hence, the counterweight dimensions are expected to be the same as the baseline. The illustrated sketch of both the options are presented in drawing ST_PJ585C-ATK-BAS-ZZ_21-DIA-ST-00003.

ADVANTAGES:	DISADVANTAGES:
• Potential for significant savings in material costs for both options. • Steel casing is lighter to transport to site and can be infilled to the desired weight on site.	• Concrete Infill material will have to be sufficiently dense to not increase tower height. • The concrete's surface cracks easily and hardly support any additional constructions.

LIST OF SUPPORTING DOCUMENTS:

ST_PJ585C-ATK-BAS-ZZ_21-DIA-ST-00003 (Counterweight concept design & VE proposals)

Reference:

Figure 1 Cast Iron Billets

Figure 2 Example of Concrete counterweight

IMPACT EVALUATION

COST BENEFIT

The baseline estimate currently includes a base construction cost of £1.7million for the fabrication and erection of the bridge counterweights. Applying Indirect costs on a pro-rata basis, this would translate to an Estimated Final Cost (EFC) of £5.9 million.

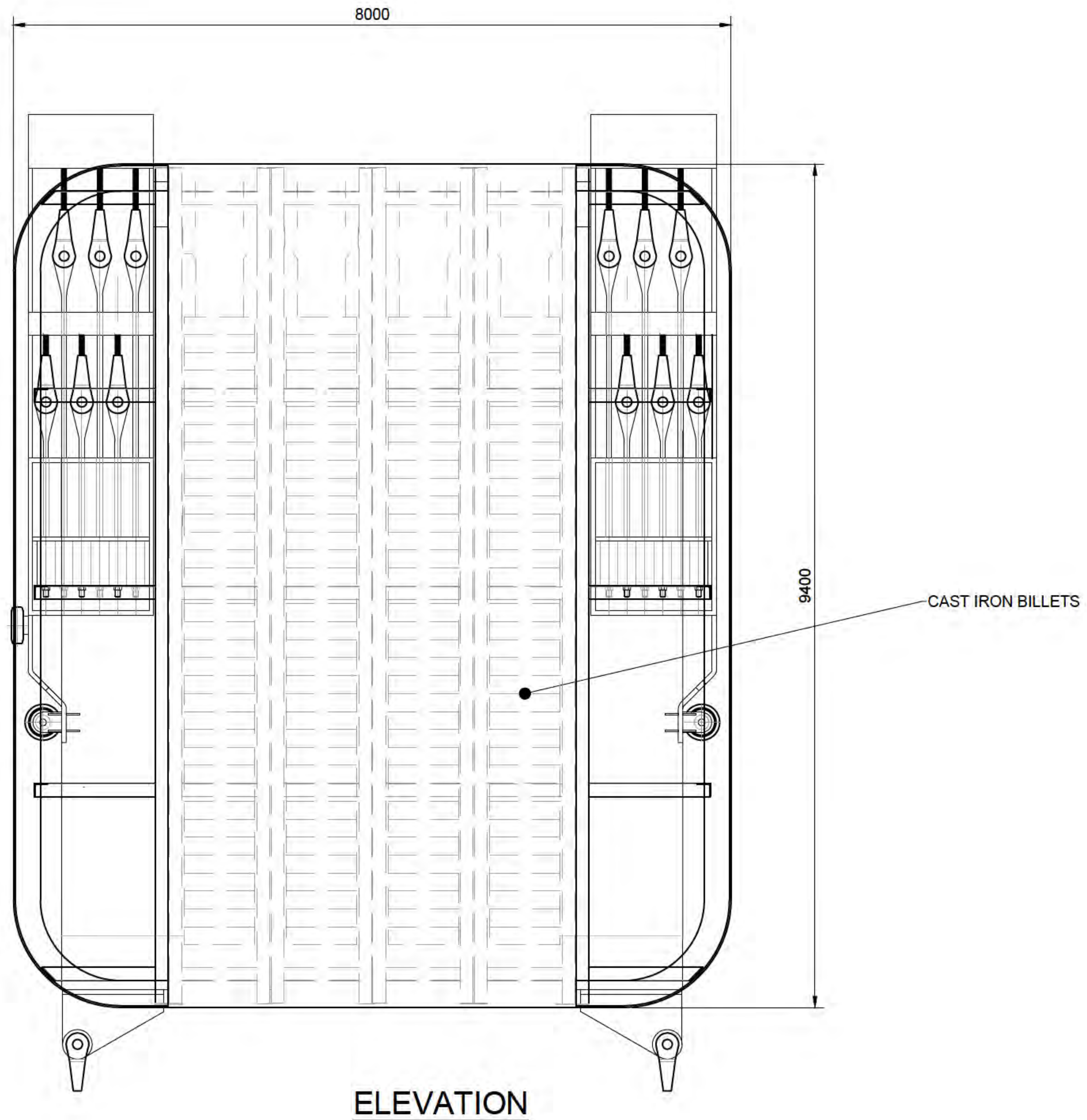
Heavyweight concrete, even if incorporating a dense aggregate such as limonite, hematite, or magnetite, or metal scrap would be cheaper in respect of its material supply costs than the steel billets currently allowed for. Initial research suggests that the material in terms of its cost per tonne would be significantly cheaper as a material than cast steel, although this is dependent on the actual aggregates/material used, its availability and the manner in which it can be transported to the tower locations. We would suggest therefore that the maximum reduction in EFC would likely be in the order of £1.8 million. If however, as has been suggested above, this would also result in the need to increase the tower height to accommodate a larger counterweight, this would eliminate this saving entirely and would actually result in an increased overall EFC.
It is anticipated that Cast iron counterweight billets would be cheaper in respect of their material supply costs than the steel billets currently allowed for. Initial research suggests that cast iron billets would be circa 30-40% cheaper as a material than cast steel, although this is dependent on the actual grades used. This would not result in a similar percentage overall reduction in EFC however as the erection element of the costs will likely remain unaltered and it is assumed that there will still be a need to construct a similar

steel frame to contain them. We would suggest therefore that the reduction in EFC would likely be in the order of £0.8 million. •
PROGRAMME BENEFIT
• Cast in place construction of concrete consumes more time than the installation of cast iron counterweights.
RISK EVALUATION
• For concrete counterweights, there will be an increase in height of the counterweight, which may increase the total height of the tower and it requires consents of local Authority / Transport and Work Acts Order (TWAO) to fit in with surrounding environment.
ENVIRONMENTAL
• Cast iron is a product of recycling and doesn't require any extraction of new raw materials, which is not the case with concrete. • Cast iron has less carbon foot print.
BUILDABILITY
Heavy weight concrete counterweights – The concrete will be casted at site using dense aggregates with encased steel frames. Special care to be taken during handling and concreting. Cast iron billets counterweights – Iron billets will be procured and transported to site and will be stacked in layers encased by steel frames. Both the options may require very large, one-off castings moved into place with heavy lift material handling equipment.
SAFETY
Necessary safety measures to be implemented for transportation, concrete mixing and shutter formwork of heavy weight concrete using dense aggregates.
OPERATIONS AND MAINTENANCE
Heavyweight concrete / cast iron billets counterweights require less maintenance than steel ones and do not require any corrosion protection measures. Concrete counterweights will be encased with steel frames to avoid any damage during lift operation. Considering the bridge weight and distributions (deck replacement, new span locks etc…) can change during its life time, counterweights to be designed to allow for the adjustment of bridge balance by providing a pocket. The pockets are then partially filled with smaller blocks to adjust the balance of the bridge.
ACCEPTANCE

Prepared: [redacted]	**Name: Deepak** [redacted]	**Signed** [redacted]

Proposal Implemented:	**Y / N (Delete as appropriate)**	
Approved by:	**Name:**	**Signed:**
IMPLEMENTATION		
COMMENTS / ACTIONS		
To be completed by TfL		

OPTION A: COUNTER WEIGHT INFILLED WITH CAST IRON BILLETS



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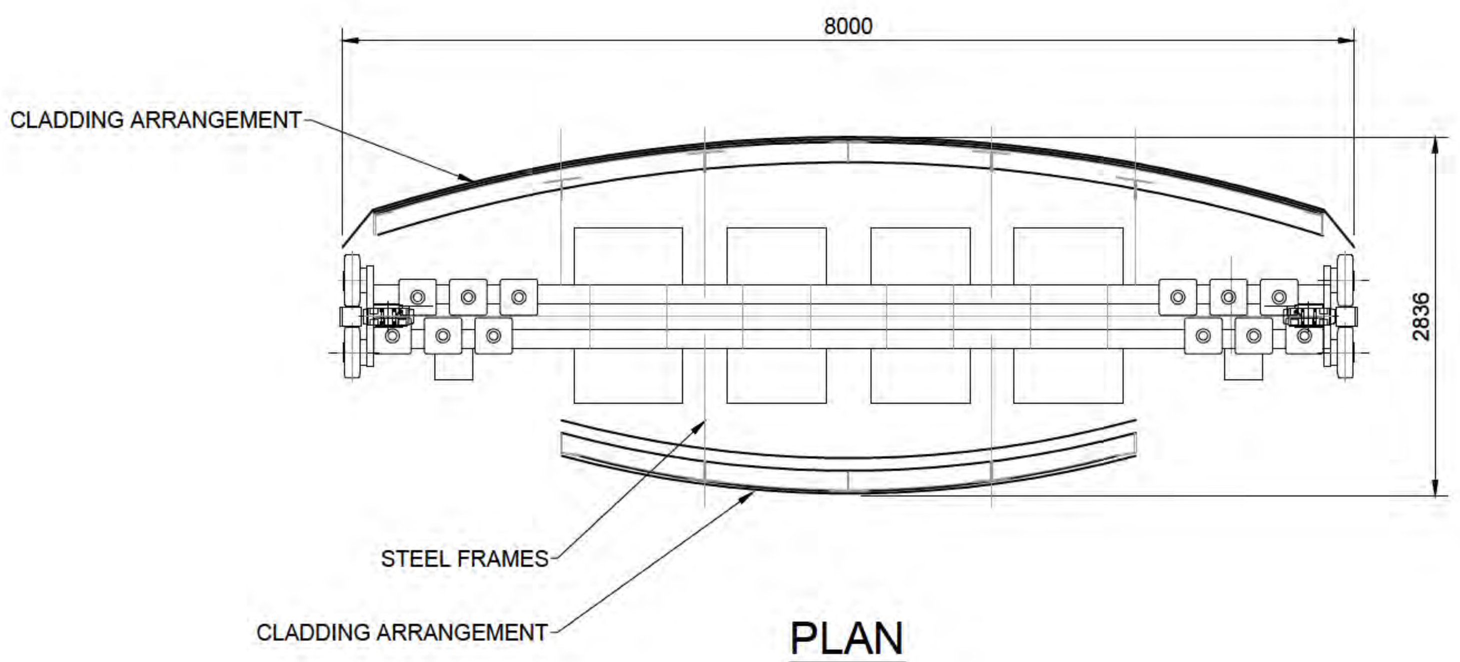
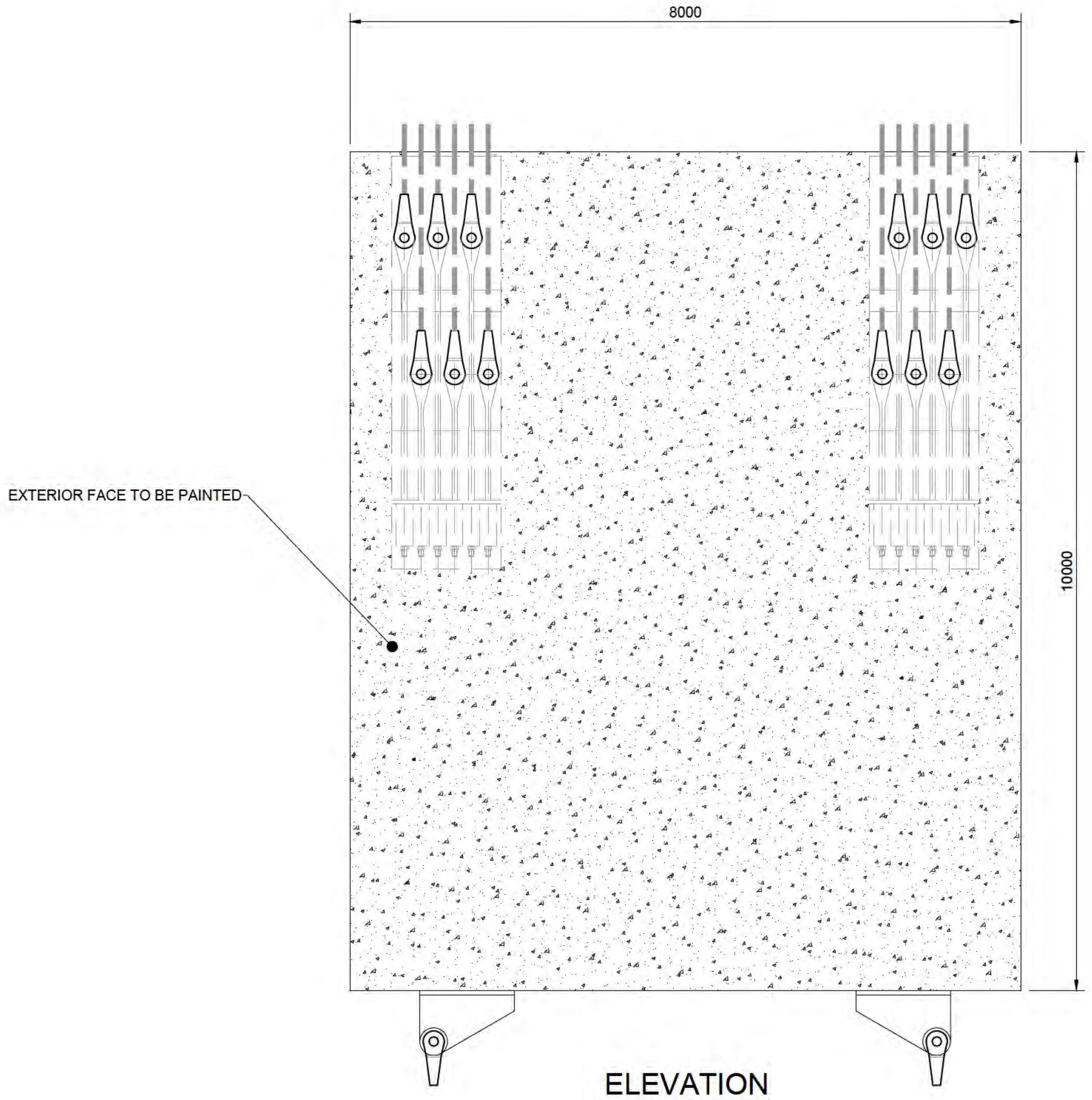


PLAN
SCALE 1:50

OPTION B: HEAVY WEIGHT CONCRETE COUNTER WEIGHT



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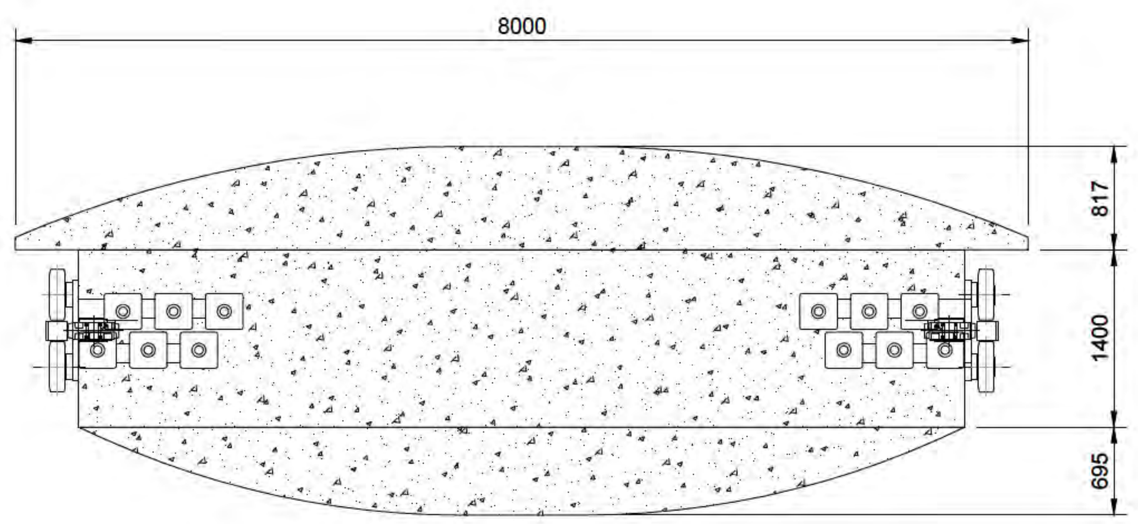

PLAN
SCALE 1:50

NOTE:- REFER TO APPENDIX - A & B FOR DIMENSIONS, LEVELS & OTHER DETAILS.

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date	scale	drn	chk	app	sheet no
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borough: Multiple Boroughs

scheme: R2CW RIVER CROSSING COUNTERWEIGHT CONCEPT DESIGN & VE PROPOSALS

suitability: S0 WORK IN PROGRESS

revision: P01.1

drawing No: ST_PJ585C-ATK-BAS-ZZ_21-DIA-ST-00003 (project, owner, asset, location, type, role, number)

DO NOT SCALE

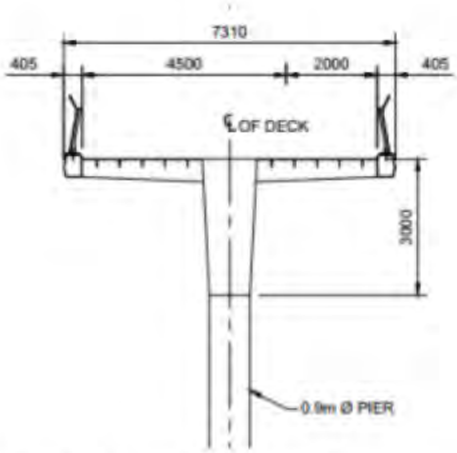
Rotherhithe to Canary Wharf River Crossing

VALUE ENGINEERING ASSESSMENT FORM	DATE: 21/09/18

- *Item Ref: VE26 – Approach Span Deck Form*
  VE28 – Maximise Approach Ramp Spans to Minimise Number of Piers in the River

SUMMARY DESCRIPTION OF VE PROPOSAL

For the approach spans, the Arcadis feasibility design consist of steel box girders below deck level with an orthotropic steel deck. The spans range from 20m-55m. The depth of the steel box girder varies depending the length of the span.



Ref: ST_PJ585C-ARC-BAS-ZZ-REP-CE-100014 Bridge Feasibility Report Appendices.

The structural form enables a slender long span structure (minimising the number of piers and foundations in the river); however, the steel orthotropic deck requires complex and expensive steel fabrication and construction costs.

The VE26 proposal consists of modifying the approach ramp structural form with the aim of minimising the cost of complex steel fabrication and maximising the approach ramp span lengths to minimise the number of piers and foundations in the river.

A concrete composite (steel box girder and RC deck) was considered to maintain the long span and minimise the steel costs. The cross-section details can be seen in ST_PJ585C-ATK-BAS-ZZ_12-DM2-ST-00012. The 40m and 55m span lengths have been considered.

<u>Steel Plate I-girders with composite deck slab:</u>

The alternate option to steel box girder for approach span is Steel plate I-girders stiffened with intermediate K-bracings (say 2.5m approx.) as shown in below Figure 1. The approximate quantity of steel for the I-girder option is 266 kg/m^2 (nearer to steel box girder quantity). The key advantage is significant reduction in fabrication costs compared to steel box girders although material costs are same, and the disadvantage is it is not visually appealing to the surroundings. This needs further investigation and discussion with the client and contractor about the feasibility and costs savings.

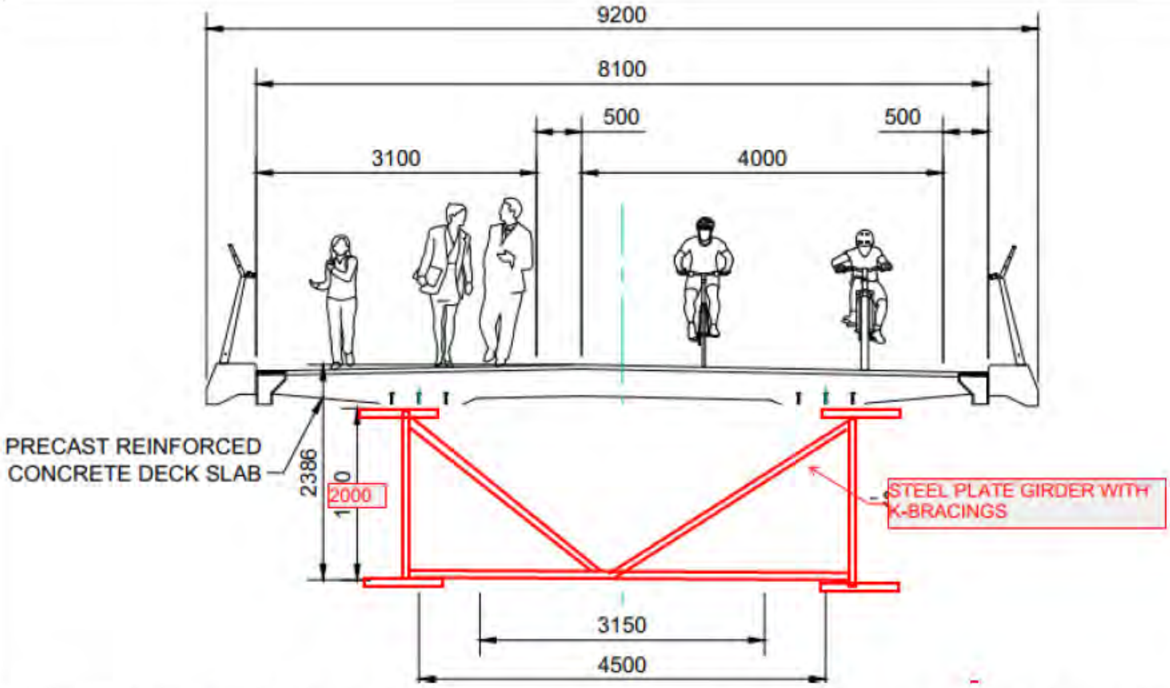


Figure 1 - Steel Plate Girder (with K-bracings & concrete deck) – alternate option to box girder

ADVANTAGES:	**DISADVANTAGES:**
• The concrete composite structural form minimises the amount and cost of steel used. • The long spans minimise the amount of river works required.	• The deck form is deeper than steel only option, which will influence the aesthetics of the structure. • The deck form is heavier than steel only option.

LIST OF SUPPORTING DOCUMENTS:

- 5162977-43-0215 C1 vs C2 Comparison P02
- ST_PJ585C-ATK-BAS-ZZ_12-DM2-ST-00012 (Approach Span GA with composite deck layout)

IMPACT EVALUATION

COST BENEFIT

A number of option estimates have been prepared and previously reported incorporating a composite deck design and potential associated increases in the spans between piers. The most pertinent of these are as follows:

- Provision of Composite deck form to CB5-CA5 alignment, maintaining 40m pier spacings. The anticipated saving in EFC for this option was £9.1 million.
- Provision of Composite deck form to CB5-CA5 alignment, increased pier spacings to 55m. The anticipated saving in EFC for this option was £15.2 million.

A composite deck design has now been adopted as part of the Concept Design proposals and any savings generated by this will therefore be incorporated within the Concept Design Capital Cost estimate.

PROGRAMME BENEFIT

It is anticipated that the steel only deck form can be lifted into position in one lift.

The composite form deck form will be significantly heavier; hence it may be preferable to lift the concrete deck separately or pour insitu. This will extend the programme appropriately.

RISK EVALUATION

All the risks pertaining to cast in situ concrete construction of deck slab (for the approach spans) over the river needs to be evaluated.

ENVIRONMENTAL

Increased environmental risk of any concrete leak /spillage into the river during cast in place construction of deck over River Thames.

BUILDABILITY

Steel girders shall be fabricated, transported to site (with temporary bracings) and installed in its place. The concrete deck slab can be achieved by either cast in place construction (requires permanent formwork, concrete batch plant & handling at the site) or using precast slabs with stitch concrete at connections (slabs will be erected using cranes / barges).

SAFETY

Increased HS risk for casting of concrete deck slab– working at height and over the River Thames for long period.

OPERATIONS AND MAINTENANCE

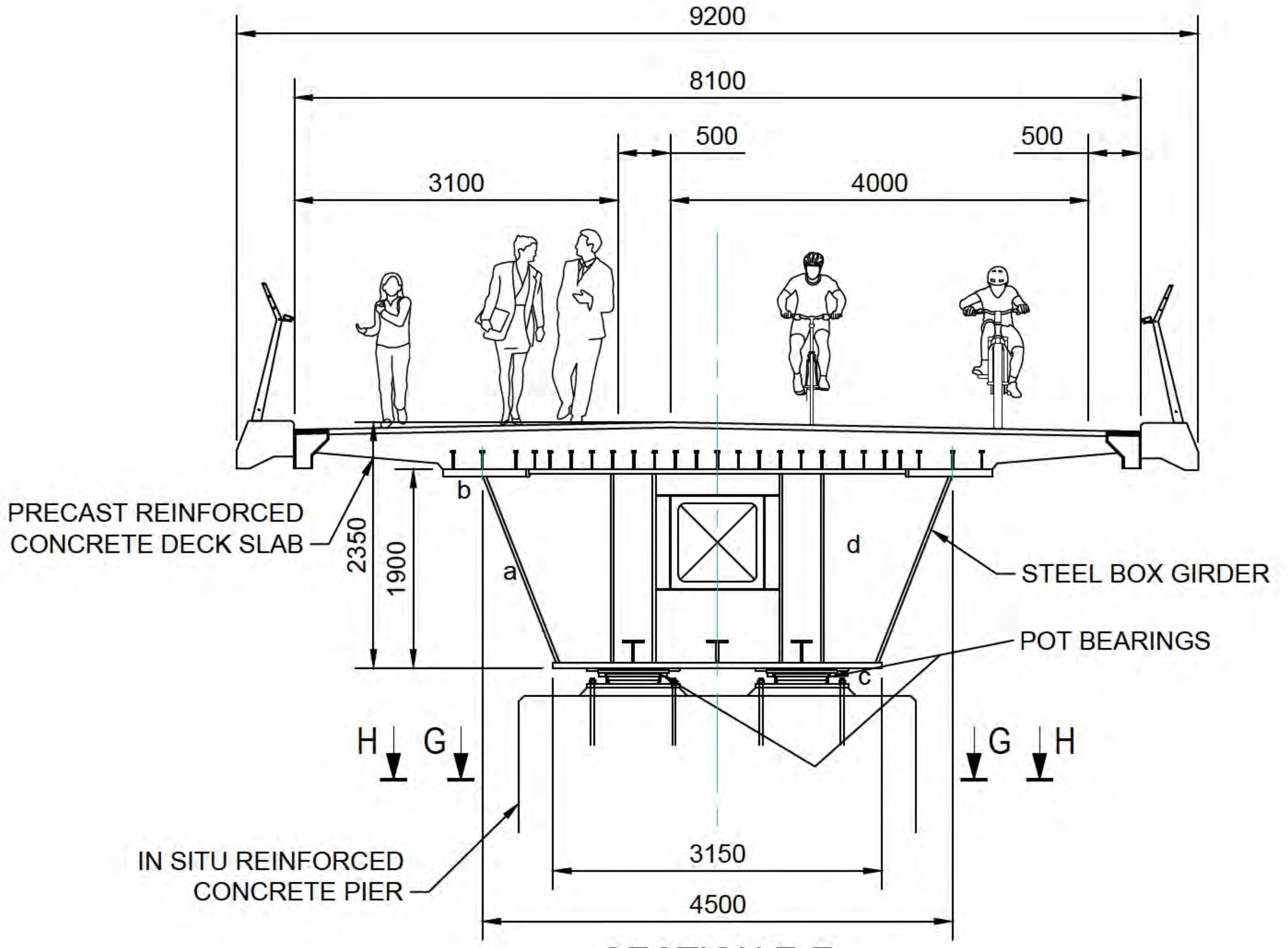
Concrete deck requires less maintenance compared to steel plate decks which requires protective coating against corrosion and needs to be repainted at regular intervals.

ACCEPTANCE

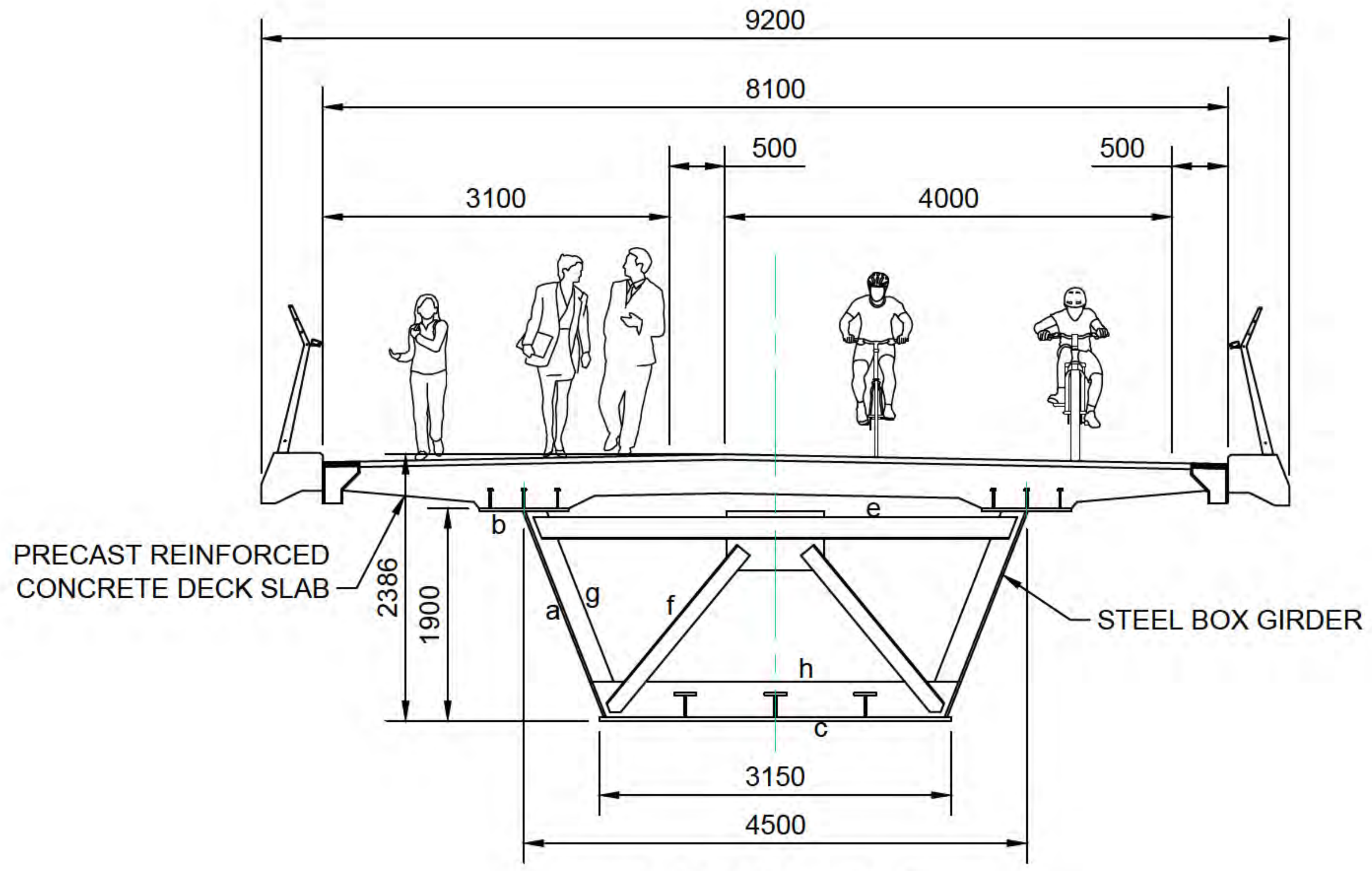
Prepared:[redacted]	**Name:** [redacted] **Krishnan**	**Signed:** [redacted]
Proposal Implemented:	**Yes, implemented in the core design with changes**	
Approved by:	**Name:**	**Signed:**

IMPLEMENTATION

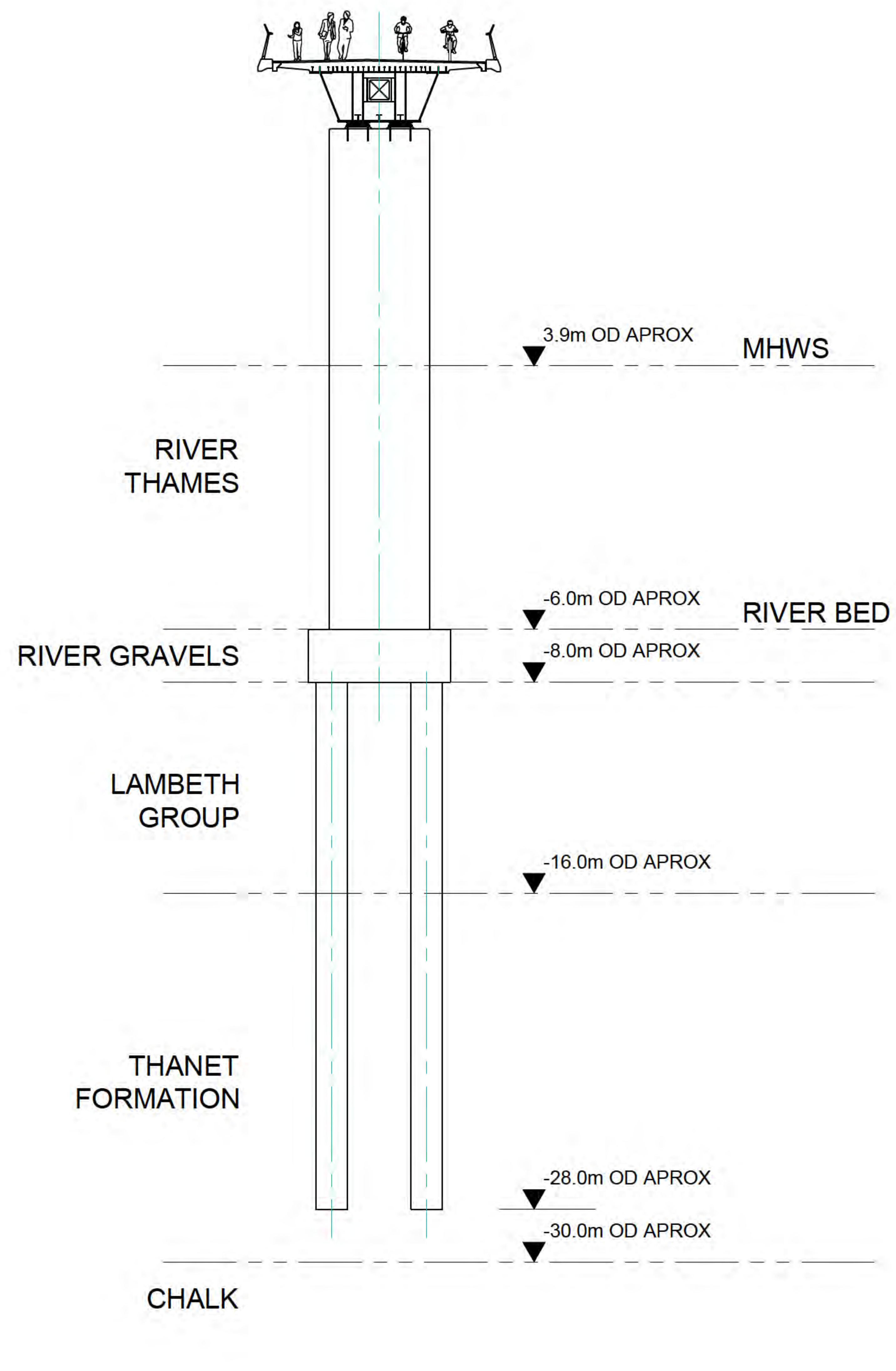
COMMENTS / ACTIONS
To be completed by TfL



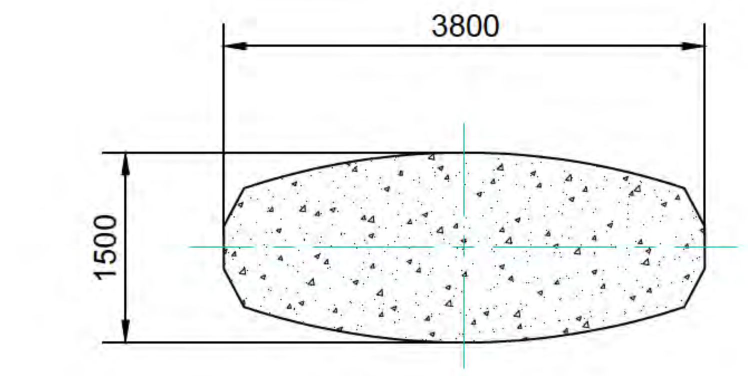
SECTION E-E
TYPICAL AT PIERS
(SCALE 1:50)



SECTION F-F
TYPICAL BETWEEN PIERS
(SCALE 1:50)

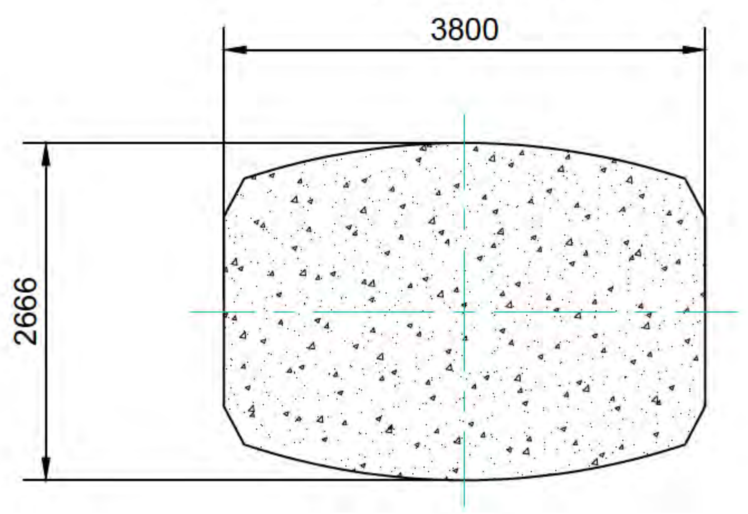


PRELIMINARY FOUNDATIONS BACK SPAN PIER
(SCALE 1:150)



SECTION G-G
SECTION THROUGH INTERMEDIATE PIER
(SCALE 1:50)

		MEMBER SIZES (mm)	
ID	MEMBER	PIER SECTION	SPAN SECTION
a	WEBS	30 THK	20 THK
b	TOP FLANGE	800 x 65	800 x 30
c	BOTTOM FLANGE	3150 x 45	3150 x 30
d	DIAPHRAGM	25 THK	-
e	K BRACING - HORIZONTAL	-	200 x 200 x 12
f	K BRACING DIAGONAL	-	150 x 150 x10
g	WEB STIFFENER	-	200 x 20
h	BOTTOM FLANGE STIFFENER	-	325 x 20



SECTION H-H
SECTION THROUGH PIER AT EXPANSION JOINTS
(SCALE 1:50)

NOTES

1. DO NOT SCALE.
2. THIS DRAWING IS IN MILLIMETRES.

rev	date	details	dm	chk	app
P01.1		FIRST ISSUE			

Transport for London
TfL Engineering
Traffic Design Engineering
Palestra
197 Blackfriars Road
London SE1 8NJ

borough: Multiple Boroughs
scheme: MAIN BRIDGE GA LAYOUT
scale: 1:1
revision: P01.1
drawing No: ST_PJ585C-ATK-BAS-ZZ_12-DM2-ST-00012

Rotherhithe to Canary Wharf River Crossing

VALUE ENGINEERING ASSESSMENT FORM	DATE: 22/08/18

Item Ref: VE31 – Remove maintenance access elevator and replace with stairs (and hoist / winch for equipment)

SUMMARY DESCRIPTION OF VE PROPOSAL

In VE31, it is proposed to remove the two maintenance access elevators located within the main span towers.

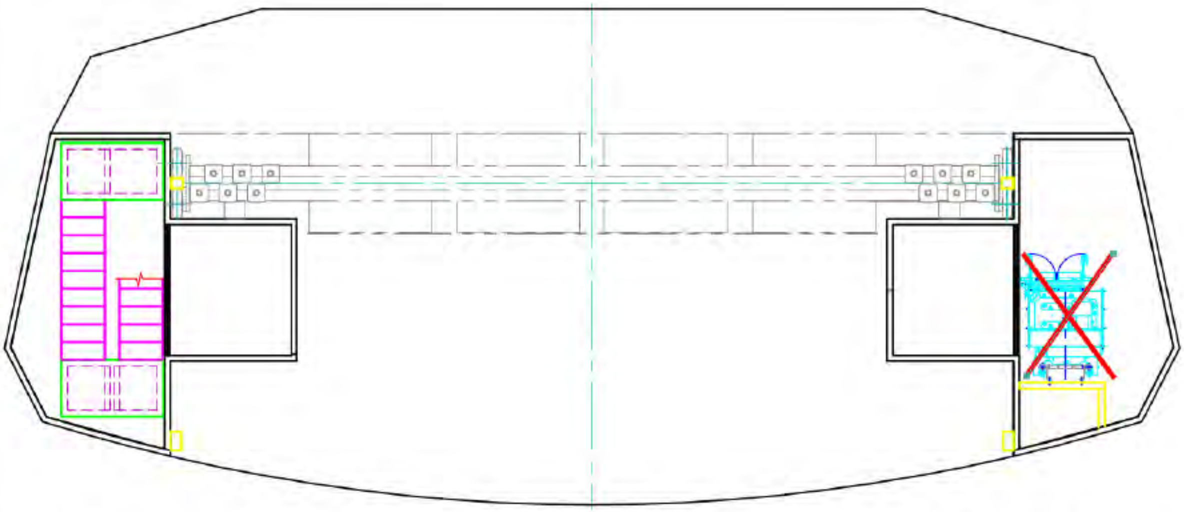


Figure 1 Tower cross-section showing the proposal to remove access elevator located inside the tower

Maintenance access stairs are already proposed on other side of the tower; it is proposed to retain the elevator shaft but replace the elevator with a motorised hoist / winch. The hoist / winch would allow equipment to be moved within the pier. It would also allow the emergency evacuation of an injured person but avoiding the need to use the staircase. Safety concerns involved are access to the steel wire ropes, spragging beams on lift shaft tower for periodical inspections and it cannot be achieved with motorised hoist / winchs.

Note: Inspection / maintenance at the top of the tower is expected every 3 months (including rope inspection at top deck) and a 6-month discharge period for automatic lubricator.

ADVANTAGES:	DISADVANTAGES:
Reduced capital requirements & lift maintenance costs	Maintenance operations would take longer. Manual handling no longer eliminated from equipment movement activity. Climbing 75m tower every 3 months (for inspection) is a H&S concern.

LIST OF SUPPORTING DOCUMENTS:

- ST_PJ585C-ATK-MEC-ZZ_21-REP-ME-00002 (Operational Concept Report)
- ST_PJ585C-ATK-MEC-ZZ_12-REP-ME-00001 (Atkins Lifting Span M&E AIP)

IMPACT EVALUATION

COST BENEFIT

Item	Description	Effect on CAPEX	Effect on OPEX
Elevator cost	Removing the elevator would result in a reduced structure costs. Moving plant within the structure would take longer, potentially increasing operational costs due to increased maintenance time. A manually operated hoist / winch would result in further CAPEX reductions, but a further increase in OPEX when compared to a motorised hoist / winch. This is because the hoist / winching operations would take longer.	Initial assessment is that saving in EFC could be in the order of £1.0 to £1.5 million but this would be dependent on the nature of the equipment installed in lieu of the lift.	Negative in respect of maintenance activities potentially taking longer but there would be a saving in lift maintenance and renewals costs.

PROGRAMME BENEFIT

Item	Description	Effect on programme
Elevator installation	Removing the elevator would offer a minor reduction in construction time	Beneficial

RISK EVALUATION

Item	Description	Effect on risk
Moving plant	Manual handling risk was reduced when using an elevator. Replacing the elevator with a hoist / winch increases the amount of manual handling operatives must complete. There is a total increase in the risk to operatives. The manual handling increases further if a manual hoist / winch is used.	Negative
Maintenance access	Maintenance access in the lift shaft tower to the steel wire ropes, spragging beams (required for periodical inspection) needs to be evaluated	Negative

ENVIRONMENTAL

Item	Description	Effect on the environment
Elevator installation	Removing the elevator decreases the total amount of embodied carbon within the structure.	Positive

BUILDABILITY

Item	Description	Effect
Elevator installation	Removing the elevator will increase the buildability of the structure. However, the buildability of any repair work will decrease as component weights may be limited by the hoist / winch capacity.	Neutral
SAFETY		
Item	Description	Effect
Safety	Appropriate safety measures to be followed while using the winch / hoist to lift machines such as tracker, monitor, trigger etc…	Neutral
OPERATIONS AND MAINTENANCE		
Item	Description	Effect
Manual handling	Manually elevating components using a hoist / winch is more time consuming than using an elevator. There also may be a limit on the size of components that can safely be elevatored.	Negative
ACCEPTANCE		
Prepared: [redacted]	**Name:** [redacted]	**Signed:** [redacted]
Proposal Implemented:		
Approved by:	**Name:**	**Signed:**
IMPLEMENTATION		
COMMENTS / ACTIONS		
To be completed by TfL		

Rotherhithe to Canary Wharf River Crossing

VALUE ENGINEERING ASSESSMENT FORM	DATE: 23/08/18

Item Ref: VE32 – Remove backup generators. Replace with hook-up generator

SUMMARY DESCRIPTION OF VE PROPOSAL

In the baseline design, the backup generator (Permanent Enclosed generator) is proposed to supply power to the lifting mechanism in the event of a power failure. It is supplemented by an uninterruptable power supply (UPS) that powers control and instrumentation while the generator powers up. The baseline design considers UPS to supply 30 mins of power.

In VE32, considering the probability of emergency power failure it is proposed to remove the backup generator and in the event of a power failure, a portable generator (such as mobile diesel generators) shall be brought on to the site and connected to the lifting motors (3 phase). Therefore, the UPS would need to run for longer, as the time between the two power supplies being operational would increase.

The time to replace any power supply would significantly increase as backup would need to be sourced, transported (amidst city traffic) and installed near the bridge deck.

A power failure is an infrequent event, either due to planned maintenance period by power companies or due to unplanned maintenance or accidental power failure which may unlikely to happen (approx. sequence TBC from data analysis of power failures – see Risk Evaluation). A power failure would keep the main span in the open or closed position as the spragging beams would keep it locked in its position. A power failure would only prevent bridge deck moving. Hence, by removing a backup generator, would not influence pedestrian/cyclist safety.

ADVANTAGES:	DISADVANTAGES:
• Reduced capital requirements & maintenance costs. • Fire and safety risks of storing fuel can be eliminated by removing generator plant within the towers.	• Replacement of the power supply will take longer time (to connect to portable generators). • The UPS would need to work for a longer period (approx.1~1.5hrs, assumption considering the transportation of mobile diesel generators to the site) between the change in power source. • There is a risk that the bridge remains closed when passage of vessels over 12m height is required during the longer period (approx.1~1.5hrs,) and unlikely to be acceptable to PLA.

LIST OF SUPPORTING DOCUMENTS:

- ST_PJ585C-ATK-MEC-ZZ_21-REP-ME-00002 (Operational Concept Report)
- ST_PJ585C-ATK-MEC-ZZ_12-REP-ME-00001 (Atkins Lifting Span M&E AIP)

IMPACT EVALUATION

COST BENEFIT			
Item	Description	Effect on CAPEX	Effect on OPEX
Cost	Omission of the backup generator & associated plant room would reduce the overall CAPEX. It would also eliminate the testing and inspection costs associated with maintaining a backup generator. However, a UPS with a longer supply duration would be required. Hiring a mobile power supply will incur cost.	Without further details as to the exact nature of the equipment type etc. being omitted and/or substituted it is not possible to assess the potential cost saving with certainty. An initial assessment would be that the potential saving in EFC is likely to range from £0.8 to 1.2 million.	Whilst the Maintenance and renewals cost associated with the generator versus an upgraded UPS is likely to reduce, there is a greater risk of additional OPEX costs being incurred dependent on the frequency at which a mobile power supply is required.
PROGRAMME BENEFIT			
Item	Description	Effect on programme	
Backup Power supply omission	Removal of the backup power supply & associated building of generator plant room from the programme would have a considerable reduction on the programme duration.	Positive	
RISK EVALUATION			
Item	Description	Effect on risk	
Mobility	Transportation of mobile diesel generators from the supplier to the bridge at canary wharf in a shorter time (amidst busy city traffic) needs to be evaluated.	Negative	
Backup Power supply omission	Probability of emergency / accidental power failure during bridge lifting operations needs to be evaluated.	Positive / Negative	
	PLA approval required for a low probable risk that the bridge remains closed when passage of vessels over 12m height is required during the longer power-off period (approx.1~1.5hrs,)	Negative	
ENVIRONMENTAL			

Item	Description	Effect on the environment
Backup Power supply omission	Elimination of storing fuel in the plant room near the river or buildings is positive to the environment. Eliminating generator plant room construction reduces carbon footprint on the site.	Positive
BUILDABILITY		
Item	Description	Effect
Omission of plant room	Building of generator plant room can be eliminated and space to be identified (near bridge deck or river bank sides) for the mobile diesel generator during power failure.	Positive
SAFETY		
Item	Description	Effect
Backup Power supply omission	Enhanced fire safety due to removal of fuels storage near the bridge site.	Positive
OPERATIONS AND MAINTENANCE		
Item	Description	Effect
Backup Power supply omission	In the event of a power failure, a mobile backup generator would have to be sourced, transported and installed. All the while, the UPS would need to maintain control and instrumentation telemetry. This would result in an increased duration of the lifting elements being non-operational.	Negative

ACCEPTANCE		
Prepared: [redacted]	**Name:** [redacted]	**Signed:** [redacted]
Proposal Implemented:	**Yes**	
Approved by:	**Name:**	**Signed:**
IMPLEMENTATION		
COMMENTS / ACTIONS		
To be completed by TfL		

Rotherhithe to Canary Wharf River Crossing

VALUE ENGINEERING ASSESSMENT FORM	DATE: 21/09/18

- *Item Ref: VE33 – Carbon Fibre Ropes*

SUMMARY DESCRIPTION OF VE PROPOSAL

VE33 proposes replacing the main span lift ropes (Counter & drive ropes) with carbon fibre lift ropes.

Lift manufacturers generally use steel cords coated with elastomeric material or carbon fibre belts.

The main advantage of the belt construction is that the smaller diameter cords permit use of significantly smaller radius pulleys and sheaves, enabling much more compact machinery. Furthermore, monitoring systems are available which permits continuous measurement of cord diameter, for assessment of remaining usable life. It is unknown what the cost comparison is vs steel ropes, however it's widespread use amongst leading elevator suppliers would suggest a cost benefit.

The main issue regarding implementation on a moveable bridge is patents. The carbon fibre belt technology is protected by the respective lift manufacturing companies, as suggested by supporting document 1. Furthermore, because the technology is protected there are no publicly available standards to cover this, refer to support document 2.

Hence, it is recommended this is not progress further.

ADVANTAGES:	DISADVANTAGES:
• Reduced maintenance costs • Durable and corrosion resistant	• The product needs to be tested and certified by the EU approval authority. • Non-availability of published standards for design and manufacturing. • Patented to few companies.

LIST OF SUPPORTING DOCUMENTS:

1. https://www.schindler.com/com/internet/en/media/press-releases-english/press-release-2014/otis-and-schindler-announce-settlement-and-license-agreement.html
2. EN81-20

IMPACT EVALUATION

COST BENEFIT

Capital costs are unknown. It's widespread use amongst leading elevator suppliers would suggest a cost benefit. However, this is likely to be achieved through significant economies of scale cost savings, which is not the case for the unique requirements associated to Rotherhithe Bridge. Furthermore, the cost of using a patented technology might come at a high cost.

Operational costs potentially decrease using monitoring technology as described above.

PROGRAMME BENEFIT

None anticipated.
RISK EVALUATION
High risks associated to using new technology with no available published standards.
ENVIRONMENTAL
None anticipated.
BUILDABILITY
None anticipated.
SAFETY
None anticipated.
OPERATIONS AND MAINTENANCE
Improvements associated to the compatibility with continuous monitoring devices.

ACCEPTANCE		
Prepared: VE Champion	**Name:** [redacted]	**Signed** [redacted]
Proposal Implemented:	**Not implemented due to the issues listed in the disadvantages**	
Approved by:	**Name:**	**Signed:**
IMPLEMENTATION		
COMMENTS / ACTIONS		
To be completed by TfL		

Appendix D. Value Engineering Workshop No.1 - Report

Rotherhithe to Canary Wharf River Crossing

Value Engineering Workshop No.1

Transport for London

25 July 2018

Notice

This document and its contents have been prepared and are intended solely as information for Transport for London and use in relation to design development.

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This document has 37 pages including the cover.

Document history

Revision	Purpose description	Originated	Checked	Reviewed	Authorised	Date
P01	For review / comments	[redacted]	[redacted]	[redacted]	[redacted]	25/07/2018
P02.1						

Client signoff

Client	Transport for London
Project	Rotherhithe to Canary Wharf River Crossing
Job number	5162977
Client signature / date	

Contents

Introduction

Rotherhithe to Canary Wharf River Crossing Value Engineering Workshop No.1 was undertaken on 4th July 2018. In the workshop, individual disciplines – Structures, Architecture, Mechanical and Electrical, Geotechnical and Constructability – presented their current design proposals and potential value engineering ideas.

This was followed by individual attendee's idea generation round. All ideas were grouped into categories and discussed in depth for potential size of benefit, advantages, risks and dependencies. The size of benefit was allocated:

- Small (S) <£500,000
- Medium (M) £500,000 - £1,000,000
- Large (L) >£1,000,000

This report documents the value engineering discussion and outputs. All individual generated ideas and meeting minutes are included in ***Appendix A*** and ***Appendix B*** respectively.

Define core team and challenge team.

1. Methodology/Process

2. Alignment

2.1. Baseline alignment design

The baseline alignment option (denoted as alignment CB5 to CA5) would provide a 1km route from Rotherhithe street opposite Durand's Wharf to Westferry Circus or Westferry Road in Canary Wharf and assumes a 12m air draught over a 40m width at the centre of the River Thames navigation channel.

The western landing (CB5) ramp would transport cyclists from Rotherhithe Street on a gentle loop around Durand's Wharf mainly in 25m horizontal radii curves to an 80m section parallel to and founded on the River Thames foreshore before joining the main bridge span. Altogether the ramp would be 465m from landing to midspan. CB5 cycle ramp would include three inclined sections at 4% gradient to fit the alignment. The remaining inclines would be at a maximum of 3% gradient and maximum 80m in length. All inclines would be interspersed by 5m flat sections. Two extended sections at 2% gradient from midspan would eliminate the need for split decks on the moving span. The 2% gradient section would also serve as a transition into another deck at 1% gradient after the moving span to provide access to lifts and stairs located in Durand's Wharf. The deviation between access to lifts and cycle ramp would occur at chainage marker 290m. The main span pier would sit next to the navigation channel with five further supports founded on the river behind the pier.

The eastern landing (CA5) in Canary Wharf would be founded in the river almost in its entirety, with seven river supports in addition to the main span pier immediately adjacent to the navigation channel. The alignment ramp would run parallel to JP Morgan developments site for 150m with the finished level at least 5m above Thames path level. The ramp would be 380m from midspan to the landing site which is Westferry Circus. The requirement for split decks would be eliminated on the moving span due to the modest gradients leading from the crest curve. CA5 would achieve shallow gradients of maximum 3% gradient for 80m but with an extended flat 0% gradient section running for 85m before tying into Westferry Circus. Similar to the CB5 landing, a 1% gradient transition at chainage marker 625m from the 2% gradient incline leading from the moving span would provide access to lifts and stairs which would be situated to the south of JP Morgan development site.

Refer to drawing ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00005 in ***Appendix C*** for further details on CB5-CA5 baseline alignment.

2.2. Value engineering options discussed

Ref.	Description	Benefit	Advantages	Risks	Dependencies	Comments	Actions
VE1	Different route across river that provides a more direct route to Westferry Circus.	M	• Shorter overall route.	• Longer span over navigable channel. • Proximity to Jubilee Line. • Unknown location of Unexploded Ordnance (UXOs) in the river bed noted. Geophysics picks up all metal items not just UXOs. Severity of hazard increases with proximity to Jubilee Line. Probability of hazard decreases with shorter structure and fewer foundations.	• Ensure tie in to Westferry Circus. • Accessibility review.	More direct route. Boroughs prefer alignment. 10m extra main span length is small in comparison to the overall saving from shorter ramp length.	Core team to refine alignment option for costing. Accessibility review to be completed.
VE2	Construction on land behind the river wall adjacent to JP Morgan development site.	M	• Adjust ramp alignments to reduce length constructed in River Thames foreshore. • Cantilever support ramp from river wall.	• Impingement of Environmental Agency (EA) exclusion zone behind river wall resulting in interaction / clash with anchors.	• Discussion with JP Morgan regarding interface required.	Intrusion into JP Morgan site that jeopardises their planning permission is deemed too risky but building in front (river side) of the river wall from land to be investigated.	To be developed by Challenge Team.

Ref.	Description	Benefit	Advantages	Risks	Dependencies	Comments	Actions
VE3	Further reduce deck width from recommended to minimum values.	S	• Minimise the use of steel which has a high unit cost.	• Excessive reduction in width may adversely impact the view of how the deck integrates with the rest of the structure i.e. narrow deck with respect to tall massive towers. • Impacts on bridge user experience.	• Not likely to generate significant savings as width has already been discussed with TfL. Potential to generate more saving if agreed design values are revisited.		Core team to cost the minimum deck width option.
VE3a	Reduce ramp widths from landing site to intersection with lifts and stairs	S	• Narrower structure, reduced steelwork weight.	• Impacts on bridge user experience.	•		Core team to cost the minimum deck width option.
VE4	Challenge Port of London Authority (PLA) on the required navigable headroom and channel width.	S	• Minimise weight of moving span (reduced deck steelwork), lifting mechanism and associated costs. • Minimise approach ramp length and gradients and possibly eliminate the need for lifts.	• Strong objection by the PLA. • Narrowing navigational channel may require the bridge to be on a straight section of the river, further south. Less desirable connection on Canary Wharf side.	• Ensure tie in to Westferry Circus. Alignment is already flat at JP Morgan side.	No further work on height – covered by heights study.	Challenge team to review BS on navigation widths before progressing further.

3. River works constructability

3.1. Baseline river works constructability assumptions

Prior to the value engineering workshop, no design had been undertaken on the foundations so the baseline design described here relates to the Arcadis design. The towers supporting the main lifting span would be supported reinforced concrete piers on 8m x 15m caissons, designed to resist ship impact loads. The back spans and approaches in the river would be supported on reinforced concrete piers on caissons up to 8m in diameter. Including the two main span piers, a total of 14 foundations would be constructed in the river.

Refer to drawing ST_PJ585C-ATK-BAS-ZZ_12-DRG-DR-00005 in ***Appendix C*** for support locations.

3.2. Baseline cost

River works baseline cost estimate (not including overheads and profit) for the baseline alignment = £25.8M.

3.3. Value engineering options discussed

Ref.	Description	Benefit	Advantages	Risks	Dependencies	Comments	Actions
VE5	Temporary causeway or bridge to access main piers (half of the river at a time)	L	• Minimises costly river works operations. • Eliminate or reduce need for barge to transport.		• Discussion with PLA required. Note: the temporary causeway/bridge can be kept out of the navigable channel. • Discussion with EA regarding temporary flood capacity required.	Technical Note required to compare against the baseline cost estimate.	Constain to develop options as part of methodology in conjunction with Challenge Team.
VE6	Auger tubular piles	L	• Minimise noise. • Reduce clearances to	• Use of bentonite for piling in the river could make it difficult			To be incorporated by the Core Team.

Ref.	Description	Benefit	Advantages	Risks	Dependencies	Comments	Actions
			Jubilee Line tunnels.	to obtain consents even with controls (suitability of alternative materials to be investigated) • Concrete in river • Note: Cofferdam reduces risks • Consents with all associated stakeholders			
VE7	Precast caissons in dry dock and floated into position.	Negative value	• Reduces site concrete work and temporary works needed.	• River bed preparation very difficult to maintain whilst dropping in precast caisson.			No further action at this stage as not seen as financially beneficial.
VE8	Precast units used inside the cofferdam to form the caisson	L	• Reduces site concrete work needed. Easier and quicker delivery to site using the river. • No advantage for temporary works			Technical Note required.	Challenge Team to develop with Costain.
VE9	Precast post-tensioned units to form the tower	L	• Reduces site concrete work and temporary works needed.				Combined with VE24

Ref.	Description	Benefit	Advantages	Risks	Dependencies	Comments	Actions
VE10	Intrusion of temporary works into navigation channel	Risk		• Navigable Channel could be tight for any temporary works for foundation of piers or discussion with PLA regarding temporary works in navigable channel.			Add to Risk Log.
VE11	Construction noise. Potentially require double skin cofferdam to mitigate.	Risk		• Construction noise needs to be carefully considered. Significant objections from Canary Wharf.	• Understand how noise will be measured.		Add to Risk Log.
VE12	Remote logistics and compound area adjacent to river required	Risk		• Compound area required for temporary accommodation for work force.			Add to Risk Log.

4. Main span

4.1. Baseline main span design

The baseline bridge main span design is the Arcadis lifting bridge option planted on CB5-CA5 alignment (***section 2.1***) which comprises a 160m long concrete twin bowstring tied arch. The deck would be such that cyclists pass between and under the arch structure and towers, while pedestrians would use the cantilever footpaths on either side of the arches. The deck width would vary along the main span length, ranging from 12.6m at midspan to almost 20m towards the towers. The cyclists and pedestrians would be generally segregated by the structure with a mixing point at midspan as the depth of the bottom chord recedes. The cycle way would have a stiffened plate deck with open mesh areas adjacent to the arch to allow rainwater to pass through without a drainage water collection system. The footway would be of a similar construction. An architect's perspective of the Arcadis baseline main span design is as shown in ***Figure A-1***.

4.2. Baseline cost estimate

Main span design baseline cost estimate (not including overheads and profit) for the baseline alignment = £15.0M

4.3. Value engineering options discussed

Ref.	Description	Benefit	Advantages	Risks	Dependencies	Comments	Actions
VE13	Steelwork connection details	L	• Cost of steelwork is predominately based on the complexity of unique steel connection details. Simplifying or standardising can have a significant influence on cost estimate. • All elements same length therefore different spacing in bay?	• Significant increase in deadweight and hence foundation requirements.	• Discussion with steelwork fabricator required.		Core Team to engage with specialist contractors

Ref.	Description	Benefit	Advantages	Risks	Dependencies	Comments	Actions
VE14	Use bridge lift mechanism to lift central span into position	L	• Reduce erection costs.	• Increased fabrication costs. • Restricts construction sequence.	• Granularity of cost rate not yet developed in detail.	Need to understand what the baseline estimate assumes.	Costain to produce technical note comparing against baseline.
VE15	Use weathering steel to avoid maintenance painting	S	• Minimise maintenance cost.	• Weathering steel sections may not be available for the desired sections. • Potential impacts on aesthetics/ planning permission.	• Capital cost and whole life cost balance.		To be considered after concept design.
VE16	Deck drainage – drain directly off deck without channelling.	S	• Eliminate deck drainage costs.	• Likely to lead to environmental concerns.	• Discussion with EA over discharging directly into river.		Core Team – covered in Drainage Strategy Technical Note
VE17	Reduce main span length to minimum navigable channel width.	L	• Reduced main span complex steelwork thereby cutting on main span weight. • Reduced M&E lift requirements. • Reduced main span foundation sizes due to lower main span weight.	• Ship impact protection (either larger foundations or otherwise) encroaching into the navigable channel.	• Discussion with PLA required.		Covered by VE4

Ref.	Description	Benefit	Advantages	Risks	Dependencies	Comments	Actions
VE18	Architectural truss form (tapered top cord)	M	• Simpler connection details. • Stiffer structure.	•	•		Core Team to develop.
VE19	Standard truss form (more rectangular)	L	• Standard sections and connections. • Stiffer structure.	• Local Authority consents required. Does not fit in with surrounding environment. • Transport and Work Acts Order (TWAO) consent	• Granularity of steel costs in cost estimate required to understand and realise saving.		Challenge Team to develop.
VE20	Limit design wind speed in lifted position. Justified by assessing ship movements in high wind.	M	• Reduce design requirements.	• Bridge will be maintained in raised position	• Discussion with PLA and other stakeholders required.		Core Team to develop.
VE21	Fibre-reinforced Plastic (FRP) deck	Negative value	• Potential for a significantly lighter deck.	• Significant cost increase anticipated. • New technology for this type and size of structure.			Challenge Team to investigate if this is worth taking any further.
VE22	Steelwork fabrication offsite and transportation.	Risk	• TfL engineering has a build off-site ambition for its projects.	• Need to identify a suitable location and secure its availability.			Constain to develop as part of construction methodology.

Figure A-1 - Architectural render of baseline Arcadis lifting bridge main span

5. Towers

5.1. Baseline tower design

Prior to the value engineering workshop, no design had been undertaken on the towers so the baseline design described here relates to the Arcadis design. The towers would be formed of painted structural steel stiffened plates and have a height of 91m above mean high water springs (MHWS) supported on reinforced concrete foundations. The towers would provide sufficient space for the plant and steel block counterweights to rise and fall, access stairs or ladders and a lift, with the floors of the ladders and stairs doubling up regularly spaced diaphragms. The towers would be formed of two legs separated by the cycleway. There would be horizontal elements and cross-bracing at the bottom of the tower at the level of the arch cross-beam and near the top around the machine room and counterweight.

5.2. Baseline cost estimate

Tower design baseline cost estimate (not including overheads and profit) for the baseline alignment = £16.4M.

5.3. Value engineering options discussed

Ref.	Description	Benefit	Advantages	Risks	Dependencies	Comments	Actions
VE23	Steel truss-type tower	S	• Wider foundation enables more and hence shallower piles.	• Has the potential to make foundations very wide. • Increase in tower weight. • Imbalance in appearance – large piers carrying a small deck. • Canary wharf local authority consents require - does not fit in with surrounding environment. • TWAO consent risk.			Challenge Team to develop.

Ref.	Description	Benefit	Advantages	Risks	Dependencies	Comments	Actions
VE24	Concrete tower – jump form, slip form or precast construction	L	• Wider foundation enables more and hence shallower piles • Benefits with respect to ship impact loads.	• Has the potential to make foundations very wide. • Increase in tower weight. • Imbalance in appearance – large piers carrying a small deck. • Canary wharf local authority consents require - does not fit in with surrounding environment. • TWAO consent risk. • Open space available for inspection access.	• Cost saving is dependent on the granularity of steelwork cost rate.	Technical Note required – Challenge Team to assist.	Core Team to develop.
VE25	Main span lift counterweight – concrete with steel casing or other infill materials	M	• Steel casing is lighter to bring to site and can be infilled to the desired weight on site. • Likely a cheaper alternative than having a solid steel counterweight. • Could be used to get M&E tested before bringing to site.	• Infill material will have to be sufficiently dense to not increase tower steelwork and footprint.		Technical Note required – Challenge Team to assist.	Core Team to develop.

6. Approach span

6.1. Baseline approach span design

The approach spans over the river would comprise steel box girders below deck level with varying spans. The river approaches would be supported by reinforced concrete piers on caissons for the main and side spans and on driven piles elsewhere.

6.2. Baseline cost estimate

Approach spans design baseline cost estimate (not including overheads and profit) for the baseline alignment = £12.8M (superstructure up to and excluding back spans) + £13.8M (superstructure for back spans).

6.3. Value engineering options discussed

Ref.	Description	Benefit	Advantages	Risks	Dependencies	Comments	Actions
VE26	Approach span deck form – concrete or steel concrete composite. There is more work to be done by concept design team.	L	• Minimise cost of complex steel fabrication and construction.	• Changing form can increase depth, and hence take visual focus away from main span.	• Optimum cost for span length.		Core Team developing options for 40m or 55m spans and steel box or steel/concrete composite.
VE27	Earthwork ramp – Durand's Wharf	S	• Potential saving on earthworks ramp compared to pier and deck. • Minimises lighting required.	• Affects public open space. • Minimises sheltered spaces.	• Discussion with local authority required.		Core Team developing options.
VE28	Maximise approach ramp spans to minimise number of piers in the river	M	• Minimise complex river work operations.	• Increasing span lengths can increase deck depth, and hence take visual focus			Covered by VE26 and alignment

Ref.	Description	Benefit	Advantages	Risks	Dependencies	Comments	Actions
				away from main span.			
VE29	Steelwork erection	L	• Smaller individual components for approach spans can potentially save cost and programme.	• Concerns about amount of time available for each bridge lift.	• Plant required for bridge lift.		Core Team to engage with specialist contractors
VE30	Control of pedestrians and cyclists	Risk		• Barriers to prevent pedestrian, PRMs and cyclists crossing whilst the bridge is open requires more thought			To be developed as part of operational concept by the Core Team.

7. Mechanical and electrical

7.1. Baseline mechanical and electrical (M&E) design

In the Arcadis baseline M&E design, the bridge deck would be lifted by a total four winches located within the piers. At the top of each tower would be a set of sheave pulleys which would support the deck and counterweight. The weight of the deck would be balanced by a counterweight in each tower which would be connected to the deck by counterweight 'lift ropes' that would pass over the sheaves at the top of the towers. 'Drive ropes' would connect the soffit of the deck with the underside of the counterweight via the 'drive drum' in the pier base.

When the drum is rotated the counterweight would be pulled down which lifts the deck. Rotating the drum in the opposite direction would allow the counterweight to rise and the deck to fall. The counterweight would weigh slightly less than the deck dead load. A second drum on each hoist would incorporate a rope which would be attached to the underside of the bridge deck to prevent any chance of the counterweight keeping the bridge open.

Each drum would be electrically powered by motors and would have full redundancy with two electric motors and gearboxes. Normal service braking would be incorporated within the motor drives, and emergency braking would be provided by spring-applied, hydraulic release disc brakes mounted directly on the drum.

Longitudinal guidance of the bridge deck would be provided by guide wheels mounted on the bridge deck with allowance for thermal expansion. Lateral guidance during bridge deck lifting would be provided by guide wheels mounted on the bridge deck. The counterweights would also be guided to reduce noise and impacts from wind.

In the lowered position the deck would be restrained vertically by electrically actuated locking pins in the abutment which engage the bridge deck and the drive cable would be tensioned before locking the motor to ensure the deck could not lift from the bearings. There would be no mechanisms on the lifting deck. In the raised position the bridge would be supported by the lift ropes. When the bridge is in the raised position for maintenance, the deck and counterweight would be fixed with additional supports which would allow the ropes to be removed.

7.2. Baseline cost estimate

Mechanical and electrical design baseline cost estimate (not including overheads and profit) = £9.2M (not including lifts).

7.3. Value engineering options discussed

Ref.	Description	Benefit	Advantages	Risks	Dependencies	Comments	Actions
VE31	Remove maintenance access lift and replace with stairs (and winch for equipment) or ladders.	M	• Note: maintenance is only expected once every 6 months.	• Recovery of personnel needs to be considered.	• Construction Design and Management (CDM) regulations make it unlikely		Challenge Team to progress.

Ref.	Description	Benefit	Advantages	Risks	Dependencies	Comments	Actions
			• Significant cost saving and weight reduction.		to be able to argue removing stairs for ladder access.		
VE32	Remove backup generators. Replace with hook-up generator. Note: Power cuts are infrequent	S/M	• Save cost of procuring, installing and maintaining back-up generators.	• Increase opening times in emergencies.	• Opening at reduced speed.		Challenge Team to progress.
VE33	Carbon fibre lift ropes.	S	• Much lighter than steel ropes resulting in smaller lifting mechanism.	• There appears to less prevalent use of synthetic ropes compared to steel belts. • Main technology owners likely to be protective of patent rights. • Lack of a suitable design standard to work to making it very difficult to justify compliance with the Machinery Directive without extensive testing and third-party certification.			Challenge Team to produce Technical Note to explain why this will not be progressed further at this stage.
VE34	Energy regeneration options	S	• Improve likelihood of progressing TWAO. • Reduced operating costs.		• Capital cost and whole life cost balance.		No further work at this stage.

Ref.	Description	Benefit	Advantages	Risks	Dependencies	Comments	Actions
VE35	Fire suppression system. Note: not many flammable elements in plant room	Negative value		• Review if required. Previous design experience suggests not required. • No allowance made in cost estimate.			Next stage of design.
VE36	Intelligent monitoring systems to reduce maintenance requirements	Negative Value	• Small allowance made in cost estimate.	• Type of motor required makes it hard to remotely sensor.	• Capital cost and whole lift cost balance.		To be developed as part of operational and maintenance concept.
VE37	Public barriers for when the bridge is open. Note: £375,000 has been allowed for in the Arcadis design.	Risk		• Manned barriers may be required. • There's a risk of the public jumping over barriers depending on barrier design.			To be developed as part of operational concept by the Core Team.

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