3FMProject

Bringing Dublin Port To 2040

COWI, South Port Access, Road Opening Bridge, Preliminary Design Report

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Third & Final Masterplan Project

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DUBLIN PORT COMPANY – 3FM PROJECT

SOUTHERN PORT ACCESS ROUTE OPENING BRIDGE

PRELIMINARY DESIGN REPORT

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The sections of this report follow the Preliminary Design Reports template provided in Appendix C of TII DN-STR-03001-04.

APPENDICES

1 Executive Summary

Structure

Name:	Southern Port Access Route (SPAR) Bridge
Location:	Ordnance Survey Ireland: N: 718,100; E: 734,300
	Coordinates: 53.345°N, 6.226°W
Primary Function:	Highway Bridge
Check Category:	Category 3
Loading:	Two lanes road
	Two active travel pathways, one with Luas provision

2 Introduction

This report has been prepared to inform the planning application for the Dublin Port Company's (DPC) 3FM Project. The 3FM project is DPC's third and final masterplan project. The project focuses on developing the Southern Estate of the Port on the Poolbeg Peninsula without which, Dublin Port would reach its maximum capacity limit prior to 2040, which in turn would risk a national port capacity shortage.

2.1 Background

Intensification of the DPC owned lands on the Poolbeg Peninsula is limited by the single carriageway Tom Clarke Bridge. Since conception it has been recognised that the intensification of the Port lands was only feasible if additional road capacity connecting the Southern Estate to the Northern Estate and the M50 (Dublin Port Tunnel) was provided.

The concept for the Southern Port Access Route (SPAR) was developed in association with and subsequently detached from the Dublin Eastern Bypass (DEB). The NRA initially released a feasibility study in 2007 which included options for the DEB to be evaluated further. The concept for the SPAR developed following the creation and subsequent reviews/revisions of the Dublin Port Masterplan 2040, the Alexandra Basin Redevelopment and further feasibility assessments for the NTA Transport Strategy for the Greater Dublin Area 2022-2042. The SPAR will be a public road with restricted use.

2.2 Previous Studies and their recommendations

In 2007, NRA (now TII) released a feasibility study of the Dublin Eastern Bypass (DEB). Sector A Dublin Port to Sandymount had 5 options as shown in Figure 1 below taken from Page 47 of the report.

- Option A1 – Medium level bridge close to East Link / Tom Clarke Bridge
- Option A2 – Shallow Cut & Cover Tunnel close to East Link / Tom Clarke Bridge
- Option A3 – Bored Tunnel on most direct route across the central port
- Option A4 – High level skew bridge on most direct route across the central port
- Option A5 – High level square bridge between central and eastern port areas

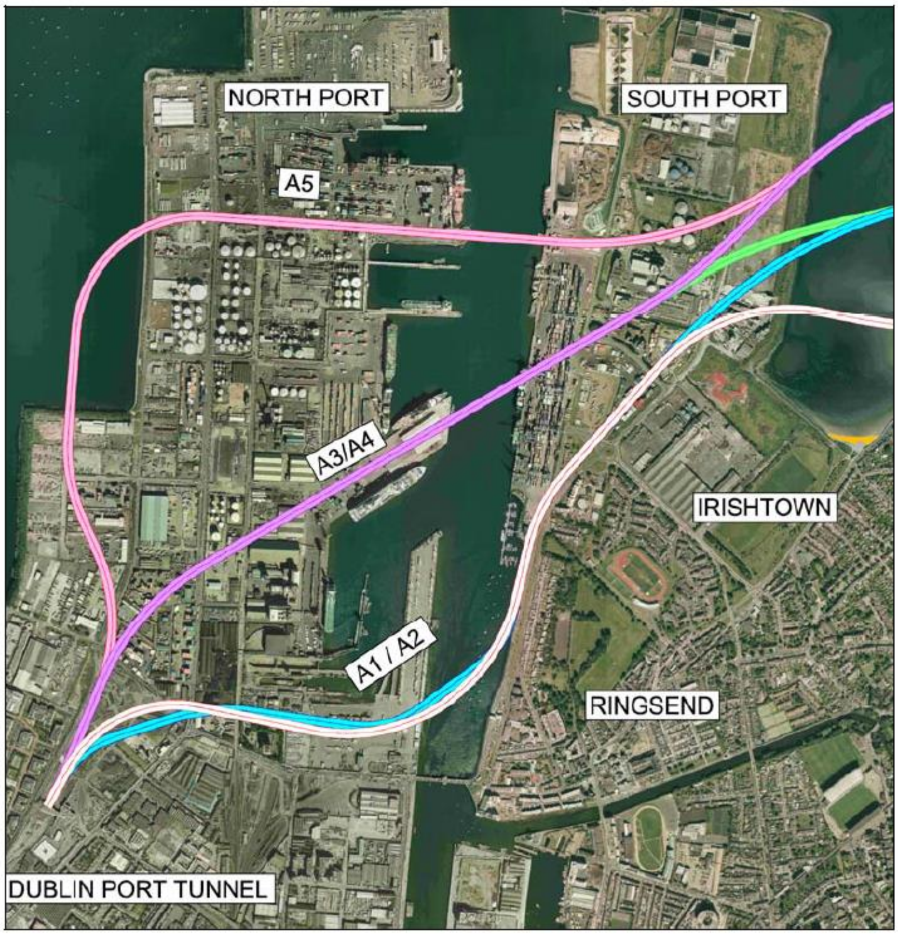


Figure 1: NRA Dublin Eastern Bypass Feasibility Study – Sector A Route Options

Options A1, A2 and A4 were identified to be brought forward for further evaluation.

Further appraisals were carried out in the intervening period culminating with the introduction of the Southern Port Access Route (SPAR) and the removal of the DEB from Policy. A Route Options for SPAR Working Paper carried out in 2021 identified that the preferred route option for the SPAR would be a medium level bridge close to Tom Clarke Bridge (similar to Option A1 from the 2007 DEB Feasibility Study).

2.3 Proposed Development

The proposed road network will primarily consist of a new section of carriageway that will connect the Northern Estate to the Southern Estate, referred to as the Southern Port Access Route (SPAR). The SPAR itself is defined as the entire route from North Wall Quay Extension in the north, to the Area O access point at the south, as shown in Figure 2 below, with a total length of 2.3km.

At the northern end, the SPAR will connect into the proposed Berth 18 Access Road which connects to Alexandra Road, providing a congestion free link across the River Liffey on a new bridge and viaduct, landing on the southern shoreline in close proximity to the proposed Maritime Village. The SPAR will then connect into a re-aligned Whitebank Road which connects into the Pigeon Hose Road and South Bank Road. The 3FM Project will also provide upgrades to the existing road network throughout the Southern Port.

Figure 2: 3FM Project Preliminary General Arrangement Layout (May 2024)

2.4 SPAR - Operational Considerations

The SPAR will be a public road with restricted use. The SPAR will accommodate port-related traffic movements from Areas K, L, N and O and connect them to the Northern Estate and the M50 (Dublin Port Tunnel). Although the majority of SPAR traffic will be HGVs connected with the operation of the Port, the SPAR will also accommodate other traffic flows such as Public Transport, traffic movements from the Covanta Waste-to-Energy Plant and other Goods vehicles.

The key principles behind the development of the SPAR are:

- The HGV vehicles will be removed from the external DCC road network,
- Port traffic will be relocated further from residential areas,
- Traffic flows will be relatively free-flowing.

These principals should reduce the impact of the HGVs on traffic capacity, congestion, air quality and noise.

The SPAR has been developed with an opening bridge section across the River Liffey and a viaduct running alongside the existing R131 until landing on the southern shoreline near the Maritime Village. The bridge section and viaduct will accommodate active travel to provide sustainable transport connections for staff and visitors of the 3FM scheme, in addition to providing a community gain and interconnection between public realm schemes.

3 Site & Function

3.1 Site Location

The bridge site is in east-central Dublin, just to the east of the existing Tom Clarke Bridge. This area has changed rapidly in recent years, with significant development extending the city centre along the banks of the Liffey to meet the edge of the port at East Wall Road. The proposed new road will run parallel to the East Link Toll Road on the south bank of the river. The SPAR terminates at the North Wall Quay Extension, continuing via the port's internal road network to connect to Alexandra Road at the Dublin Port Company's entrance to the north port.

The site plan is included in Appendix A; an extract is shown in Figure 3.

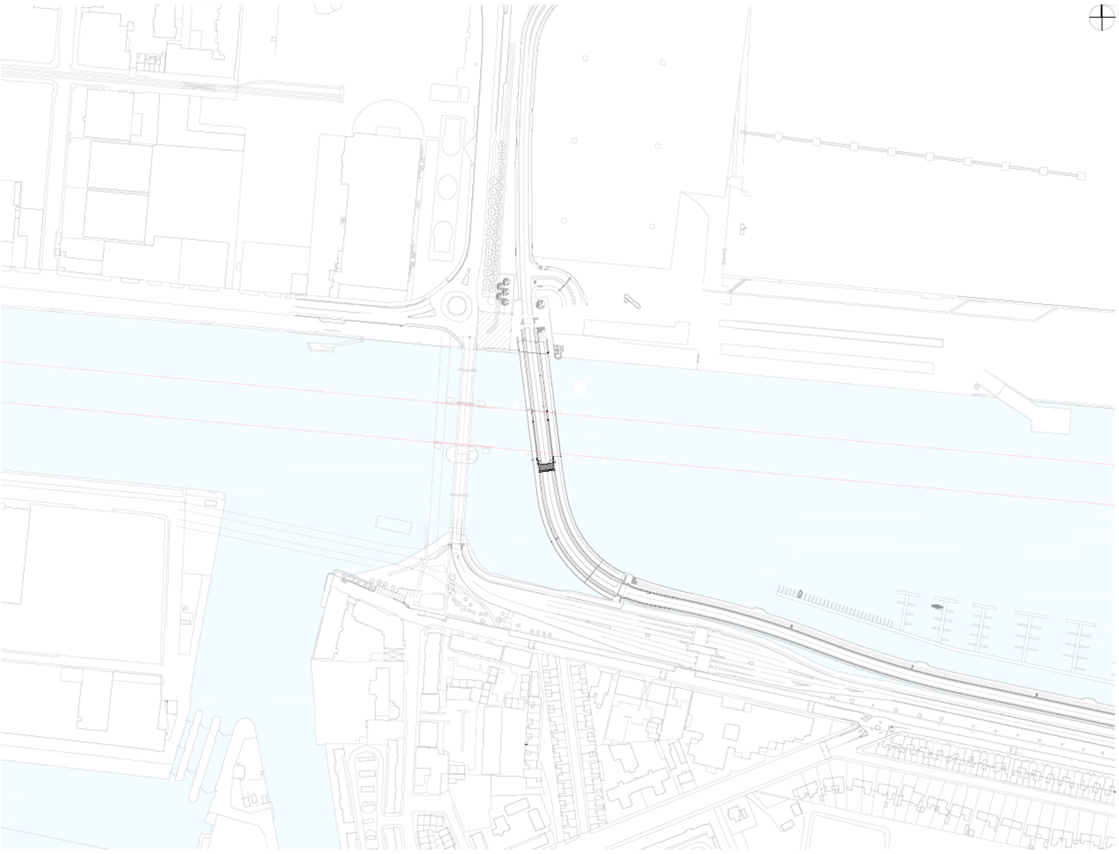


Figure 3: Site Plan, extracted from drawing CP1901_3FM-MOXON-SBR-SP-DR-A-100-00001

3.2 Function of the structure and obstacles crossed

The bridge will carry two lanes of vehicular traffic, one in each direction. This is expected to comprise a high proportion of HGVs. The bridge provides a dedicated link between the northern and southern sides of the port development which will significantly reduce the volume of port traffic that currently uses the adjacent Tom Clarke Bridge.

Pedestrians and cycles will be carried in both directions on active travel pathways which are segregated from the vehicle carriageway. The active travel routes connect the current pedestrian routes along the North Wall Quay to the Marina on the South bank of the Liffey and the Poolbeg Peninsula beyond.

The North abutment of the SPAR bridge will be located adjacent to the proposed North Wall Square at the southern end of the Liffey-Tolka scheme. This proximity will allow a clear, legible connection between the two schemes.

The primary active travel route is provided on the seaward side of the SPAR bridge allowing users an unobstructed view out towards the sea for the entire crossing length. This arrangement requires users to cross the SPAR itself to return to the city on the North and South banks of the river.

Figure 4 shows an illustrative summary of the pedestrian and traffic flows.

The scheme includes provision for the potential extension of the Luas system. A supplementary active travel path allows pedestrians to cross the Liffey whilst remaining on the western, city-facing side of the bridge. The primary bridge structure shall be designed to enable this walkway to be converted into a corridor for light rail in the future.

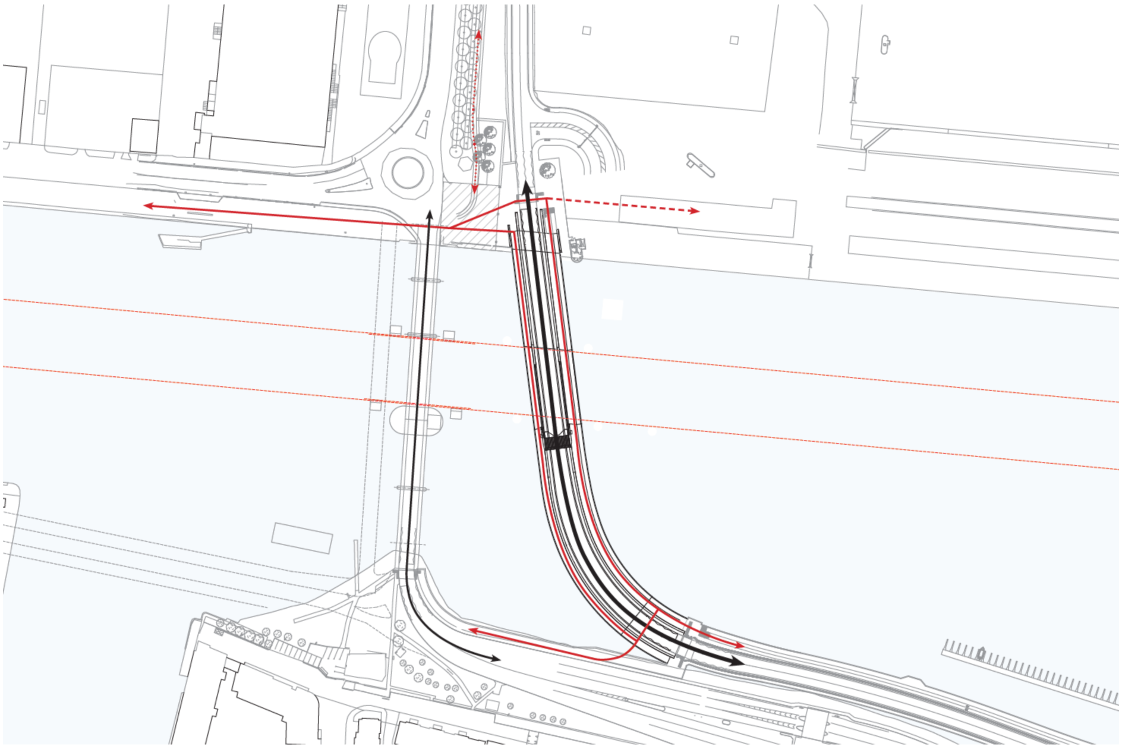


Figure 4: Diagram showing pedestrian and traffic flows

The bridge crosses the River Liffey and must provide the following navigation envelopes:

Open Position:

The position and size of the navigation channel is defined by the adjacent Tom Clarke Bridge. It has unlimited vertical clearance for a width of 30.5 m and a slightly reduced clearance adjacent to the machinery pier, see Figure 5. The navigation channel is parallel to the northern quayside.

For comparative purposes, the designers' understanding of the clearances at the Tom Clarke Bridge are shown in Figure 6.

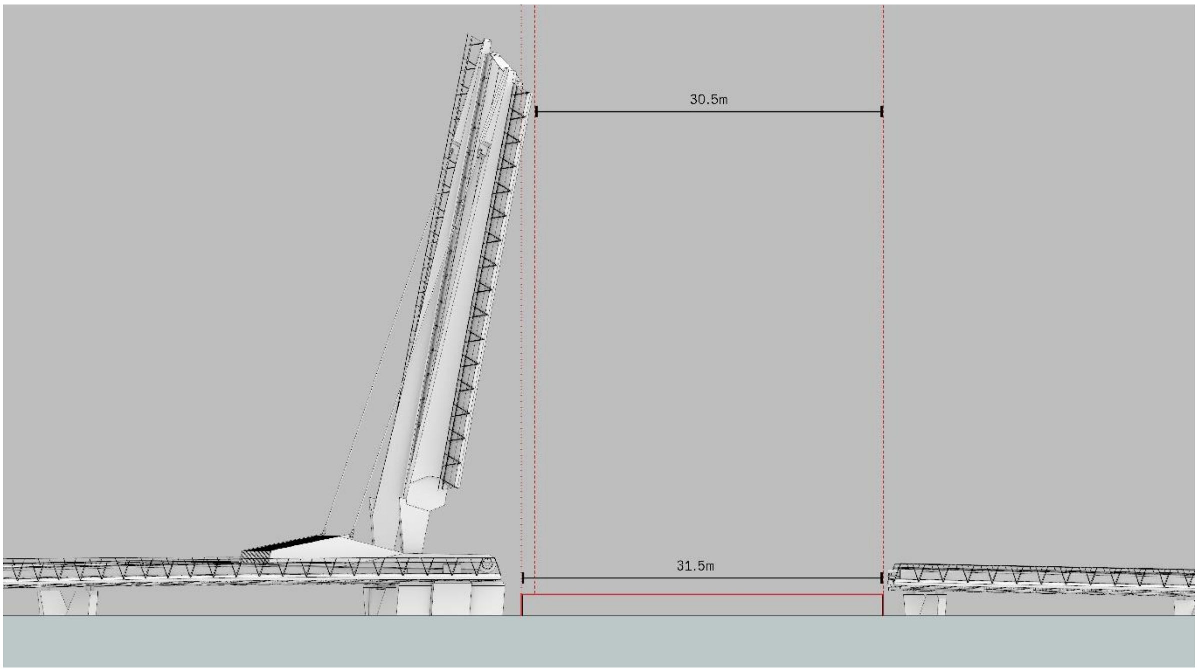


Figure 5: Proposed SPAR Bridge - Open Position

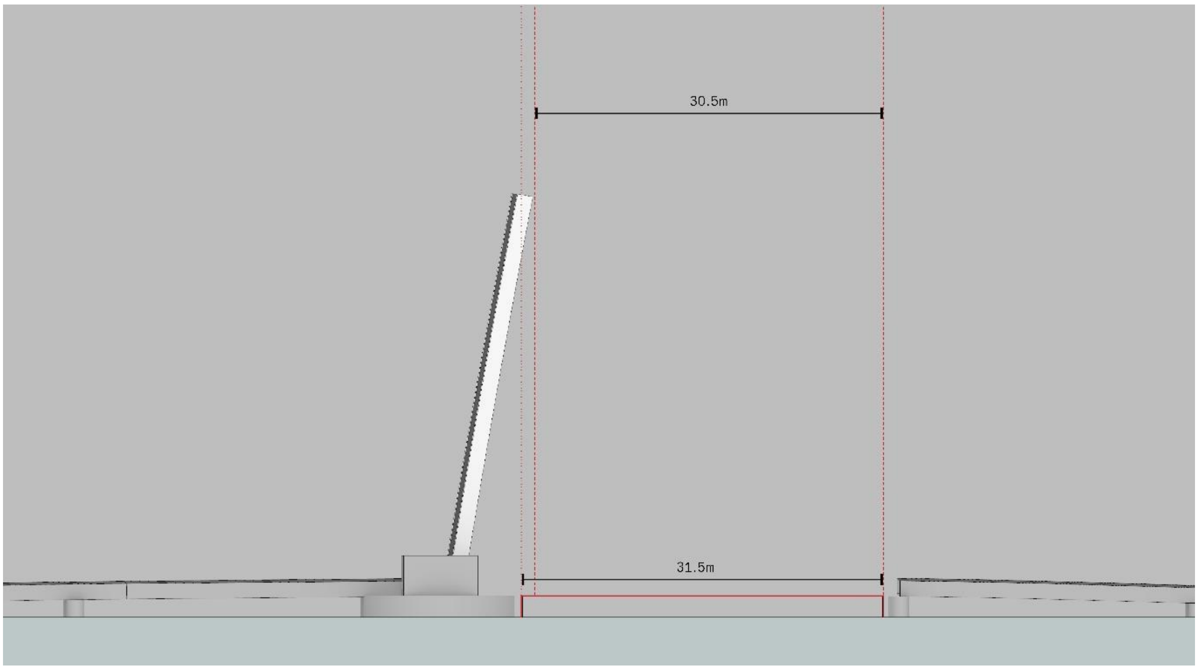


Figure 6: Understanding of Tom Clarke Bridge Clearances in Open Position

Closed Position:

A minimum clearance of 1.85 m above the Highest Astronomical Tide level across the full width of the navigation channel.

An additional navigation envelope that is desirable to maintain is the section of river used by the local rowing club adjacent to the Tom Clarke Bridge. This has been assumed to be a 20 m wide channel aligned as shown in Figure 7, with a 1.2 m clearance above the Highest Astronomical Tide.

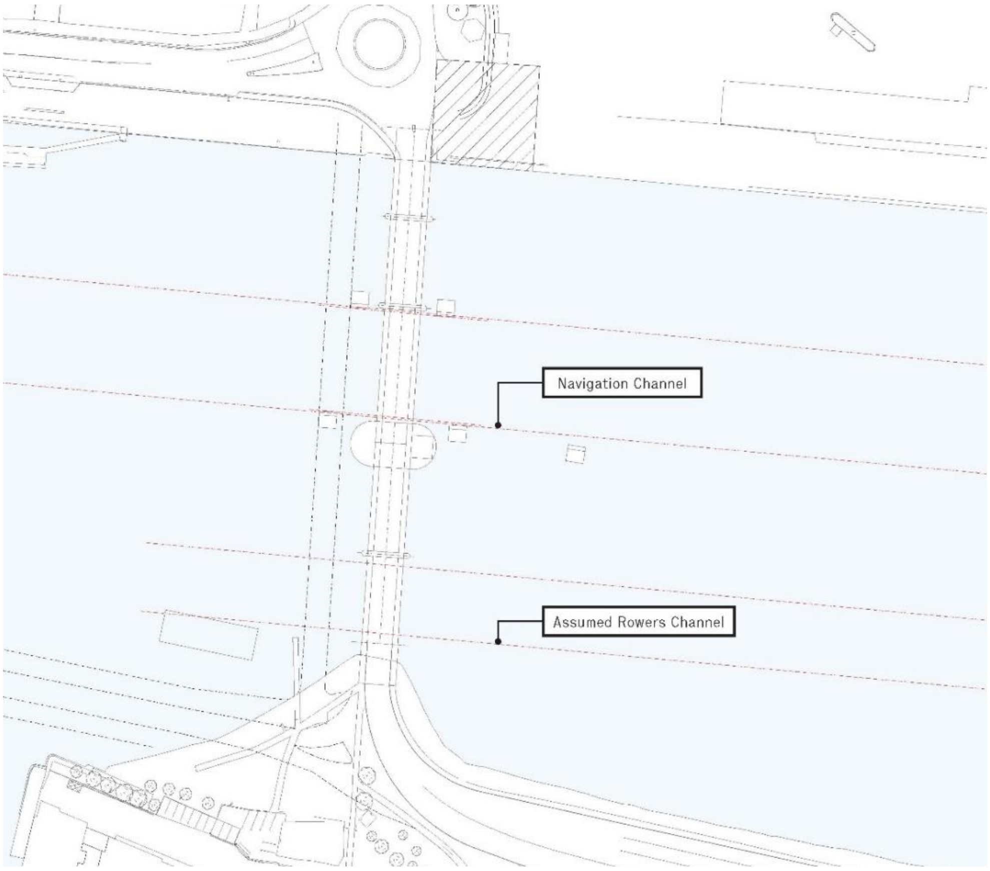


Figure 7: Plan of channels with respect to the existing Tom Clarke Bridge.

To minimise additional obstruction in the river to the rowers' channels, the piers on the SPAR bridge will be aligned to the existing supporting structures on the Tom Clarke Bridge. In general, lines parallel to the channels shown in Figure 7 are used to inform the allowable extents of piers for the SPAR bridge.

3.3 Choice of location

The choice of location is described in 3FM reports produced by the Dublin Port Company. The chosen alignment was determined as a result of the studies in CP1901_3FM-RPS_26-HGN-XX-RP-C-00001.

3.4 Site description and topography

The site is situated in the Dublin Docklands Area, a largely flat urban environment with significant industrial operation. The bridge is surrounded by primarily commercial buildings up to eight storeys in height on the north side, and residential buildings up to three storeys in height on the south side. Notable adjacent buildings include the 3Arena (Point Theatre) on the north side.

The proposed bridge is approximately 50 m from the Tom Clarke Bridge, as measured from the centrelines of the bridges' carriageways on the north bank of the river.

The usefulness of Active Travel routes on the bridge relies on their connectivity to adjacent schemes. Key adjacent schemes include:

- Liffey-Tolka Greenway: New public realm along East Wall Road connecting the River Liffey to the River Tolka. The North Wall square would be a key interface with the North Abutment of the SPAR.
- Point Bridge: Potential bridge scheme located directly West of the Tom Clarke Bridge to supplement and/or replace the Active Travel pathways on the Tom Clarke Bridge.
- Dodder Bridge: Proposed public transport bridge link across the mouth of the Dodder to link the South Quay to the Southern end of the Tom Clarke Bridge. The bridge will cater for local buses, pedestrians and cyclist. Provision for a Luas (light rail system) extension is included, however private cars will be prohibted from using the bridge.

3.5 Vertical and horizontal alignments

3.5.1 Horizontal Alignment

The majority of the existing bridges crossing the River Liffey connect roughly North-South across the river, typically taking a straight path for the shortest route from bank to bank (Figure 8). The orientations of the bridges are generally informed by their onward connections, with the majority aligned to the city grid which runs roughly perpendicular to the channel. East of the Tom Clarke Bridge the city grid becomes less rigid, reducing the perceived influence of the grid on the alignment.

Figure 8: Overview of existing bridges across the River Liffey (Google Maps)

The horizontal alignment for the SPAR Bridge is an important consideration. The challenge is to bring the port traffic from a North-South route on the North bank to an East-West route on the South bank whilst retaining a straight and efficient alignment in keeping with the other bridges over the River Liffey.

The northern landing point of the Bridge is constrained by the proximity of ABR development, the proximity of and interaction with the proposed Liffey Tolka project including the North Wall Square, the proximity of the existing R131, and Port ownership boundaries. The North Wall Quay Extension is currently being added to the Record of Protected Structures by Dublin City Council. Careful consideration therefore needs to be given to the design of the bridge abutment at this location to avoid impact, if possible, or to minimise impact where interventions are deemed necessary.

The southern landing point of the bridge/viaduct is constrained by the proximity of the existing R131, the Maritime Village, and Coastguard Cottages on Pigeon House Road. The R131 is a toll road, and the existing toll booths present a local widening of the road; the SPAR will run parallel to this road and would need to curve around the toll area.

Providing a compliant highway alignment requires a bend in the horizontal alignment above the river. For the chosen bascule opening mechanism it is desirable to retain a straight lifting span. Several alternative alignments were considered to achieve this, as discussed in the Feasibility Study, CP1901_3FM-RPS_S26-HGN-XX-RP-C-00001.

The final horizontal alignment for the SPAR Bridge follows a skew of approximately 12.5° relative to the perpendicular from the north bank. This runs parallel to the alignment of Pembroke Cottages (Figure 9). The alignment allows the bridge to run straight until the southern end, where it curves to run parallel to the southern bank. The radius of curvature is 90 m, measured at the centreline of the vehicle carriageway. The length of the bridge crossing is minimised as far as possible considering the previously listed constraints.

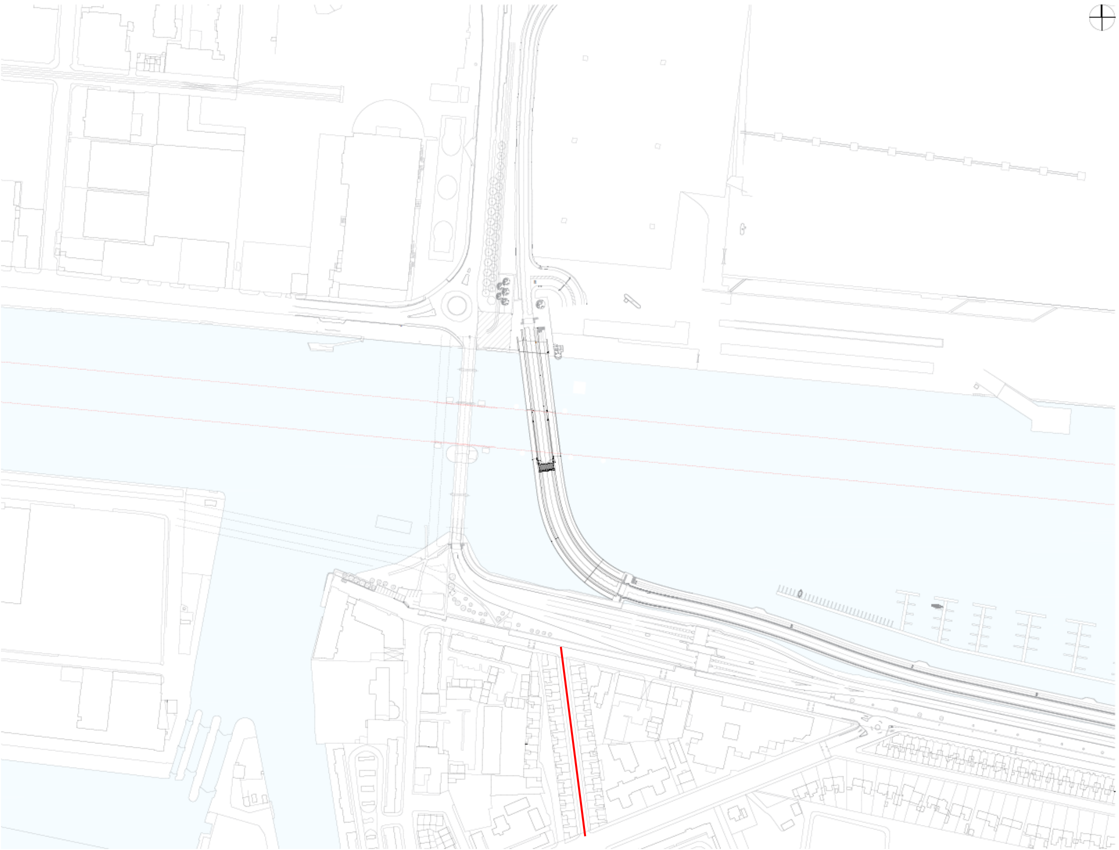


Figure 9: SPAR Alignment with Pembroke Cottages highlighted.

3.5.2 Vertical Alignment

The vertical alignment of the top surface of the deck is defined to satisfy accessibility and drainage requirements as follows:

- Longitudinal geometric limit – Maximum 1 in 25 over 70 m (1 in 30 preferred). Maximum 1 in 50 achieved, providing a comfortable gradient for pedestrians and cyclists.
- Transverse geometric limit – Typically up to 1 in 50 on pedestrian walkways.

In addition to the structural and architectural criteria, the deck soffit profile must also satisfy the required clearances for waterway traffic described in Section 3.2. For the flooding requirements, minimum clearances are based on the flood levels provided in Section 3.9.

Pier P3 houses the mechanical components used to lift the bridge. The top of the pier wall is located at +4.45m OD elevation. This corresponds to the design 200 years return period flood event, plus 1 m allowance for climate change, plus freeboard of 0.3 m as defined in Dublin Port Coastal Water Levels Design Memo (RPS June 2022). This ensures that the key lifting components are protected against foreseeable flooding events to ensure continued operation during and after such conditions.

It is not feasible to achieve this same design level at all intermediate piers and abutments, whilst also connecting to adjacent roads and pathways. There is also a desire to reduce the visual impact of the structure as it nears the riverbanks, particularly from residential properties on Pigeon House Road.

The lowest levels on the beams at each pier are given in the below table, defined by the highway alignment. Note that the top level of the pier will be defined by the beam level and the thickness of the bearing and associated connections and plinth.

Pier	NA	P1	P2	P3	P4	P5	P6	P7
West Beam Lowest Point (mOD)	3.28	3.77	4.25	4.84	4.72	4.26	3.74	3.33
East Beam Lowest Point (mOD)	3.28	3.77	4.25	4.84	4.56	3.95	3.42	3.05

The significant climate change allowance means that the SPAR Bridge has been designed for more onerous flood levels than those that were used for the Tom Clarke Bridge. This manifests in the soffit of the SPAR bridge sitting higher than that of the Tom Clarke Bridge. Care has been taken to minimise this difference in level.

The cross-section arrangement, as described in Section 3.6, allows the running surfaces of the SPAR Bridge to stay as close to those of the Tom Clarke Bridge as possible, such that bridge users are at a similar level on both bridges. This helps reduce the perceived difference in level between the SPAR bridge and the Tom Clarke Bridge.

3.6 Cross sectional dimensions on the alignments

The functional width of the bridge comprises the following elements shown in Figure 10:

- A traffic-carrying central deck with varying width from 10.8 m to 11.8 m, including:
  - A two-lane carriageway with total width varying from 7 m to 8 m (i.e. 3.5m to 4m per lane)
  - Vehicle containment system, drainage, etc.
- A primary Active Travel path, including:
  - A two-way cycleway with a minimum clear width of 3 m.
  - A footway adjacent to the cycleway with a clear width of 2 m. The footway is located to the outside edge of the bridge to allow the slower moving pedestrians to pause and look at the view.
- An additional path with a clear width of 3.3 m, initially considered as a shared footway and cycle path but with provision to be converted to accommodate the Luas

By allowing the main structural elements to protrude above the deck level, the level of the deck surfaces can remain low. This allows the carriageways and Active Travel pathways to meet ground level earlier, reducing the length of approach ramps. This also minimises the height that the bridge is required to climb to pass over the navigation clearances, enabling the comfortable longitudinal alignment described in Section 3.5.

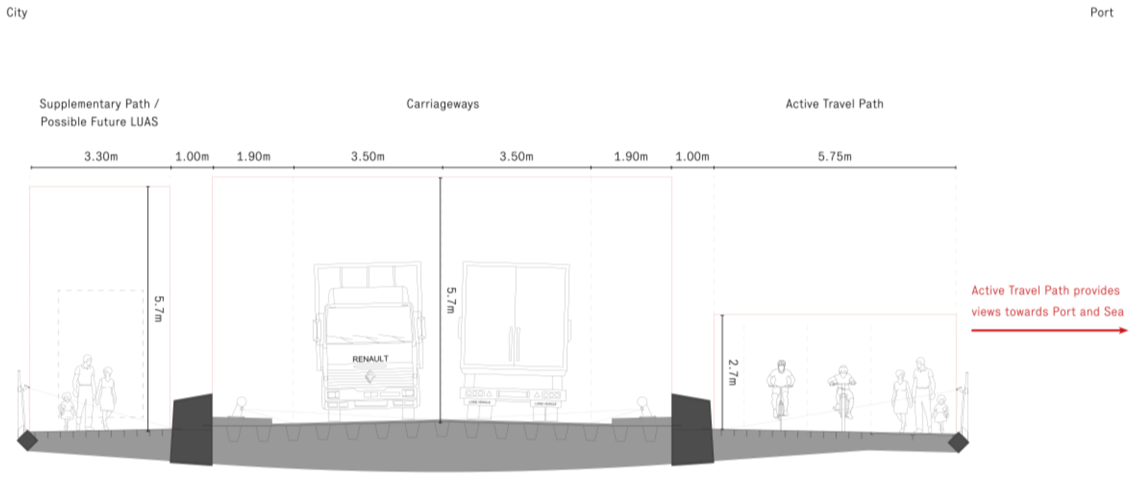


Figure 10: Functional Cross Section showing typical bridge widths

Locating the main structural beams adjacent to the carriageway provides segregation between the carriageway and Active Travel pathways, increasing the perceived comfort of the Active Travel users. This also allows lightweight structures to be used for the Active Travel walkways, reducing the visual impact of the structure.

3.7 Existing underground and overground services

There is a 38kV Cable close to the North Abutment which may need to be diverted depending on the extent of works in that area.

There are no known services in the river.

The feasibility report (CP1901_3FM-RPS_S26-HGN-XX-RP-C-00001) discusses services along the SPAR route.

3.8 Geotechnical summary

The geotechnical design is discussed in Section 8. To summarise, the ground around the bridge comprises clayey deposits with underlying strata of glacial deposits and limestone. The bridge piers are expected to be situated on piled foundations with piles of approximate 1200 mm diameter which penetrate into the underlying strata. However, the pile diameters and pile layout will be developed and reviewed during detailed design.

3.9 Hydrology and hydraulic summary

The tidal levels applicable to the site are:

Description	Abbreviation	Level relative to OD Malin OSGM15
Highest Astronomical Tide	H.A.T.	+1.99 m
Mean High Water Spring	M.H.W.S.	+1.59 m
Mean High Water Neaps	M.H.W.N.	+0.89 m
Mean Sea Level	M.S.L.	-0.11 m
Mean Low Water Neaps	M.L.W.N.	-1.01m
Mean Low Water Springs	M.L.W.S.	-1.81 m
Lowest Astronomical Tide	L.A.T.	-2.61 m

The flood levels applicable to the site for various return periods are:

Return Period	Annual probability of exceedance	Flood Level relative to OD Malin OSGM15
5 years	20%	+2.79 m
10 years	10%	+2.86 m
50 years	2%	+3.01 m
100 years	1%	+3.08 m
200 years	0.5%	+3.15 m
An additional 1 m may be considered for a high-end future climate change scenario		

The datum used for these levels is the Malin Head Ordnance Datum. The marine chart datum is 2.51 m below the Malin Datum.

3.10 Archaeological summary

An archaeological survey has not yet been carried out at the site of the SPAR bridge. However, a survey conducted as part of the proposed Docklands Bridges nearer the Samuel Beckett Bridge to the west of the Tom Clarke Bridge found no items of archaeological interest.

The existing North Wall Quay is a protected structure, constructed in the 19th century. The wall comprises large substructure blocks (devised by the engineer Bindon Blood Stoney) topped with large granite blocks, concrete rubble, and a blocked granite façade. The North Wall Quay Extension, the section of the quay east of the Tom Clarke Bridge, is currently being added to the Record of Protected Structures by Dublin City Council.

3.11 Environmental summary

The environmental constraints in the vicinity of SPAR are described in the Environmental Impact Assessment accompanying this application. The report herein forms part of the basis for the EIA. The conclusions of the EIA are provided in its own report which has been prepared in parallel to this report.

4 Structure & Aesthetics

The bridge is to be designed in accordance with Transport Infrastructure Ireland (TII) publications and IS EN Eurocodes with their associated Irish National Annex. An architectural render of the bridge is shown in Figure 11.

Figure 11: Architectural render of proposed SPAR bridge

4.1 General description of recommended structure or family of structures and design working life

The overall structure comprises seven spans, listed in order from north to south: two spans for the northern approach; one opening span over the navigation channel; three spans for the southern approach; and a transition span to the adjacent SPAR viaduct structure. The SPAR viaduct is described in a separate Preliminary Design Report, document reference IE000336.

The main span will be lifted as a single-leaf bascule, pivoted on the machinery pier to the south of the navigation channel. A visible counterweight is held above the deck on a pair of shaped steel arms that are in turn supported on the machine pier, providing a dramatic and unexpected opening sequence. The counterweight provides assistance to the opening of the bridge, which will be raised by a pair of hydraulic cylinders located in the machinery pier and connected to the underside of a transverse beam below the deck.

General arrangements are provided in Appendix A. Further architectural views are provided in Appendix C.

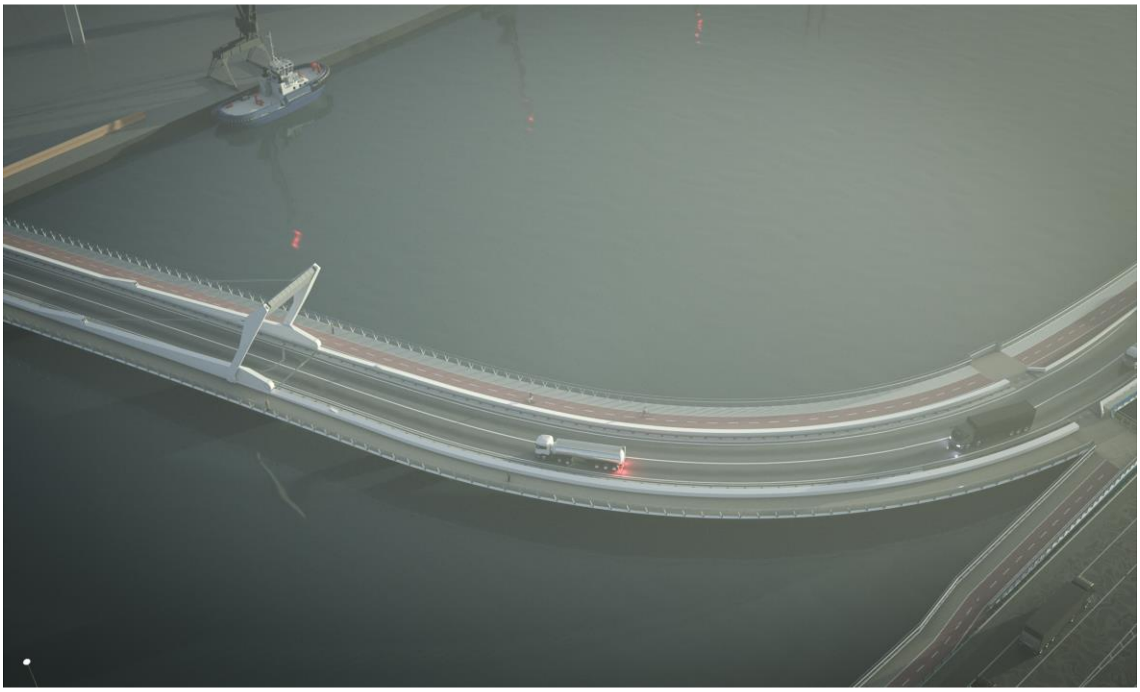


Figure 12: SPAR Bridge Overview

4.2 Aesthetic considerations

Section 2 describes the SPAR Bridge location and how the site constraints have informed the design. The following section describes the overall aesthetic ambitions of the proposed design. The architectural and aesthetic considerations have been an integral part of the design and decision-making process, and therefore discussion of aesthetics is not confined to this section.

As described in Section 2, the SPAR Bridge is located on the edge of the city centre, where the new urban development meets the boundary of Dublin port. The port remains a busy working port (the bridge is required as part of a project to expand its capacity) and the associated boats and cranes are clearly visible from within the city.

Figure 13: View of the Port infrastructure from the Tom Clarke Bridge

This location on the threshold of the port and the city offers the opportunity for a modern bridge design that draws on the port heritage. An opening bridge provides further possibility to reference the cranes and machinery of the port. The bridge is designed to express the different parts of the opening mechanism, how they are connected and how they move around each other in operation to achieve their function in a dramatic but efficient manner.

4.2.1 Opening Span

As the easternmost bridge over the River Liffey, the SPAR bridge occupies a prominent location. It is important that it acts as a gateway for marine traffic entering and leaving the city. The visible counterweight gives the structure a distinct identity, and the opening sequence provides additional drama as the bridge moves to allow vessels to pass. The counterweight and support arms act as a gateway for vehicles travelling between the two sides of the Port to pass through.

The main spine beams that support the lifting span are shaped according to their function and structural need. The tapering form is dictated by the structural demand, growing from the typical beam depth at the tip of the cantilever to become deeper above the machinery pier where the structural demand is greatest during opening. The beams are shaped to receive the connections to the hydraulic lifting cylinders, pin bearings and counterweight cables, clearly expressing how the different components of the mechanism meet.

Where the beam passes the arm supporting the counterweight, the elements are shaped such that they can only move in the way they are intended. The shaping of the beam prevents the counterweight from rotating towards the navigation channel, even if the cables were to fail. See also Section 6.3

The shape of the opening span (in plan) is defined by the skewed relationship between the lifting span and the navigation channel. This results in an angled cut to the end of the opening span, that is designed to minimise the area of deck lifted whilst providing the required navigation clearance.

Figure 14: SPAR Bridge Opening Span during opening sequence.

Figure 15: Shaping at Pivot of Opening Beams

4.2.2 Counterweight

The counterweight provides a distinctive, gateway-like structure, creating a landmark for the port and the city.

Figure 16: Counterweight portal acts as a gateway to the Port

Initial conceptual designs for the counterweight incorporated granite slabs to provide the required mass. The intention is that the granite complements the material used in of the quayside including the historic North Wall Quay. The material could be sourced either from local quarries or existing blocks removed as part of the 3FM Project if available. The slabs are arranged in a vertically striated pattern parallel to the plane of rotation of the counterweight arms, breaking up the mass of the block and giving a more dynamic aesthetic.

The use of local granite is the preferred solution; however the detailing of the solid granite will require particular consideration at the detailed design stage in order to minimise material waste, optimise the size of the slabs and ensure suitable fixings. It is likely that design and performance criteria would be driven by client requirements as there are few standards available that concern the detailing of solid granite.

An alternative solution could be to use a reconstituted stone - effectively concrete with a significant proportion of granite aggregate – to achieve a similar effect; this would be subject to significant sampling to ensure a suitable finish. In this case, reinforcement or precast shells could be used to provide a suitable structure to span the carriageway. The design and detailing of such a counterweight would be significantly similar than using larger granite blocks.

4.2.3 Typical Cross Section - Thin Edge & Pedestrian Experience

Locating the main structural beams adjacent to the carriageway provides segregation between the carriageway and active travel pathways. This physical separation between the vehicular traffic and Active Travel users gives a greater feeling of safety and increases the comfort of the bridge users.

Locating the active travel paths on the outside edge of the carriageway allows uninterrupted views off the bridge, allowing views straight down to the water. Physically separating the active travel paths from the carriageway also allows a more lightweight cantilevered structure with slimmer edge beams to be used for the active travel paths. As the paths form the outside elevation of the structure this thin edge reduces the visual impact of the bridge.

Separating the active travel paths from vehicles also opens up opportunities for different surface materials on the paths and allows a lightweight parapet to the outer edges of the bridge. This is especially important as these are the elements that members of the public will come into direct contact with.

Figure 17: Traffic separated from walkways by spine beams allows a thin, open edge condition

4.2.4 Soffit

The soffit of the bridge is shaped to respond to the structural demand, with the soffit describing a smooth arc deepest in the middle of the transverse beams. This form extends into the cantilevers supporting the Active Travel paths making a clean, simple soffit form.

The grid of beams and the cantilever arrangement has been considered carefully. The soffit is visible to marine traffic at all times, and when the bridge opens the soffit of the lifting span is revealed. Studies were undertaken to define an efficient module that also resolved the skewed form of the lifting span cleanly. This resulted in the spacing for the transverse beams with an angled sub-grid related to the angle of the navigation channel defining the alignment of the cantilevers.

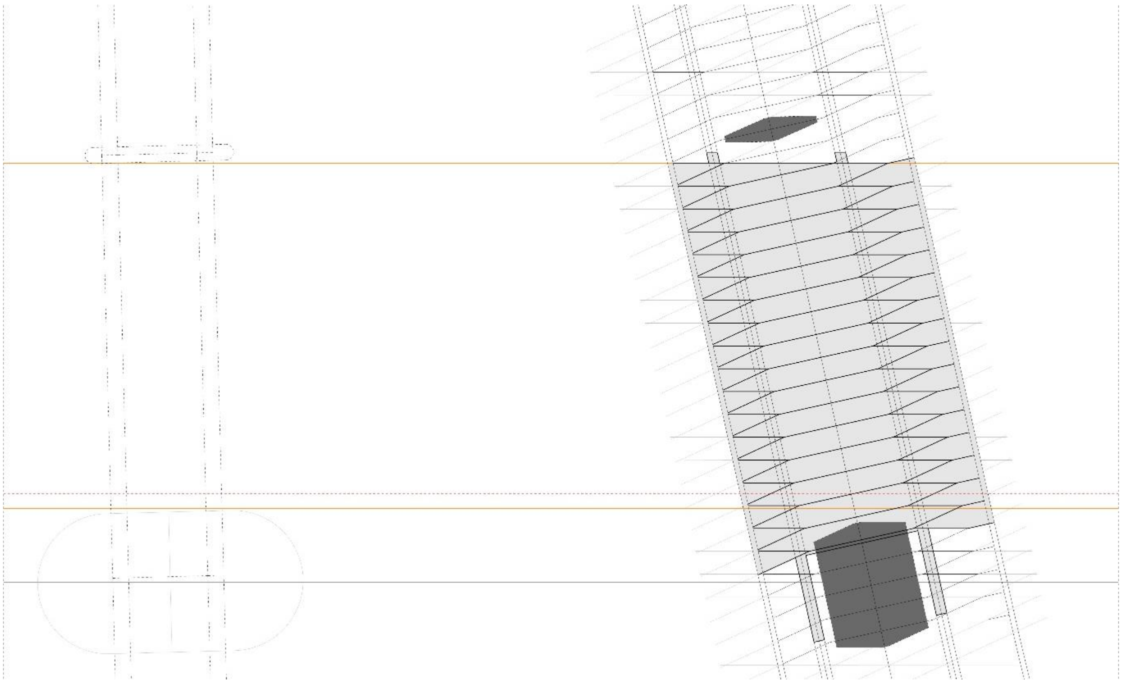


Figure 18: Soffit diagram showing sub-grid defining geometry

Figure 19: Lifting Span Soffit View

4.2.5 Piers

See also 4.3.6

The Y-shaped form of the piers was chosen as a natural response to the arrangement of the cross-section. The form allows the base of the pier to be as narrow as possible, reducing the impact on the river and requiring a single foundation. The pier then bifurcates to pick up the two main longitudinal beams.

The plan form of the pier is lozenge shaped, relating to the angled sub-grid described in Section 4.2.4. This gives a thin leading edge which reduces the impact on the flow of the river and reduces the visual mass of the pier. The angled faces of the pier further break up the visual mass of the pier.

Figure 20: The geometry of the piers allows light to catch the faces differently to break up the visual mass

4.2.6 Parapet

As noted in Section 3.6, locating the pedestrian walkways outside of the vehicular containment system allows a more lightweight parapet system more suited to a pedestrian environment. Section 4.3.9. describes the technical requirements for the parapet to act as edge protection for the pedestrian and cyclists.

Located on the edges of the bridge the parapet is an important part of the appearance of the bridge from a distance. Simultaneously, as one of the elements closest to the active travel users it is also an important part of the experience from on the bridge.

The proposed parapet consists of a bespoke assembly consisting of an array of V-shaped twin plate painted steel posts and stainless steel rails with a lightweight stainless steel tension mesh infill. The posts are shaped to reflect the language of the cantilevers visible on the soffit of the bridge, continuing this above deck.

The bifurcating posts support a stainless steel lean rail at 1.1m above deck that encourages pedestrians to pause and take in the views out to sea. The lean rail also conceals lighting for the active travel paths and will be utilised for any interfaces with the pedestrian barriers.

The tips of the bifurcating posts support a minimal top rail at 1.45m above deck, proposed as a rectangular stainless steel flat. The cross-section of this should be minimised to reduce impact on the views off the bridge.

An infill is required to ensure that there are no gaps in the edge protection through which a sphere >100mm in diameter may pass. The proposed infill is a stainless-steel tension mesh that offers a lightweight infill. The mesh forms a continuous run, broken at the lifting span, and spans vertically between continuous cables fixed to the parapet lugs.

Figure 21: Parapet runs seamlessly across opening spans and approach spans

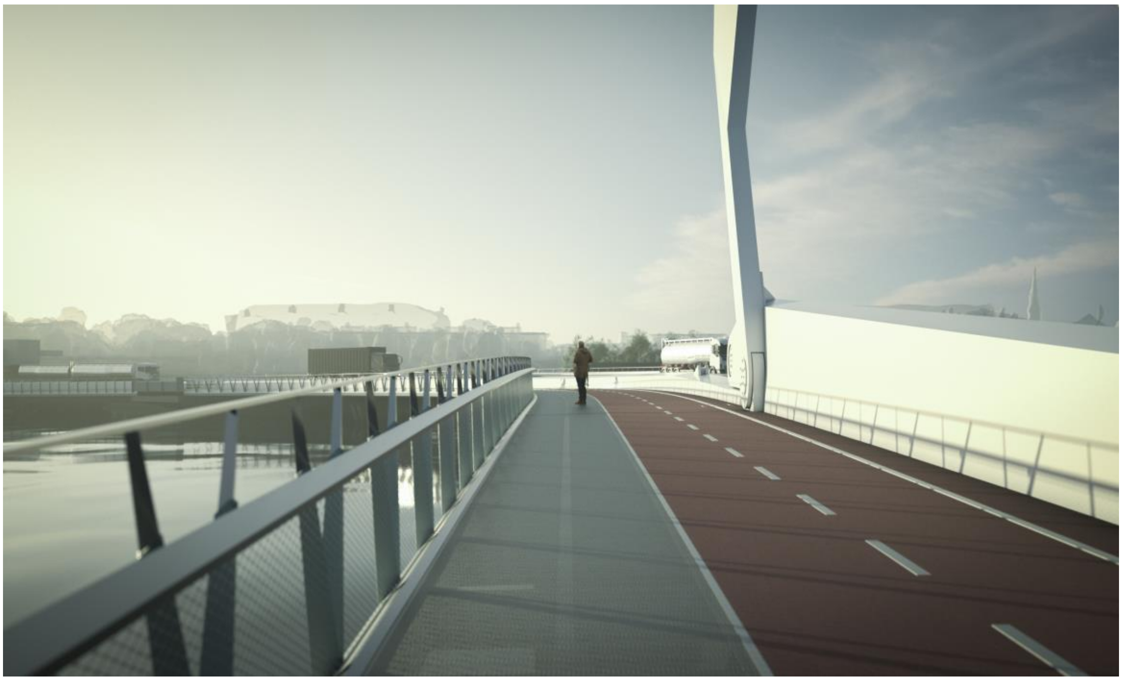


Figure 22: Lightweight parapet as viewed from on the deck

4.2.7 Barriers and Additional Equipment

As described in Section 5 there is additional equipment required for the opening sequence. These include:

- WIG WAGs and other warning lights
- Sounders
- Traffic and Pedestrian Barriers
- Cameras
- Signage
- Potential marine navigation lights / sounders

These should all be integrated into discrete elements housing multiple pieces of equipment to provide an uncluttered environment. Separate mountings for individual pieces of equipment should be avoided. These elements are a key set of details to develop in the detailed design phase.

The current proposed strategy is to provide "totems" directly above Piers P1 and P4 to house the equipment above. Aligning to the piers provides a logical location offset from the lifting span.

The totems may contain all the equipment listed above; however, it may be considered beneficial to move the active travel barriers closer to the opening span. This would reduce the opening time by reducing the time spent to clear the opening span and afford pedestrians a better view of the opening elements, from a point separate to the vehicular traffic. These potential forward locations are indicated in the design drawings in Appendix A. In this scenario additional totems may be required to house the barriers, alternatively swing barriers may be integrated into the spine beams and/or parapets.

4.2.8 Lighting

The functional lighting should be integrated into the elements of the bridge to avoid detracting from the architectural form. Low-level lighting is proposed to avoid use of light-poles that may interfere with the opening span. Lighting should be contained within the bridge to avoid excess light pollution or light spilling off the deck into the water and impacting marine life. LED lighting is proposed to provide a compact, low-energy solution.

The proposal to achieve the functional lighting for the active travel pathways is to integrate the luminaires into the parapets. Provision is made within the lean rail for a LED fittings to be mounted discreetly beneath the lean rail. Lighting from beneath the lean rail is intended to wash the walking surface whilst avoiding glare for the bridge users.

The functional lighting for the carriageway is proposed to be integrated beneath the VRS system. Provision is made for linear luminaires to be mounted beneath the steel tube of the

VRS system. This is similar to the carriageway lighting used on the nearby Samuel Beckett Bridge.

Additional aesthetic lighting to the counterweight arm is proposed to light the inner faces of the counterweight, emphasising the gateway effect of the portal and minimising potential for light spill into the surrounding environment.

The functional lighting design has been developed in conjunction with RPS Lighting team to verify the low-level lighting solution can meet the required lux levels.

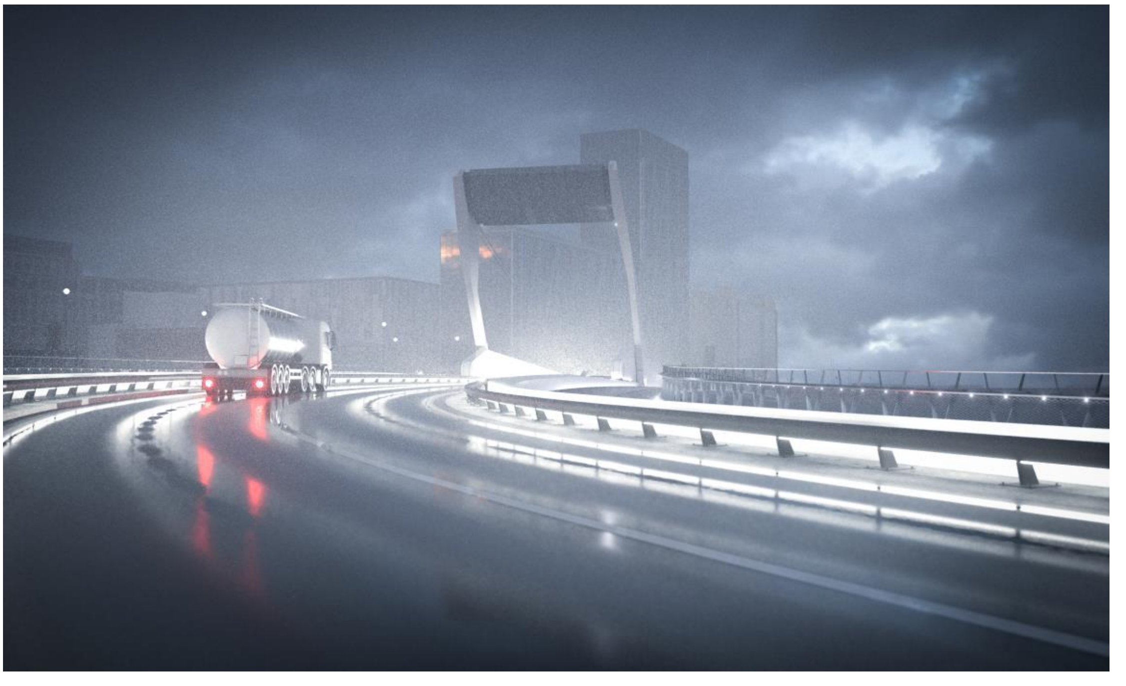


Figure 23: Low level functional lighting on SPAR Bridge

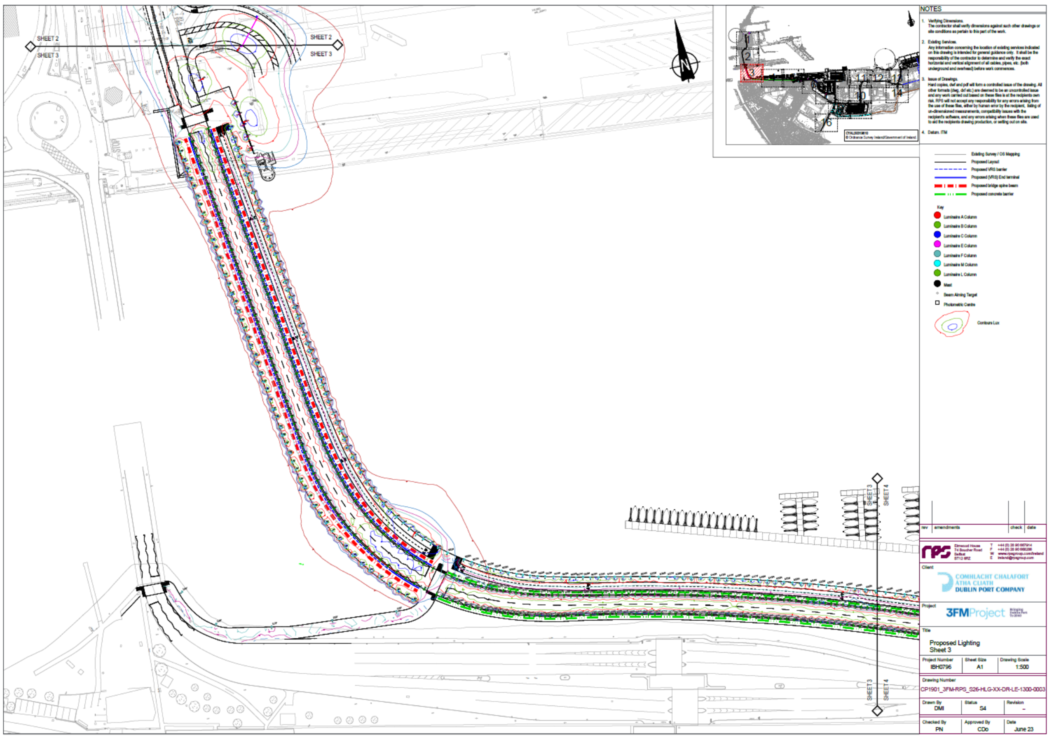


Figure 24: Extract from Lighting Analysis Drawing showing full extent of SPAR

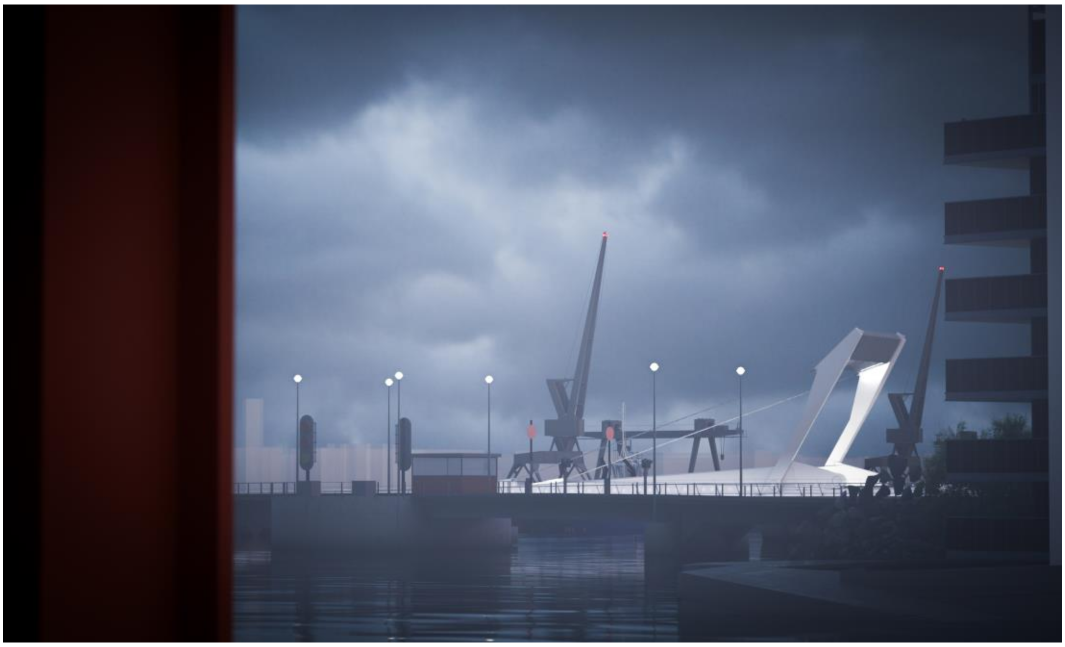


Figure 25: Aesthetic lighting to internal faces of counterweight assembly

4.2.9 Surfacing

The SPAR Bridge is an opening bridge which requires lightweight finishes to the moving span. For the vehicle carriageway, an epoxy grit bound combined waterproofing and anti-slip surfacing is proposed to minimise weight. For the fixed spans a conventional asphalt system will be used.

For consistency the same finishes are proposed for the entire length of the structure on the active travel paths. For the cycleway of the main active travel path and the supplementary active travel path, a grit bounded epoxy combined waterproofing and anti-slip surfacing is proposed. This is applied directly to the structural steel plate of the cycleway, offering slip-resistance and a robust finish. Different tones of aggregate will be used for consistency with the wider active travel path surfacing; buff aggregate on the pedestrian walkway to the West and dark red aggregate on the cycleway to the East, white painted lines demarcate the cycle lanes.

At joints in the deck or access hatches stainless steel trims will be provided to contain the aggregate surfacing. The same aggregate surfacing should be provided to the top of hatches for visual consistency.

To clearly demarcate between the footpath and cycle path a change of material is proposed to a proprietary aluminium decking system on the footpath. This lightweight system is mechanically fixed to the steel cantilever structure. The decking slats will be laid transversely to the direction of travel, texture to the top of the decking offers slip resistance. The slats allow the footway to drain freely.

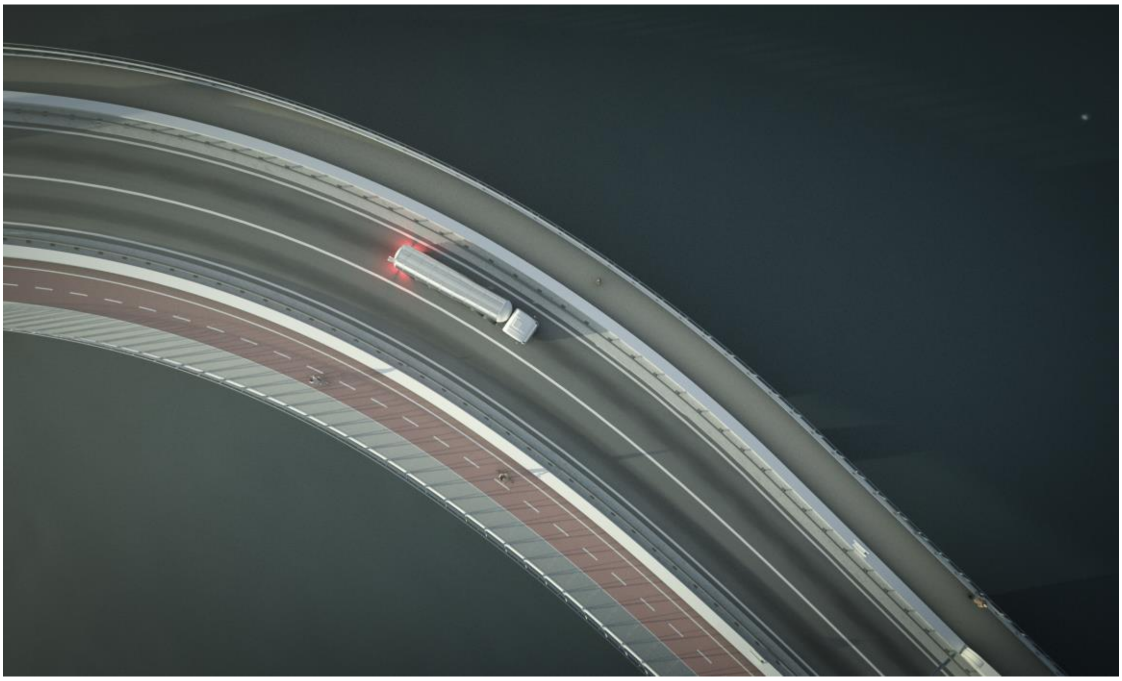


Figure 26: Overview showing changes in surfacing across deck.

4.2.10 North Abutment

North Quay Public Realm (Stop Point A)

The North abutment of the SPAR Bridge meets the quayside adjacent to North Wall Square at the Southern end of the Liffey-Tolka project. A new piece of public realm manages the transition between the SPAR Bridge abutment and North Wall Square has been developed by Darmody Architects and TTT Landscape Architects – this area is referred to as Stop Point A, refer to Darmody design for further information. The bridge carriageway and active travel paths continue to meet ground level in the square. Beyond the bridge, shaped granite blocks are arranged to provide a clean termination to the structural spine beams and the parapets.

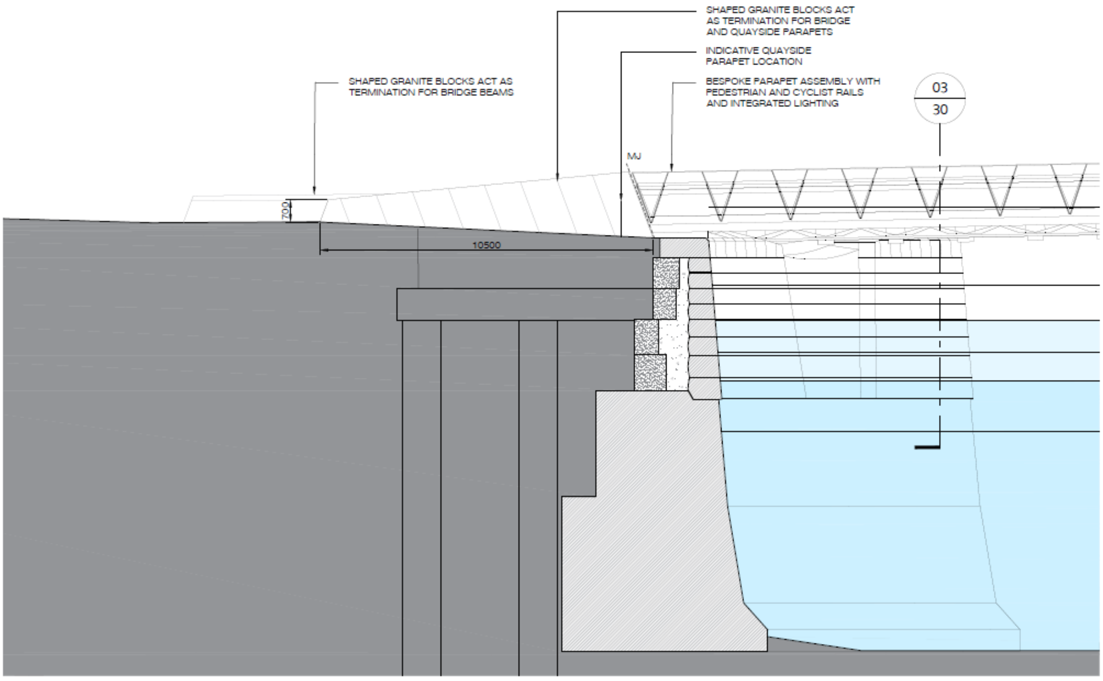


Figure 27: Elevation of Granite Termination Blocks at North Abutment

North Wall Quay Extension

The North abutment of the SPAR Bridge interfaces with the North Wall Quay Extension. As described in Section 3.10 this wall is currently undergoing the process to become a registered protected structure.

Through discussion with the heritage team, it was felt that it would not be appropriate to alter the elements of the quay wall designed by Bindon Blood Stoney. It would also represent a significant technical challenge to modify these blocks of concrete, granite and steel.

The abutment of the SPAR Bridge should therefore be constructed behind the heritage wall, with any impact on the Blood Stoney blocks to be avoided. This abutment placed behind the wall necessitates an inspection chamber to allow access for inspection and maintenance of the bridge bearings and structure.

The construction of the abutment and inspection chamber requires some modification to the existing granite blocks forming the top of the wall above the Bindon Blood Stoney blocks. The proposal is to reinstate the wall with a shaped recess that keeps the bridge and wall separate, acknowledging the bridge passing over the wall to the supports beyond. Reuse of the existing granite / reclaimed local granite should be explored during the detailed design phase. The existing mooring ring should also be reinstated in its current location, albeit set within the newly recessed wall. The existing services behind the North Quay wall may also need to be rerouted (see Section 3.7).

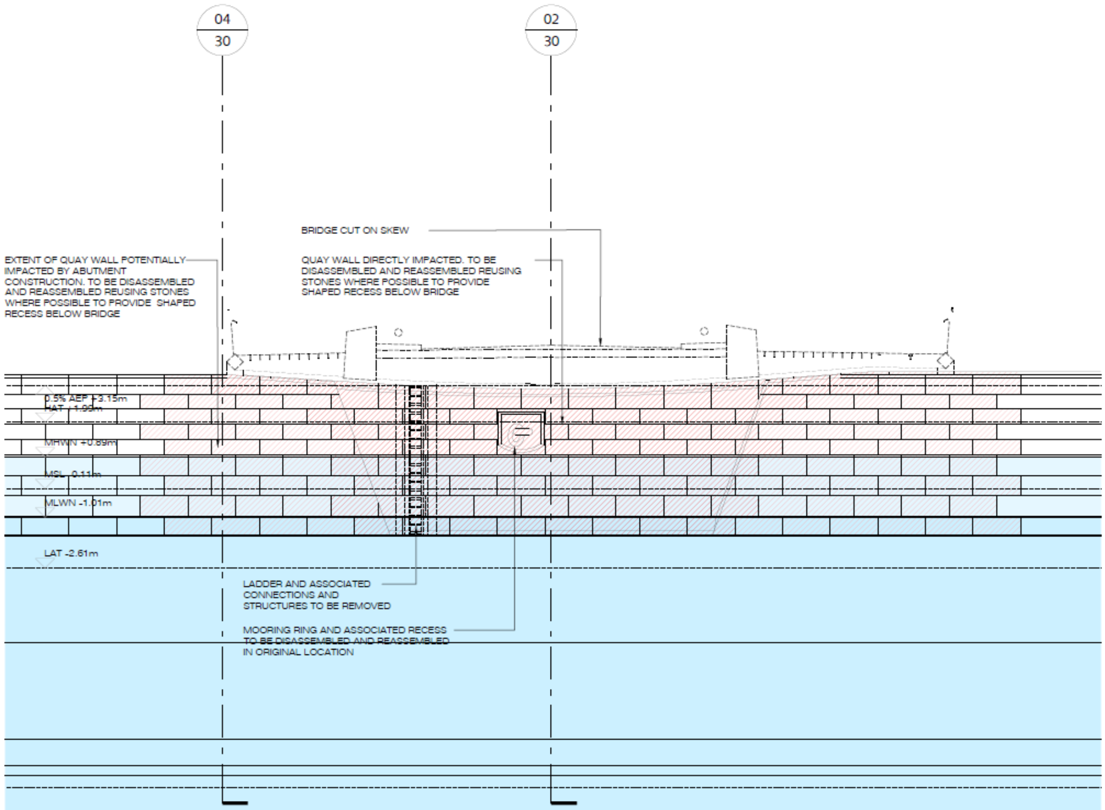


Figure 28: Proposed Reinstatement of North Quay Wall with Shaped Recess beneath SPAR Bridge

4.2.11 Southern Interface

The southern end of the SPAR bridge interfaces with a multi-span approach viaduct which runs parallel to the existing R131 road. This structure is designed separately but the two structures will each terminate on the same shared pier. The transition between the two structures has been considered carefully to ensure the scheme remains cohesive. This is described further in the Southern Port Access Route Viaduct PDR.

Figure 29: View from river showing SPAR Bridge continuing onto approach viaduct

4.2.12 Material Summary

Fixed Spans		
Element	*Material / Colour*	*Reference Image*
Typical Bridge Primary Structure (including primary beams, edge beams and cantilevers)	Light Grey Painted Steel	*See Figure 45: Typical Material Distribution*
Bridge Piers	Mid Grey Concrete	
Carriageway Surfacing (Fixed Spans)	Asphalt	
Carriageway Kerbs	Concrete	
VRS System	Mid Grey Painted Steel	
Termination Blocks in North Wall Square	Granite blocks to match existing Quay Walls (Natural Stone)	

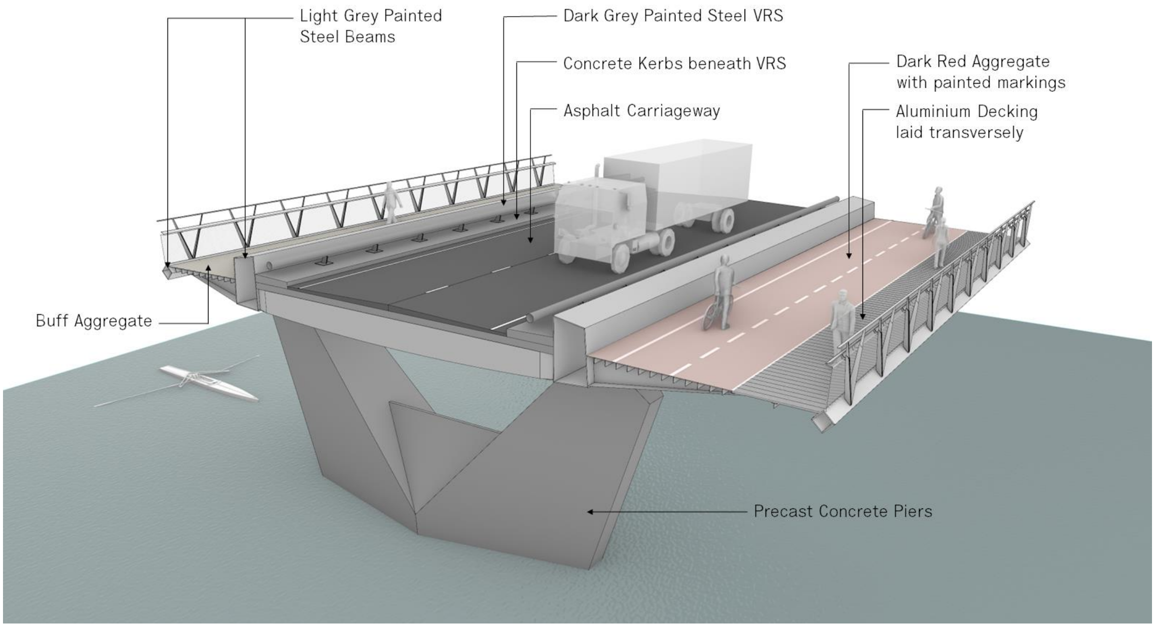


Figure 30: Typical Material Distribution

Opening Span		
Element	*Material / Colour*	*Reference Image*
Typical Bridge Primary Structure (including lifting beams, counterweight arms, edge beams and cantilevers)	Light Grey Painted Steel	*See Figure 31 and Figure 32.*
Machinery Pier	Mid Grey Concrete	*See Figure 31.*
Underside of Lifting Span Deck Surfaces	Dark Grey Painted Steel	
Carriageway Surfacing (Opening Span)	Dark Grey Epoxy Aggregate Surfacing to match Asphalt	
Counterweight Block	Granite tones to match existing Quay Walls (Natural / Reconstituted Stone Blocks)	*See Figure 32.*
Counterweight Cables	Steel Cables and Connection Details	
Accent Colours on Opening Span Pivots and on Ram Connections	Blue-Grey to match Parapet Posts	

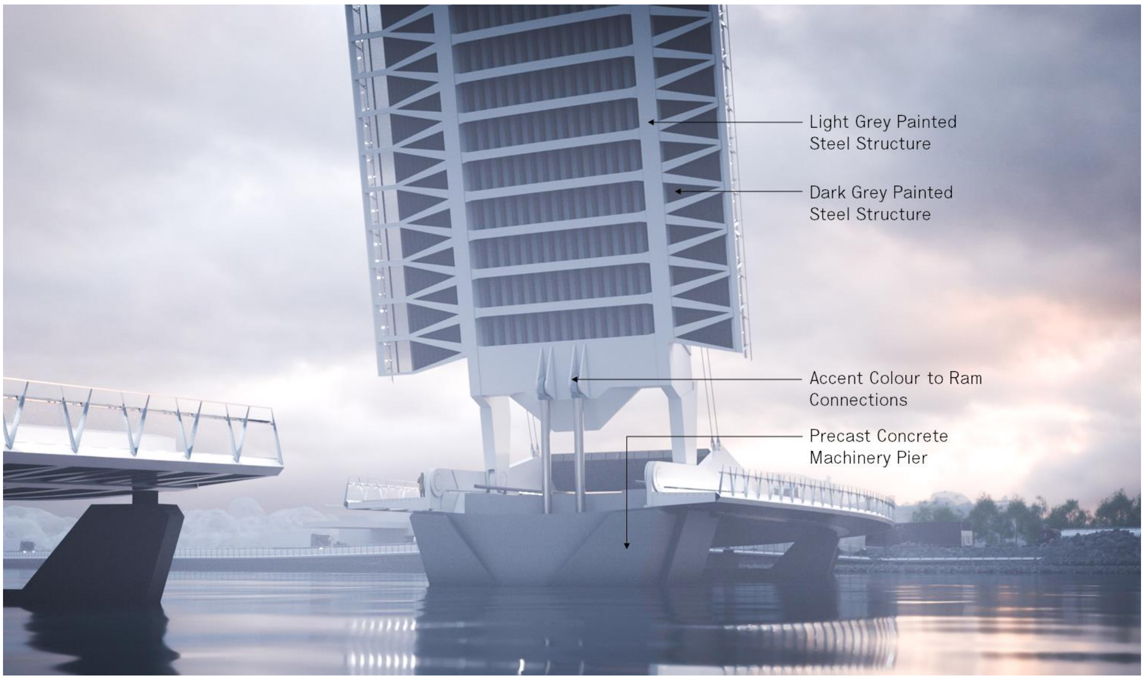


Figure 31: Opening Span Soffit Materials

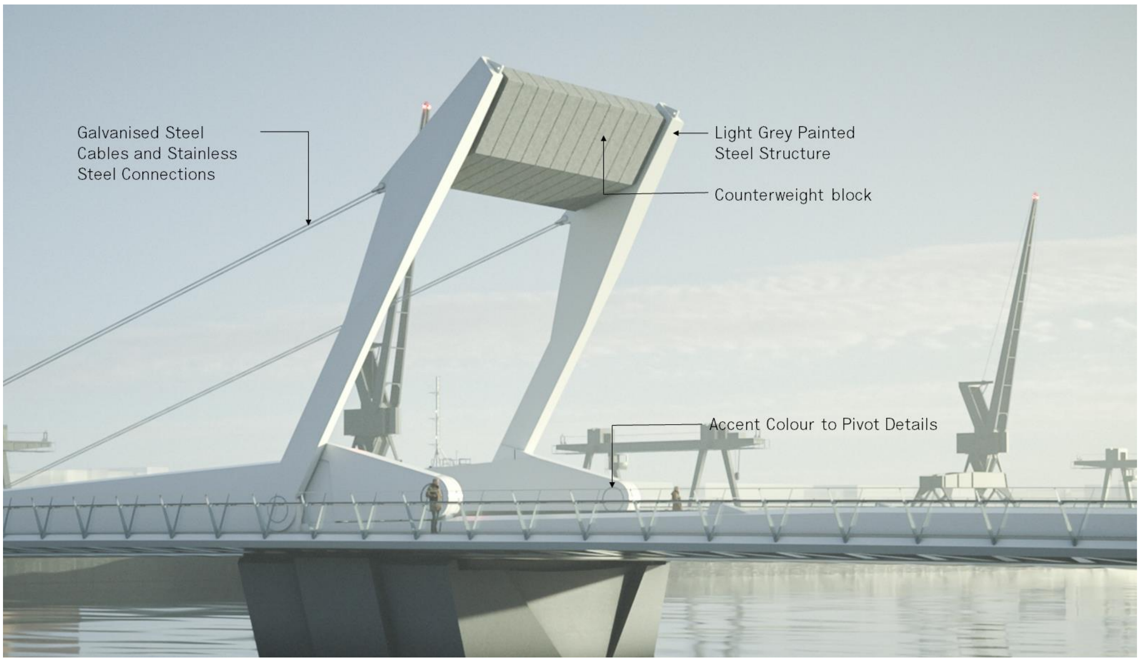


Figure 32: Opening Span Materials

Active Travel Surfacing and Parapet		
Element	*Material / Colour*	*Reference Image*
Active Travel Path Typical Surfacing East & West	Epoxy Aggregate Surfacing with Stainless Steel trims at joints/access hatches. Colours: Buff aggregate to West (pedestrian only) Dark red aggregate to East (cycle path)	*See Figure 30*
Active Travel Path East (Pedestrian Walkway)	Aluminium Decking	
Parapet Posts	Blue-Grey Painted Steel	*See Figure 33*
Parapet Rails and Lugs	Stainless Steel	
Parapet Infill	Stainless Steel Tension Mesh	

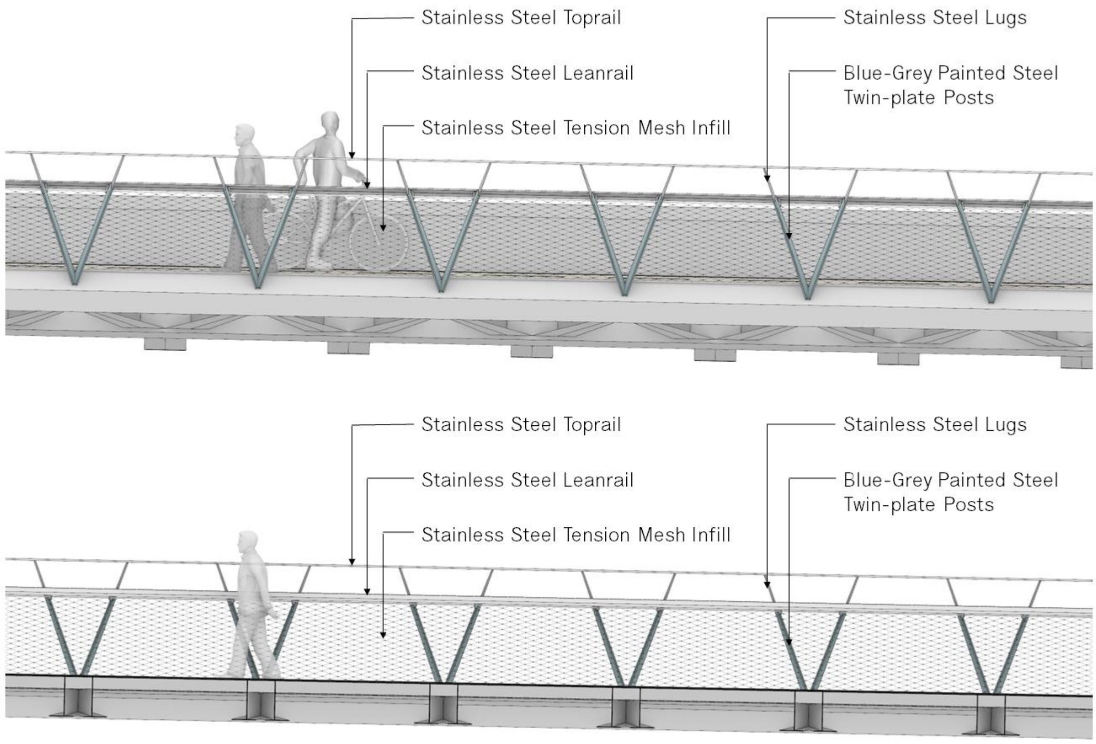


Figure 33: Parapet Materials (External Elevation above, Internal Elevation below)

4.3 Proposals for the recommended structure or family of structures.

4.3.1 Proposed Category

As a moveable bridge, this structure is classed as a Category 3 structure as per TII DN-STR-03001-04 and *"will require a check to be carried out by a Checking Team from a separate organisation with their own Professional Indemnity Insurance and no connection to the project, proposed by the Designer and agreed in writing by the Structures Section, having knowledge and experience relating to the type of structure it is to examine."*

Design Life

The structure will have a design working life category 5 (120 years) to I.S. EN1990 Table NA.1 except for the operating machinery, bearings, movement joint which will have working life category 2 (up to 30 years)

Consequence Class

Class CC3 for primary structure in accordance with the Irish National Annex to IS EN1990 clause NA.3.1 Annex B.

Consequence Class CC3 is defined in IS EN1990:2002 table B1 as: *"High consequence for loss of human life, or economic, social or environmental consequences very great".*

Reliability Class

Class RC3 for whole structure.

Reliability classes are defined in BS EN1990:2002 and are directly associated with consequence classes.

K_{FI} shall be taken as equal to 1.0, according to DN-STR-03020-01. Reliability shall be ensured by means of workmanship quality management.

Design Supervision Level

Class DSL3 for whole structure.

Design Supervision Level DSL3 is classed as "extended supervision" and is defined in BS EN1990:2002 table B4 as requiring calculations, drawings and specifications to be: *"Third party checked: Checking performed by an organisation different from that which has prepared the design."*

Inspection Level

Typically Class IL2. Items requiring a higher inspection level shall be indicated on the drawings. This is defined as extended inspection using third party inspection.

4.3.2 Span arrangements

The drawings in Appendix A show the span arrangements.

Due to their proximity, the SPAR Bridge has a particular relationship with the nearby Tom Clarke Bridge. This relationship is key to defining the span arrangements for the SPAR Bridge.

- The piers of the SPAR Bridge should align with the piers of the Tom Clarke Bridge where possible, reducing the impact on existing navigation channels and the hydrology of the river.

- The opening span should open from the South side of the river to match the Tom Clarke Bridge. This aids vessels navigation passed both bridges and allows the larger machinery piers to be aligned.

From North to South, the key dimensions by span are:

Span	Span 1	Span 2	Span 3	Span 4	Span 5	Span 6	Span 7
Span Length (on C/L) (m)	27.2	24.2	47.3	28.6	33.0	30.8	24.6
Carriageway width (m)	10.8			Transition	11.8	11.8	
Radius of Curvature (m)	-			Transition	90	90	

Span lengths are measured along the curve of the bridge alignment between pier centres. The carriageway width is measured between the inside edges of the spine beams and includes the width allocated to the vehicle restraint system and its working width. The radius of curvature is measured along the carriageway centreline.

The machinery pier, P3, will be configured to house the mechanical components for bridge lifts. Therefore, the supports for the spans will not be located on the pier centre.

Where possible, the bridge follows a 2.2 m structural grid (measured along the bridge centreline), and the span lengths following the bridge’s curvature are to be divisible as such.

4.3.3 Minimum headroom provided

The minimum headroom provision for river users is as specified in the functional

The overhead counterweight provides a minimum clearance of approximately 11.5 m above finished roadway. This exceeds the limits defined in DN-GEO-03036-06.

4.3.4 Approaches including run-on arrangements

Approach viaducts connect the main span to the northern riverbank and the adjacent SPAR viaduct. The SPAR viaduct runs parallel to the riverbank before connecting to land near to

Pigeon House Road. The transition span is connected integrally to the first pier of the SPAR viaduct and the interaction with this structure requires detailed consideration.

The connections between the viaducts and new roads forms part of the design of the highway.

4.3.5 Foundation type

It is expected that foundations for regular piers can comprise a pilecap and a small number of large-diameter piles. This is preferred due to the depth of the rockhead and the expected lateral forces.

4.3.6 Substructure

The machinery pier will be a large, hollow enclosure constructed with reinforced concrete. It is essential that this pier is protected from water ingress to protect the machinery; it is intended that the top of the pier will be above the level corresponding to a 200-year return period flood plus 1 m climate change allowance.

The pilecap for the machine pier is close to the boundary of the navigation channel; due to the profile of the riverbed and the dredged navigation channel, there is a risk that the pier needs to extend deeper into the ground to ensure the navigation channel is not compromised above the riverbed. This would increase the loads on the foundation and require larger piles to withstand the additional bending.

Intermediate piers are Y-shaped, splaying from a single stem to individual pier-tops for each bearing. Each pier-top will require additional space for jacking plinths in the temporary condition. It is intended that piers remain as a single stem from the riverbed to the low tide level. Sloped surfaces will be provided to prevent build-up of debris.

Piers P1, P2, P4, and P5 will each contain one set of bearings. P6 supports two sets of bearings to handle the joint between the southern approach and the transition structure. P7 is integrally connected to the transition span and the first span of the SPAR viaduct.

The north abutment will be aligned with the protected North Quay, at a skew of around 77.5 degrees relative to the bridge centreline. The abutment is to be situated around 8 m behind the protected North Quay Extension such that the bridge's foundation does not impact on its historically significant substructure.

It is likely that a gallery will be required beneath the structure beyond the quay wall to allow the inspection and maintenance of the steelwork and bearings. The effect on the quay wall should be minimised. The gallery could be liable to flooding so a pump-sump system would be required to ensure safe access.

There may be an opportunity at detailed design to create a fully integral abutment which requires minimal maintenance. The detailing of this is complex and the construction is likely to be more expensive, though the impact on the land behind the quay wall would be minimised.

4.3.7 Superstructure

The primary structural support in all spans is a pair of spine beams which are constructed as closed steel boxes. The height of these spines is constant on the approach spans, but tapers to a peak height around the lifting mechanism and pivots on the main span. The spine beam will be partly situated above deck level to achieve an overall slimmer profile of the deck.

The carriageway spans between the spine beams. In the approach spans and transition span, this will be constructed as a composite structure comprising a concrete slab and regular steel beams. Precast concrete planks would be used as a permanent formwork and the remainder of the concrete slab would be constructed in situ.

On the main span, the carriageway will comprise steel beams and an orthotropic steel deck. This is intended to reduce the weight of the structure and therefore reduce the demand on the lifting mechanism.

The pathways are supported on transverse cantilevers. These cantilevers will be tapering steel beams and an orthotropic steel deck plate will be used. An aluminium surface is considered on the eastern cantilever to provide a subtle demarcation between the cycle path and footway.

The structural grid of 2.2 m defines the layout of the transverse beams and cantilevers. The grid provides visual continuity on the underside of the bridge and the consistency of spacing allows for more standardised connection details to the main spine beams.

4.3.8 Articulation arrangements, joints, and bearings

If deemed feasible in detailed design, the approach spans will be articulated on elastomeric bearings. These have a greater tolerance to water than pot bearings as the steel components are encased in elastomer. This will allow an overall reduction of the height of the bridge while also allowing horizontal forces to be distributed relatively evenly. The level of elastomeric bearings is desired to be above the flood level corresponding to a 50-year return period.

Should additional horizontal restraint be required, simple shear keys with no vertical support could be included in the design. This would be preferable to guided pot bearings which can seize up if corrosion becomes severe.

The main span will be supported at its tail end on large pivots through the spine beams. The lifting force is provided by hydraulic cylinders situated in the machinery pier which are assumed to be disengaged when the bridge is closed and open to traffic.

The nose end of the main span will rest on a cantilevered section of the approach span. The relative skew of the navigation channel means the length of this cantilever is uneven.

A small section of carriageway over the machine pier will form a transverse-spanning simply supported section. This is provided to allow the removal and replacement of large equipment within the machine pier in the event of mechanical failure. See 4.3.13.

The transition span between the southern approach spans and the SPAR viaduct will be integral with P7, along with the first span of the viaduct, and articulated on elastomeric bearings at P6. The integral connection is deemed necessary as the bearing level would not be sufficiently high to be protected from flood water. The stiffness of the structure means that this span being integral at both ends would induce large loading on the deck and piers due to temperature changes.

An articulation diagram is provided in Appendix A.

Bridge deck expansion joints shall be used at the joints between the bridge deck and riverbanks. These shall be waterproof and suitable for vehicles or pedestrian and cyclists as appropriate.

4.3.9 Restraint Systems

Vehicle Restraint

A Vehicle Restraint System in the form of a continuous barrier will be required to isolate the vehicular traffic and protect the structural beams against impact. Structurally, the VRS will be connected to the transverse beams on the main span, or into the carriageway slab on the approach spans.

The TII document DN-REQ-03034-12 provides guidance on the design of restraint systems. Following the procedures in this document results in a containment level of **N2**. The justification for this is that the legal speed limit is less than 60 km/h and there are no major aggravating factors such as crossing a railway.

The high proportion of HGVs may mean more containment is required, though the low design speed and additional separation provided by the spine beams means that N2 containment is likely sufficient. This will need to be confirmed during consultation with the technical approval authority.

The drawings included in Appendix A show a bespoke parapet; such non-standard parapets require testing to verify their containment level. The shown parapets could be replaced with a proprietary system providing certified N2 containment to reduce cost and testing requirements.

Pedestrian Parapets

Steel parapets at the deck edges will be provided with a minimum height (H0) of 1450mm for enhanced restraint of cyclists as per DN-STR-03011-03. The parapet will incorporate an additional lean rail at approximately 1100mm. The parapet will be a bespoke design that follows the principles of DN-STR-03011-05 and PD CEN/TR 16949:2016 and will be designed to deter people from climbing. The parapet shall incorporate an upstand above the walking surface with a minimum height of 50mm.

The horizontal rails will be designed for the following loads to PD CEN/TR 16949:2016:

- Uniform horizontal load: q_{hk} = 1.2 kN/m (horizontal load class D)

- Concentrated horizontal load: Q_{hk} = 1.0 kN
- Uniform vertical load: q_{vk} = 1.0 kN/m
- Concentrated vertical load: Q_{vk} = 1.0 kN

The infill will be designed for load class 1 or load class 2 depending upon the final parapet design.

Snow and wind loads on the parapet shall be in accordance with IS EN1991-1-3 and IS EN1991-1-4 respectively.

The loads on the parapet will be combined to the fundamental combinations defined in PD CEN/TR 16949:2016 Annex A

4.3.10 Drainage

A two-way crossfall will be provided on the carriageway to ensure that run-off from the vehicular deck flows to designated drains which carry water to the abutments for safe disposal. Water on the main span will be drained to the north when closed due to the vertical alignment of the structure. When opening, water will be drained to the south such that a system can remain in place when the bridge opens. The geometry of the opening mechanism means that the lifted span moves slightly backward, meaning water on the deck should drain directly onto the southern approach. This means it is feasible that a small permanent gutter could be included for contingency, rather than a mobile hopper system. The design of this system will be undertaken in the detailed design stage.

If the environmental assessment deems it acceptable, drainage on the pathways will be directly into the river. The isolation between pathways and carriageway means there should be no petrochemicals present on the pathways, reducing the risk of river contamination.

4.3.11 Durability

The steelwork is typically detailed as an externally painted sealed box constructed from structural steel to minimise future maintenance. The steelwork has smooth external surfaces to prolong the service of the paint system by providing few crevasses that water and dirt can accumulate. The smooth surfaces also ease future repainting.

The spine beams will be constructed as closed box sections which may only be inspectable and maintainable by remotely controlled devices (for which an internal rail could be provided).

The deck structural steelwork will typically be Grade S355 W to EN 10025. The appropriate subgrade shall be selected during detailed design to satisfy ductility requirements. Mild steel may be used for certain secondary components. Higher grade steels may be required for specific components.

Reinforcement will typically consist of Class B, 500 Grade standard steel reinforcement bars. Stainless steel reinforcement may be considered for the splash zone of the piers to improve concrete durability where the corrosion environment is particularly harsh.

Corrosion Protection

The proximity to the coast presents a more corrosive environment which precludes the use of unprotected weathering steel.

The corrosivity of the environment is defined according to ISO 9223, with ranges between C2 (Low corrosivity) and C5 (Very high corrosivity) generally applicable to bridges. The corrosivity categories assigned to the bridge will be dependent on likely exposure. The following categories are proposed:

Corrosivity Category	Example Elements
C2 (Low)	Internal surfaces of non-critical elements situated above the maximum flood level, with minimal air exchange.
C3 (Medium)	Internal surfaces of non-critical elements situated below the maximum flood level, with minimal air exchange. Internal surfaces of primary structural beams above the maximum flood level.
C4 (High)	Internal surfaces of primary structural beams below the maximum flood level. External surfaces above the maximum flood level
C5 (Very high)	External surfaces below the maximum flood level

In general, we consider that the main lifting span is to be entirely above the design flood level, though the approach spans have some elements situated below it.

It is proposed that all external surfaces have a protective coating applied which is maintained as required. It is nonetheless proposed that a nominal sacrificial thickness is provided to allow for paint deterioration.

Internal surfaces are likely to be inaccessible. It is proposed that small elements such as parapet girders and deck stiffener troughs are hermetically sealed. The spine beams are to be sealed but with a tap at the low point for regular monitoring for water ingress.

The internal surfaces will require a sacrificial thickness; specified values are proposed in the British National Annex to EN 1993-2, though the Irish National Annex does not provide the same guidance.

A summary of the corrosion categories and proposed allowances are given below:

Span	Element	Internal	Provision	External	Provision	Total
Lifting span	Spine beam	C3	1.0 mm	C4	0.5 mm	1.5 mm
	Parapet girders	C2	0.5 mm	C4	0.5 mm	1.0 mm
	Deck plate hollow stiffeners	C2	0.5 mm	C4	0.5 mm	1.0 mm
	Other	n/a	n/a	C4	0.5 mm x2	1.0 mm
	Spine beam	C4	1.5 mm	C5	1.0mm	2.5 mm

Approach spans and Transition Span	Parapet girders	C3	1.0 mm	C5	1.0 mm	2.0 mm
	Other	n/a	n/a	C5	1.0 mm x2	2.0 mm

Note – external sacrificial allowance further to other protection layer (paint, waterproofing, concrete)

Additional thicknesses on all steel plates will increase the weight of the structure and the total material usage. This has ramifications for the embodied carbon of the project and the mechanical requirements to lift the main span. It is proposed that a detailed assessment is conducted during later design stages.

Joints between stainless steel and weathering steel elements can be subject to bimetallic corrosion. Isolation, for example with polymeric washers, should be provided at joints where required to minimise this effect.

Fatigue

The usage of the bridge as a highly trafficked route for Heavy Goods Vehicles means there is a high susceptibility to fatigue.

Inaccessible elements such as internal steelwork in the spine beams should be designed for no damage, i.e., infinite life.

Where elements are inspectable, some damage may be tolerated based on a probabilistic assessment. For the preliminary design, the constant amplitude fatigue limit (defined in EN 1993-1-9) may be used.

4.3.12 Sustainability

The structural form of the bridge presents a cost effective and sustainable solution. The lightweight superstructure will minimise use of materials and reduce energy consumption during opening. Careful detailing and material choices will result in a low maintenance structure with lasting quality and ultimately reduce the scheme's carbon footprint.

The concrete specification will be selected in accordance with IS EN206-1 in order to maximise the service life of the structure. The use of ground-granulated blast-furnace slag (GGBS) participates in reduction of carbon footprint of concrete works.

The embodied carbon associated with the construction of the structures is influenced by the quantities of material used and the processes used to manufacture the materials. The quantities of materials are determined by the design, and the detailed design stage should be used to minimise material quantities where possible. The associated embodied carbon with each material should form an important part of the procurement process.

At the end of the service life of the bridge, the concrete elements can be crushed and reused as hard-core or aggregate for other projects. Similarly, the metal components of the bridge superstructure can be recycled and re-process to produce new materials/products.

Low energy lighting shall be provided to suit the functional and aesthetic requirements of the design. Lighting will be directed so as to minimise light spill into the river and be subdued so as not to cause night blindness either directly or by reflections from the water.

4.3.13 Inspection and maintenance

All materials, finishes and workmanship will be specified to minimise maintenance requirements. The top of the machine pier housing the main lifting mechanism will be placed above the design flood level (including a climate change allowance) to improve durability and reduce maintenance. The mechanical and electrical systems that lift the bridge are located within the machine pier, but access from deck level will be provided so that these can be accessed easily and safely.

Bridge bearings shall be placed above a flood level corresponding to a return period greater than the anticipated service life and will be designed so that they can be replaced and inspected easily. The relatively low level of the bridge means that the soffit can also be inspected inexpensively from water level using a boat.

The main access into the machine pier is via hatches in the walkways on either side. A stairway and a lift for equipment will be provided. A small section of the carriageway over the machine pier chamber will be removable by lifting to allow the removal and replacement of large equipment while the bridge is in its closed position.

A full operation and maintenance manual shall be prepared during a subsequent phase of the project.

5 Mechanical Arrangements

5.1 General Description of Mechanical and Electrical Installation (M&E)

5.1.1 Overview of M&E Equipment

The bridge operating equipment consists of several key elements. The main mechanical elements are as follows:

- A pair of pivot bearings which form an axis about which the deck rotates. Each pivot consists of a spherical bearing which can accommodate construction tolerances and provides the sliding surface for the rotational movement.
- A pair of counterweight frame bearings which form the axis about which the counterweight rotates. Each pivot consists of a spherical bearing which can accommodate construction tolerances and provides the sliding surface for rotational movement.

  Two hydraulic cylinders which provide the lift force to raise the moving span. Each cylinder has a spherical bearing at each end and a load holding valve / manifold block mounted to the cylinder body.
- A plant room located in the machine pier (Pier 3) containing:
  - Multiple pump Hydraulic power unit (HPU) to supply pressurised oil to the hydraulic lift cylinders
  - Electrical cabinets to house the control and power distribution equipment associated with bridge operation and lighting.
- A pair of vehicular control barriers and lights at each end of the moving span
- A pair of cycle and pedestrian control barriers and lights at each end of the moving span
- A control desk, located in a dedicated control building on the north quayside
- A control link between the control position and the plant room, either wired or wireless
- A CCTV system to monitor the approach spans, moving span and trapping points. Monitors for the CCTV located with the bridge control interface

5.1.2 Proposed mode of operation of structure

The lifting span of the bridge shall be articulated by a pair of large bore hydraulic cylinders located next to each other, below the deck and housed in the machine pier. The bridge pivots about a pair of spherical bearings mounted at the southern end of the moving span. An overhead counterweight mounted on a frame is provided to assist the lifting mechanism. The counterweight frame is hinged by a pair of spherical bearings. The counterweight frame is attached to the lifting span via steel cables.

5.1.3 Location of operating and control mechanism

The lifting cylinders will be located within the machine pier. The hydraulic power unit that provides pressurised oil will be located within the same pier along with the electrical control cabinets.

5.1.4 Electrical power supply and distribution

The electrical supply will be sourced from the mains and pass over the fixed deck to the plant room. From there it will be distributed to the motor controllers and the main control system.

5.1.5 Stand-by-power facilities (UPS etc.)

Connection points to enable a backup generator to be used to power the bridge will be provided. No permanently installed generator will be provided.

5.1.6 Design working life

The following table outlines the expected design life of mechanical equipment subject to regular maintenance and inspection:

Item	Design Life
Fabrications for the mechanical components inc. bearing housings, cylinder mounts	120 years
Main pivot bearings	50 years
Electrical equipment (generally due to obsolesce and availability of replacement parts)	25 years
Hydraulic equipment – major items (cylinders, pumps, manifolds, valves, subject to regular maintenance and interim overhaul)	50 years
Hydraulic equipment – minor items (seals and hoses)	5 years
Corrosion protection to all equipment and surfaces	25 years

5.1.7 Frequency of operation

The bridge will be designed for an average of two complete lifting cycles per day. It is assumed that there will be a minimum period of four hours between lifting operations.

5.2 Operational Design Criteria

5.2.1 Design Actions

Operational Design Actions are described in Section 7.1.

When the lifting deck is in the lowered position the hydraulic cylinders shall be isolated from the structure to avoid creating a hard point which would subject the hydraulic seals to fluctuating loads and lead to shortened life.

Traffic actions on main pivot bearings and the nose support bearings will be checked against EN 1337. No traffic load is directly transferred to the counterweight support bearings. However, the counterweight is connected to the deck via the cables. During detailed design the cumulative bearing movements caused fluctuating deflections of the deck will be assessed.

5.2.2 Relevant safety consultation documents

The hydraulic system will be designed in accordance with industry best practice.

The design of the hydraulic cylinders will be to an internationally recognised standard such as DNV.

5.2.3 Proposed safety critical fixings

The fixings securing the main deck pivot bearings, counterweight frame pivot bearings and upper and lower hydraulic cylinder mounts will all be safety critical.

5.3 Basis of Operation and Control

5.3.1 Normal operation conditions

Under normal operating conditions the bridge equipment is in the following conditions:

- Deck lowered
- Hydraulic cylinders retracted
- Traffic warning lights off
- Cycle and pedestrian lights off
- Traffic barriers raised/ open
- Cycle and pedestrian barriers open
- Navigation lights off

- Control system off
- CCTV cameras pointing wherever is useful when the bridge is closed

Operator Action	Bridge Action	Interlocks Required to Proceed
The operator activates the control system using a key or login on the HMI screen	CCTV system moves the cameras to predefined positions to cover the areas where direct line of sight isn't sufficient for safe bridge operation. The control system checks that the wind speed is within the required limits, the hydraulic power unit is healthy and that power is available.	
The operator watches for vehicular and cycle traffic and pedestrian movement. When ready the operator presses the 'ACTIVATE PEDESTRIAN AND CYCLE WARNING LIGHTS' push button.	Pedestrian warning lights activate on either side of the bridge. Marine navigation lights turn on, showing red signal. Best point of passage light turns off.	
The operator watches via the CCTV and direct line of sight when the pedestrians and cyclists have cleared the bridge. Using individual controls the operator closes the four pedestrian barriers CLOSE NE PEDESTRIAN BARRIER, CLOSE NW PEDESTRIAN BARRIER, CLOSE SE PEDESTRIAN BARRIER, CLOSE SW PEDESTRIAN BARRIER.	NE pedestrian barrier lowers NW Pedestrian barrier lowers SE pedestrian barrier lowers SW pedestrian barrier lowers	NE pedestrian light illuminated NW Pedestrian light illuminated SE pedestrian light illuminated SW pedestrian light illuminated
Once all pedestrians and cyclists are off the bridge the operator can stop the road traffic using the 'WIG-WAGS ON' push button	Traffic control Wig-Wags illuminate.	Wig-Wags illuminated
As the bridge clears of road traffic, the operator can lower the entry road barriers at each end of the lifting span using the 'LOWER ENTRY BARRIERS' push button	Entry road barriers lower	Wig-Wags illuminated Entry barriers lowered
Once the bridge is clear of vehicles the operator can lower the exit barrier using the 'LOWER EXIT BARRIERS' push button	Exit barriers lower	All barriers lowered Pedestrian warning lights illuminated Wig-Wags illuminated
The operator makes a final check that the bridge is clear of all forms of traffic. Once satisfied that it is safe to open the bridge, the operator presses and holds the 'RAISE BRIDGE' push button.	Bridge begins to open, accelerating from rest to full speed. As it nears the limit of travel it decelerates to creep speed before coming to rest in the fully raised position.	All barriers down Pedestrian warning lights illuminated Wig-Wags illuminated HPU healthy Bridge fully raised
Once the bridge is fully raised the operator can set the	Navigation lights go green to suit selector switch position.	Bridge fully raised

Operator Action	Bridge Action	Interlocks Required to Proceed
navigation control lights in either direction to green via a selector switch		
Once all marine craft have passed the bridge the operator can then lower the bridge. The operator uses the CCTV to check that the bridge area is clear of vessels and that there are no vessels approaching the bridge. Once satisfied it is safe to lower the operator presses and holds the 'LOWER BRIDGE' push button	The navigation lights all turn back to red. The bridge begins to lower, accelerating from rest to high speed. As the bridge nears the fully lowered position it slows to creep speed and then comes to a controlled stop at the fully lowered position.	All barriers down Pedestrian warning lights illuminated Wig-Wags illuminated HPU healthy Bridge fully lowered
Once the bridge is fully lowered the operator checks that the bridge is safe to open and that no one is near the barriers. If safe to do so all barriers can be operated simultaneously or in quick succession. Operator presses and holds the 'OPEN ALL PEDESTRIAN BARRIERS' (NW / NE / SW / SE) push button and 'RAISE BARRIERS' push button.		Bridge fully lowered Pedestrian warning lights illuminated Wig-Wags illuminated
Once all the barriers are raised/ open the Wig-Wags and pedestrian lights can be extinguished and the system shut down. The operator deactivates the system by logging out or turning the activate key to OFF.	System shuts down Any faults or warnings remain displayed on the screen to enable maintenance to resolve.	Bridge lowered All barriers raised/ open All warning lights and sounders extinguished

* If at any point during the bridge movement sequence the operator needs to reverse the action currently being undertaken, they can do so by releasing the button currently being pressed and carry out the required action.

The opening sequence is expected to progress as follows:

Phase	**Duration (sec)**
Vessel requests bridge opening	-
Activate pedestrian sounders and red man lights, navigation lights set to red	5
Wait for bridge walkway to clear, check CCTV and ensure walkways are clear	60-180 (estimate)
When safe, lower pedestrian barriers	10
Activate road sounders and wigwags	10
When safe, lower road entry barriers	10
Wait for bridge to clear of road traffic	20 (estimate)
When safe, lower road exit barriers	10
Bridge lifts open to fully raised	180
Turn off pedestrian and road sounders	0
Navigation lights set to green, vessel passes through, return navigation lights to red	Dependant on vessel movements and number passing
Bridge lowers to fully closed	180
All sounders activated to warn road traffic and pedestrians that barriers are about to raise	5
Raise all barriers	10
All wigwags, lights and sounders turned off	10
Traffic resumes	-

5.4 Plant room

5.4.1 General layout

The equipment required to operate the bridge will be located in the machine pier. The equipment will be split onto different levels with the hydraulic power pack deepest in the room so that pipe runs to the cylinders are kept as short as possible. The electrical panels will be arranged on the floor above.

Access into the plant room will be via an access hatch at deck level and then down a series of ships ladders. Barriers around the hatch will provide edge protection when the hatch is open for access.

A series of removable panels will also be provided to enable large elements of equipment to be removed. These panels will be in the main carriageway and hence are only for major maintenance activities.

5.4.2 Drainage and associated pumping requirements

The base of the cylinder pit will be shaped such that any rainwater shall drain to a sump. The sump will be equipped with a sump pump which is connected to an interceptor tank which will remove the oil before any water is discharged into the local foul water system.

5.4.3 Plant room environment; heating, lighting, humidity, ventilation.

To minimise the risk of flooding in the plant room any ventilation shall be provided from the top of the machine pier, above the flood level. The bridge operating frequency is sufficiently low to enable the system to cool down sufficiently between operations.

5.4.4 Mechanical and electrical equipping

The plant room will be equipped with power sockets to enable power tools to be used or charged. Lighting and ventilation shall be provided to create a safe working environment.

A davit crane should be installed within the plant room to make removing and moving equipment easier and safer.

5.4.5 Security; intruder and fire alarm systems

The method of access means it is visual if someone is trying to get access, however, the cost of an intruder alarm is minimal and so recommended.

CCTV will be provided to view the equipment within the plant room and check that there are no obvious issues such as oil leaks, fires, or the presence of people.

5.4.6 Proposed firefighting measures

No automated firefighting measures are proposed. Fire extinguishers shall be provided next to relevant equipment (electrical cabinets, hydraulic power pack)

5.5 Description of Inspection and Maintenance Arrangements

5.5.1 Proposals for inspection and maintenance of M&E installation

The hydraulic cylinders have been sized so that the deck can be lifted on a single cylinder to enable a damaged or failed cylinder to be removed with the deck in the raised position. It is recommended that a tie-back is provided to ensure the deck remains in its lifted position while maintenance works are undertaken.

See Section 4.3.13 for provisions in the structural arrangement for access to the machine pier.

5.5.2 Proposed documentation

- Full set of 'As Built' drawings for both the Electrical and Mechanical Equipment
- Complete training literature for both operation and maintenance
- Digital plus two hard copy sets of Operation and Maintenance Manual

- UKCA Technical File
- Records of Factory and Site Acceptance Testing
- Commissioning procedures

5.5.3 Proposals for plant monitoring, data collection and management

Data collected by the PLC will be accessible via the Dublin Ports SCADA system.

The control desk will be equipped with a Human Machine Interface (HMI) that can display feedback to the operator and provide a list of faults.

The HMI/SCADA default screen will be programmed to display the current status of the Hydraulic Power Packs and other site equipment. Each section of the control system will be displayed on individual screens. The system also logs the most recent alarms which can be acknowledged using this page. By logging-in using a username and password code, Operators can access the data such as:

- Site wide general arrangement of equipment
- Alarm history
- All data shown on the control panel graphic Operator terminals
- All PLC inputs and outputs
- Override functions for safety lock out systems
- Operational run hours for all motors
- Read outs for all sensors and transducers
- Data logger to log fault code history, warnings, alarms, operating data etc with enough capacity to store data for 6 months. Operational data, such as number of operations, fault logs etc should be stored for maintenance and review purposes. Data that is no longer required may be overwritten although provision should be made so that it is possible to backup and archive all data to an external source if required.
- Other variables and screens can be set up as required.

The data can be transferred from the HMI to a laptop via an inbuilt USB port.

The system will include a facility for viewing the HMI screens and data at a remote station through the use of PC Anywhere (or similar) software, whereby a remote Operator can dial in and log into the HMI/SCADA to view system status and other screens. No parameter changes will be possible from the remote location.

6 Safety

6.1 Traffic management during construction including land for temporary diversions

6.2 Safety during construction

As required by the Safety, Health and Welfare at Work (Construction) Regulations 2013, the designer will comply with the General Principles of Prevention (of accidents) and liaise with the Project Supervisor Design Process. The Project Supervisor for the Design Process (PSDP) will be required to:

- Prepare the Preliminary Health and Safety Plan
- During the design of the project and when estimating the period for completion, take account of the General Principles of Prevention (of accidents), as specified in the First Schedule of the Safety, Health and Welfare at Work (Construction) Regulations 2013,
- Co-ordinate the work of the designers engaged in work related to the design of the project
- Obtain all appropriate information required for the compilation of the Safety File, Health and Safety regulations, etc.

The Designer and the PSDP will liaise with the Project Supervisor appointed for the Construction Stage (PSCS) as required by the Safety, Health, and Welfare at Work (Construction) Regulations 2013. The Project Supervisor for the Construction Stage (PSCS) will:

- Coordinate the implementation of the construction regulations by contractors,
- Organise co-operation between contractors and the providers of information, and
- Coordinate the checking of safe working procedures

The design will seek to maximize offsite construction to improve safety and reduce environmental and social impact during construction.

6.3 Safety in use

Counterweight

The current proposal contains a counterweight which is suspended above the carriageway by the weight of the lifting span and the connecting cables. The tension in the cables is limited by the weight and incline of the counterweight.

The counterweight could move of its own accord if the cables were to fail or if external forces applied to the counterweight were sufficient to overcome their tension. A passive safety catch has been designed as extensions to the beams and counterweight arms to exploit the twin-pivot geometry such that it prevents independent movement of the counterweight. This means the counterweight cannot move unless the deck is also being lifted. When the bridge lifts as intended, the geometry of the two elements and their respective pivot locations ensure the safety catches miss each other, allowing the bridge to open.

The counterweight struts should also be designed such that the failure of one cable does not cause the frame to fail under the resulting asymmetric deformation. Two cables per side are proposed to ensure redundancy. The kinematic of the system means that these cables must be aligned horizontally.

During Lifts

Barriers will be provided on both pathways and the carriageway to restrict access to the lifting span. The barriers shall be configured such that pedestrians and vehicles are kept clear from exposed edges of the structure and from the moving counterweight.

If barriers are designed to swing closed, they should do so without risk of entrapment; that is, they should re-open away from the traffic they are restraining.

Pedestrian barriers should be designed such that they are capable of resisting horizontal and vertical loads equal to those expected on a parapet, refer to Section 4.2.6.

Vehicle barriers should include a traffic light system but do not need to resist impact loading.

An operative in the control tower will use their own view and CCTV to ensure the lifting span is clear prior to the commencement of lifts.

6.4 Lighting

See Section 4.2.8.

7 Design Assessment Criteria

7.1 Actions

This section details the actions on the structure for the purposes of design.

The actions in this section are applied in combination with partial and combination factors as per IS EN 1990:2002 and using traffic groups defined in the National Annex of IS EN 1991-2:2003. These combinations are described below:

Traffic Groups (Table NA.3, IS EN 1991-2:2003)

Load type		Carriageway						Footways and cycle tracks
		Vertical forces				**Horizontal forces**		**Vertical forces only** [a]
Reference		4.3.2	4.3.3	Annex A	4.3.5	4.4.1	4.4.2	5.3.2.1 Equation (5.1)
Load system		LM1 (TS and UDL)	LM2 (Single axle)	LM3 (Special vehicles)	LM4 (Crowd loading)	Braking and acceleration forces	Centrifugal and transverse forces	Uniformly distributed load
Groups of loads	gr1a	Characteristic						0,6 times Characteristic [b, c]
	gr1b		Characteristic					
	gr2	Frequent [d]				Characteristic	Characteristic	
	gr3 [a]							Characteristic [b]
	gr4				Characteristic			Characteristic [b]
	gr5	Frequent [d]		Characteristic				
	gr6			Characteristic		Characteristic	Characteristic	
	(shaded)	Dominant component action (the group is sometimes designated by this component for convenience).						

[a] This group is irrelevant if gr4 is considered

[b] Characteristic value obtained from subclause 5.3.2.1

[c] This is a reduced value accompanying the characteristic value of LM1 and should not be factored by $\psi 1$. However, when gr1a is combined with leading non-traffic actions this value should be factored by $\psi 0$

[d] The $\psi 1$ factors should be taken from the national annex to I.S. EN 1990.

Note that crowd loading (LM4) is not considered. LM2 will be considered for local verification only.

Notation

The notation of the combinations in this section is as follows:

- E_d = Design Value of Combination Action
- G_k = Characteristic Permanent Effects
- P = Prestressing Effects
- Q_k = Transient and Variable Effects
- A_d = Design Accidental Effects
- γ = Partial Factor Corresponding to Action
- ψ = Combination Factor

Serviceability Limit State

Quasi-Permanent

- $E_d = \sum_{j\geq 1} G_{k,j} + P + \sum_{i\geq 1} \psi_{2,i} Q_{k,i}$ (IS EN 1990:2002 Eqn. 6.16)

i.e.: Characteristic permanent effects and the quasi-permanent values of other variable effects

Frequent

- $E_d = \sum_{j\geq 1} G_{k,j} + P + \psi_{1,1} Q_{k,1} + \sum_{i>1} \psi_{2,i} Q_{k,i}$ (IS EN 1990:2002 Eqn. 6.15)

i.e.: Characteristic permanent effects; the frequent value of a leading variable effect; and the quasi-permanent values of other variable effects

Characteristic

- $E_d = \sum_{j\geq 1} G_{k,j} + P + Q_{k,1} + \sum_{i>1} \psi_{0,i} Q_{k,i}$ (IS EN 1990:2002 Eqn. 6.14)

i.e.: Characteristic permanent effects; the characteristic value of a leading variable effect; and the combination values of other variable effects

Ultimate Limit State (Sets B and C)

- $E_d = \sum_{j\geq 1} \gamma_{G,j} G_{k,j} + \gamma_P P + \gamma_{Q,1} Q_{k,1} + \sum_{i\geq 1} \gamma_{Q,i} \psi_{0,i} Q_{k,i}$ (IS EN 1990:2002 Eqn. 6.9)

i.e.: Factored permanent effects; the factored value of a leading variable effect; and the factored combination values of other variable effects

Accidental Design Situations

- $E_d = \sum_{j\geq 1} G_{k,j} + P + A_d + \psi_{1/2,1} Q_{k,1} + \sum_{i\geq 1} \psi_{2,i} Q_{k,i}$ (IS EN 1990:2002 Eqn. 6.11)

i.e. Characteristic permanent effects, the accidental design load, a second leading variable with either a frequent or quasi permanent combination factor depending on design situation, and quasi-permanent values of other variables

Combination Factors

The combination factors provided in IS EN 1990:2002, Table NA.7, are:

Action	Group of Loads	Load components	ψ_0 (Combination)	ψ_1 (Frequent)	ψ_2 (Quasi-Permanent)
Traffic loads	gr1a	TS/UDL Pedestrian	0.75 0.40	0.75 0.40	0 0
	Gr1b	Single Axle	0	0.75	0
	Gr2	Horizontal	0	0	0
	Gr3	Pedestrian	0	0.40	0
	Gr4	Crowd	0	0	0
	Gr5	Vertical - SV	0	0	0
	Gr6	Horizontal - SV	0	0	0
Wind Loads	F_{Wk}	Persistent Execution	0.50 0.80	0.20 -	0 0
	F_W	Execution	1.00	-	0
Thermal	T_k		0.60	0.6	0.5
Snow	$Q_{Sn,k}$		0.80	-	-
Construction	Q_c		1.00	-	1.00

Partial Factors

The partial factors for ULS combinations are provided in IS EN 1990:2002 Tables NA.9 and NA.10:

Γ		ULS Set B		ULS Set C	
		Beneficial	Adverse	Beneficial	Adverse
Permanent actions					
Concrete self-weight		0.95	1.35	1.00	1.00
Steel self-weight		0.95	1.20	1.00	1.00
Super-imposed dead load		0.95	1.20	1.00	1.00
Road surfacing		0.95	1.20	1.00	1.00
Ballast		0.95	1.35	1.00	1.00
Self-weight of other materials		0.95	1.35	1.00	1.00
Settlement	Linear	0	1.20	1.00	1.00
	Non-linear	0	1.35		
Variable actions					
Road traffic actions (gr1a, gr1b, gr2, gr5, gr6)		0	1.35	0	1.15
Pedestrian actions (gr3, gr4)		0	1.35	0	1.15
Wind actions		0	1.70	0	1.45
Thermal actions		0	1.55	0	1.30

7.1.1 Permanent actions

The characteristic values of permanent loads shall be determined in accordance with IS EN 1991-1-1:2002 using the Nationally Determined Parameters stated in the relevant Irish National Annex, except as described otherwise in this document.

Dead and Superimposed Dead Loads

The following characteristic unit weights of materials shall be used:

- Reinforced and precast concrete 25 kN/m³
- Unreinforced concrete 24 kN/m³
- Structural steel (carbon or stainless) 77 kN/m³
- Footway surfacing 22 kN/m³

The weight of secondary components and equipment such as parapets will be determined explicitly using the appropriate component size and material density.

Services to be carried by bridge

None, other than for bridge drainage, lighting, and those required for the bridge operation.

Support Settlements

The effect of settlement of supports will be considered as a permanent load where no special provision has been made to remedy the effect. Expected magnitudes of settlement will be assessed based on ground investigations and a design value will be derived. A differential settlement at any pier of 10 mm is assumed at preliminary design.

Creep and Shrinkage

Creep and shrinkage effects of concrete structures shall be determined in accordance with IS EN 1992. The average humidity ratio will be taken as 80%.

Early-age thermal crack control will be assessed to Circa C766, revision 2018

7.1.2 Snow, wind, and thermal actions

As per IS EN 1990:2002, clause A2.2.2, wind and snow actions need not be combined with horizontal traffic loads for traffic group gr2. Snow loads need not be combined with traffic Load Models 1 and 2 or their associated traffic groups, gr1a and gr1b. No wind action greater than the smaller of F^*_W and $\psi_0 F_{wk}$ should be combined with Load Model 1 or with the associated traffic group gr1a.

Wind

The structure will be designed for wind loading to I.S EN 1991-1-4 with a return period of 120 years. When determining the exposure factor, $c_e(z)$, the process outlined in the Irish national annex to IS EN 1991-1-4 clause NA.2.17 shall be used, including the factor $c_{eT}(z)$ to account for town terrain.

Three conditions shall be considered for the bridge opening as defined below.

Bridge Closed Position

The fundamental basic wind velocity $v_{b,map}$ is 24.8m/s. The probability factor, c_{prob}, shall be taken equal to 1.05 consistent with a design life equal to 120 years.

Directional factors c_{dir} will be determined according to NA to I.S. EN 1991-1-4 clause NA.2.6.

Bridge Opening – Normal Service

For normal service the wind speed shall be restricted to 15 m/s for bridge opening. This is defined using the basis hourly mean. The relationship between hourly mean wind speeds and the design 10-minute mean used in EN 1991-1-4, shall be taken as:

- $v_b(10\ min) = 1.06\ v_b(1\ hour)$

The probability factor, c_{prob}, shall be taken equal to unity for normal service.

Bridge Opened – Accidental

An additional accidental limit state event shall be considered as a high wind event coincident with failure of the mechanical systems so that bridge is in the open condition. For this load case, the following parameters shall be used:

- Fundamental basic wind velocity $v_{b,map}$ = 24.8m/s.
- The probability factor, c_{prob} = 0.78
  - Calculated for n=0.5; K=0.2. Probability of annual exceedance, p, taken as 0.5 in accordance with I.S. EN199-1-6 Table 3.1 for durations less than 3 days.
- The seasonal factor, c_{season} = 1.0

This shall be considered as the leading accidental limit state action with the reduced characteristic wind speed defined above.

Wind dynamics

Wind tunnel testing is to be carried out at a later stage, if required.

Snow

For the opening case, the operational manual shall specify that the bridge shall not be opened whilst there is snow on the bridge. However, to allow for the possible build-up of compacted snow/ice that is not cleared from the bridge, a reduced characteristic value of snow load on the ground of 0.2 kN/m² will be adopted.

This value is based on a third of the value defined in the ground snow map from NA to IS EN 1991-1-3 and corresponds to 200 mm thick fresh snow, 100 mm settled snow or 50 mm of wet snow.

The snow load is considered as the leading variable action and combined with thermal cooling only. Snow is not considered with any other variable load combinations, and no exceptional snow loads are considered as accidental actions due to the restriction on lifting the bridge with snow present on the bridge.

Thermal

The coefficient of linear expansion for both steel and concrete shall be taken as:

$\alpha_T = 12 \times 10^{-6}$ / °C

Thermal loads shall be in accordance with IS EN 1991-1-5 and the Irish National Annex.

- Minimum shade air temperature, T_{min} = -11.5°C
- Maximum shade air temperature: T_{max} = 30.5°C

(Adjusted for a 120-year return period and +5m OAD altitude)

The all-steel main span will be considered as Type 1; the approach spans will be considered as Type 3. The uniform bridge temperatures by type are derived from the bridge type and surfacing. Assuming the surfacing is only waterproofing, larger corrections apply – this is a conservative approach until the amount of surfacing is confirmed. The derived uniform bridge temperatures are:

	Type 1	Type 2	Type 3
$T_{e,min}$	T_{min}−3+0 = -14.5°C	T_{min}+4-3 = -10.5°C	T_{min}+8−1 = -4.5°C
$T_{e,max}$	T_{max}+16+4 = 50.5°C	T_{max}+4+4 = 38.5°C	T_{max}+2+2 = 34.5°C

The initial temperature, T_0, shall be defined during detailed design. A lower bound and upper bound for T_0 shall be defined to allow for uncertainty in the setting temperature.

For the time being the following shall be used; 5°C < T_0< 15°C

The temperature range used for the design of the bearings and expansion joints will be in accordance with I.S. EN 1991-1-5 §6.1.3.3 Note 2. The temperature at which the bearings and expansion joints are set will be specified in the design. Consequently, the recommended design values of ($\Delta T_{N,exp}$ + 10)°C and ($\Delta T_{N,con.}$ + 10)°C, will be used to calculate the thermal movement range of the bearing and expansion joint thermal movement.

The effects of differential temperature will be considered. Vertical temperature difference components with non-linear effects shall be according to Approach 2 of EN 1991-1-5 as specified in the Irish NA.

The design will consider the effect of differences in temperature between the bridge deck and counterweight. A temperature difference of 5°C shall be considered. A linear temperature difference between the opposite outer faces of concrete piers shall be taken as 5°C. Combined uniform temperature and temperature differences shall be considered. In accordance with I.S. EN 1991-1-5 cl N 2.12 ω_N = 1.00 and ω_M = 1.00 shall be used for combined uniform and differential temperature but with T_N determined from the relevant value of T_0 and $T_{e,max}$ above 25°C and $T_{e,min}$ of up to 8°C below.

7.1.3 Actions relating to normal traffic

Road Traffic

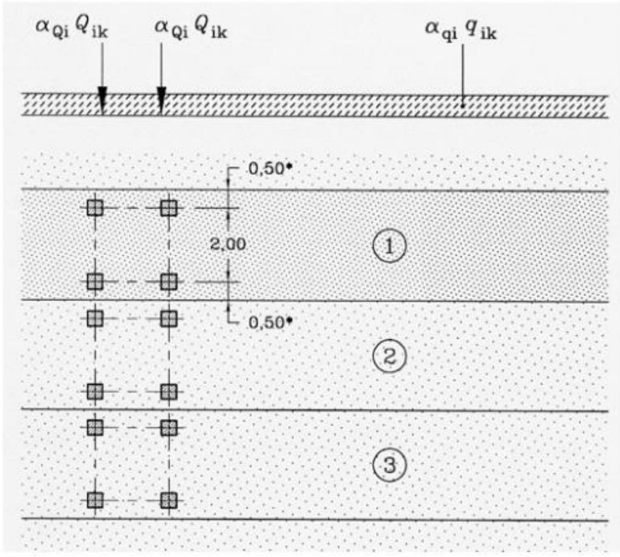
Load Model 1 will be used for global verification, comprising two partial systems:

- A double-axle concentrated load tandem system where each axle has a weight $\alpha_Q Q_k$, applied in one location per lane to produce the most adverse effect.
- Uniformly distributed loads with a weight per square metre of $\alpha_q q_k$, applied to produce the most adverse effect.

The characteristic values and adjustment factors are provided in Table 4.2 and Table NA.1 of IS EN 1991-2:2003 respectively, shown below:

Location	Tandem Axle Loads (per axle)		Uniformly Distributed Loads		
	Q_{ik} (kN)	α_{Qi}	q_{ik} (kN/m²)	α_{qi}	α_{qi} q_{ik} (kN/m²)
Lane 1	300	1	9	0.61	5.5
Lane 2	200	1	2.5	2.2	5.5
Lane 3	100	1	2.5	2.2	5.5
Other Lanes	0	-	2.5	2.2	5.5
Remaining Area	0	-	2.5	2.2	5.5

A diagram of the application of Load Model 1 is shown below, from Figure 4.2a of IS EN 1991-2:2003.



The associated characteristic braking force is defined for Load Model 1 by IS EN 1991-2 clause 4.4.1 as:

- $Q_{lk} = 0.6\ \alpha_{Q1}\ (2Q_{1k}) + 0.1\ \alpha_{q1}\ q_{1k}\ w_1\ L$
  - w_1 and L are the width and length of the loaded lane respectively
- Limits on total force: $180\ \alpha_{Q1} < Q_{lk} < 900$ (kN)

This force is applied as a distributed load over the loaded length.

A centrifugal load is also applied as a point load at any point at the finished carriageway level with magnitude defined in IS EN 1991-2 clause 4.4.2 as:

- $Q_{tk} = 0.2\ Q_v$ for $r < 200$ m
  - Q_v is the total maximum weight of the vertical loads of the tandem systems of LM1 (all lanes)

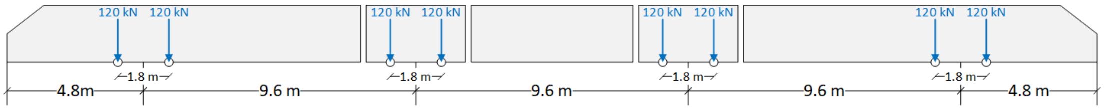
IS EN 1991-2 Table NA.3 explains the combination of individual load effects to form traffic groups. The groups used are shown below. For special vehicle loading, see Section 7.1.4.

Load type	Carriageway				Active Travel
	Vertical Forces		Horizontal Forces		Vertical Only
Load system	**LM1 (TS + UDL)**	**LM3 (Special Vehicle)**	**Braking and Acceleration**	**Centrifugal and transverse**	**Uniformly Distributed Load**
gr1a	Characteristic				0.6 x Characteristic
gr2	Frequent		Characteristic	Characteristic	
gr3					Characteristic
gr5	Frequent	Characteristic			
gr6		Characteristic	Characteristic	Characteristic	

Luas Line Provision

The RPA document, B1_SAr_0001-02, describes the Luas loading using two non-concurrent loads:

- A uniform track load of 25 kN/m (divided equally between rails)
- A 38.4 m long tram vehicle with 8 axles loaded with 120 kN per axle. Axles are spaced 1.8 m apart in pairs, with each pair 9.6 m apart, as per the below diagram. Up to 6 tram vehicles are considered to be coupled with the vehicles butted hard up against each other.



The worst load effects from these loads are taken; the point loads are equivalent to the uniform track load in terms of load per unit length but will govern for local verifications.

It is required that a restriction on bridge traffic is enforced such that the Luas line cannot use the bridge while an abnormal special vehicle is present.

The permanent fixtures required to operate the Luas, including derailment kerbs, track slabs or sleepers, and power supply will need to be established prior to detailed design. The weight of these elements could be significant and will need to be accommodated in the primary structural members.

The design criteria for the running of a Luas line, including deflection limits and transitions at the ends of the bridge, have not been available to the designers. Therefore, these have not been considered. Expansion joints in the rails should be prevented as far as possible, though it is acknowledged that joints are unavoidable at the ends of the lifting span.

Some modifications to the cantilever intended to carry the Luas may be required. This may take the form of closing the soffit to create an enclosed box with additional stiffness and adding additional supports as necessary to mitigate relative deflection. Alternatively, the cantilevers could be made into a composite structure with the addition of a concrete slab; this would make track fittings more conventional. A more lightweight solution would be required for the lifting span.

The likelihood of the Luas line provision being used will inform how the bridge as constructed would accommodate it. That is, the upfront cost of the provision and additional capacity in the structure should be weighed against the ease and cost of the retrofit installation. It is anticipated that the inclusion of a Luas line would be determined prior to the detailed design stage.

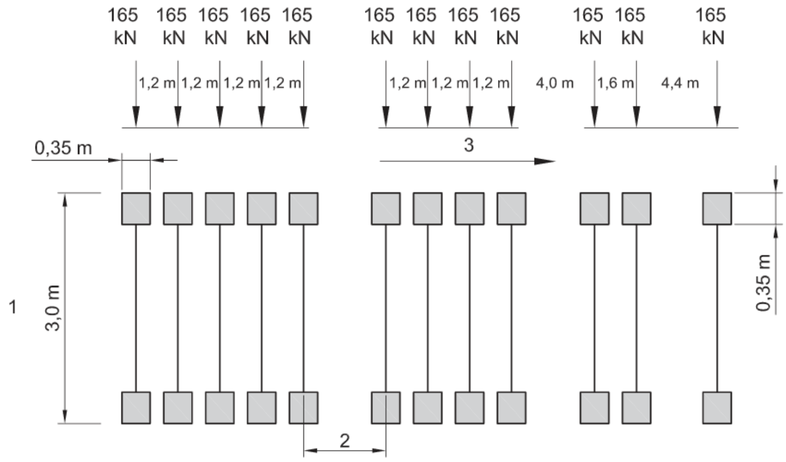
The provision for the Luas is currently situated on an Active Travel route. Should this prove unfeasible for detailing reasons or for the integration with traffic, an alternative may be considered where the Luas provision is located on a shared path with the road carriageway. This integration is common elsewhere in Dublin (and in other cities with tram systems) where the Luas shares the road network.

7.1.4 Actions relating to abnormal traffic

The special vehicle, SV196, as defined in NA.2.16.1.3 to IS EN 1991-2:2003 will be used as the abnormal load model. This vehicle "represents the effects of a single locomotive pulling a typical abnormal load with a maximum gross weight of 150 tonnes and a maximum basic axle load of 16.5 tonnes with the gross weight of the vehicle train not exceeding 196 tonnes"

The SV196 vehicle forms part of the traffic groups gr5 and gr6.

The definition of SV196 vehicle from IS EN 1991-2:2003, Figure NA.1(c) is shown below:



Key

1 = Outside track and overall vehicle width
2 = Critical of 1,2 m or 5,0 m or 9,0 m
3 = Direction of travel

A dynamic factor of 1.12 is to be applied as per Table NA.2 of IS EN 1991-2:2003.

The application of the SV196 vehicle is as follows:

- Placed at the most unfavourable position, at any transverse position on the carriageway with its side parallel to the kerb.

- Combined with frequent values (0.75 x characteristic value) of Load Model 1 (clause 4.5), together with adjustment factors from NA.2.12. Load Model 1 loads should not be placed within 5 m of either end of the special vehicle.

Horizontal loads (i.e., centrifugal and braking loads) are also to be applied proportionally to the vertical axle loads.

A maximum braking load of 750 kN is to be applied (IS EN 1991-2:2003, NA.2.17). The load is distributed such that a quarter of the vertical load per axle is applied (IS EN 1991-2:2003, NA.2.18.1).

The centrifugal load is also applied proportionally to the vertical axle loads; the total load is calculated according to IS EN 1991-2:2003, NA.2.18.2 as:

- $Q_{tk,s} = W V^2 / (g r)$

- where V is the maximum speed in m/s; r is the radius of curvature; and W is the total vehicle weight.

7.1.5 Footway or footbridge live loading

As per IS EN 1991-2:2003, clause 5.3.2.1, a uniformly distributed load of q_{fk} = 5 kN/m² should be applied to the footways in unfavourable locations.

For local verification, a concentrated load of 10 kN acting on a square of sides 0.1 m may be used.

The footway shall be designed for a small service vehicle. The load model used for the service vehicle will be defined during detailed design.

7.1.6 Provision for exceptional abnormal loads

[N/A]

7.1.7 Accidental actions

Ship Impact

The ship impact loads on the bridge superstructure will be limited to the 1 MN load transverse relative to the axis of the bridge. This load is supported by the Irish National Annex to IS EN 1991-1-7, clause NA.2.37.

Dolphins will be used to protect the piers either side of the navigation channel from impact from vessels intending to pass under the bridge. A probabilistic approach is recommended, based on studies of the sizes of vessels that pass under the Tom Clarke Bridge. Based on the number of vessels and the control expected for marine operations, it is considered that design for a large ship impact is not required.

The northern side of the river is a dredged channel and can be populated by large vessels including cruise ships and ferries. In lieu of designing the bridge for impact with these vessels, a berthing dolphin will be required with sufficient clearance from the structure to minimise the chance of impact. Such a dolphin would be designed according to the port’s requirements.

The southern approach structure is protected by the low water depth to the south of the navigation channel.

Impact due to debris from flooding is considered less onerous than the ship impacts outlined and therefore will not be explicitly considered.

Cable Failure

The possibility of cable failures must be considered in the design. The structural components should be designed such that the effect of the failure of a single cable does not cause progressive failure.

Vehicle Collision with Kerbs and Vehicle Restraint System

As per IS EN 1991-2:2003 clause 4.7.3.2, action from vehicle collision with kerbs or pavement upstands should be taken as a lateral force equal to 100 kN acting at a depth of 0.05 m below the top of the kerb.

This force should be considered as acting on a line 0.5 m long and is transmitted by the kerbs to the structural members supporting them. In rigid structural members, the load should be assumed to have an angle of dispersal of 45°. When unfavourable, a vertical traffic load acting simultaneously with the collision force equal to 0.75 α_{Q1} Q_{1k} should be considered.

For collisions with the Vehicle Restraint System, IS EN 1991-2:2003 Table NA.6 recommends a horizontal force dependent on a defined class dependent on the stiffness of the system:

- Class A: 100 kN transverse
- Class B: 200 kN transverse
- Class C: 400 kN transverse; 100 kN longitudinal; 175 kN vertical
- Class D: 600 kN transverse; 100 kN longitudinal; 175 kN vertical

The horizontal force, acting transversely, may be applied 100 mm below the top of the selected Vehicle Restraint System or 1.0 m above the level of the carriageway or footway, whichever is the lower, and on a line 3 m long.

Emergency Stop during Opening

A maximum rate of deceleration in the event of the emergency stop being pressed shall be agreed during the detailed design stage. A rate of deceleration that brings the bridge to a controlled and prompt stop, and does not cause structural design issues, will be selected.

7.1.8 Actions during construction

The structural arrangement during construction will be considered to ensure the stability of the structure in its temporary states.

Loads specific to the execution stage are as specified in IS EN 1991-1-6, and will be considered as appropriate where they cause adverse effects on the structure or any temporary structures used in construction:

- Wind and thermal loads with a reduced return period compared to the permanent condition. As per Table 3.1 of IS EN 1991-1-6, a return period of 50 years is used for projects with a nominal duration greater than 1 year.
  - Unbalanced wind effects will be considered for stability in temporary conditions.

- Loads due to the water on temporary retaining structures.
- Construction loads as per Section 4.11 of IS EN 1991-1-6, with characteristic loads as follows:
  - Personnel and hand tools: A uniformly distributed load of 1 kN/m² applied to obtain the most unfavourable effects
  - Storage of movable items: A uniformly distributed load of .2 kN/m² and a concentrated load of 100 kN
  - Non-permanent equipment: Initially considered as a uniformly distributed load of 0.5 kN/m², which should be revised based on information from suppliers
  - Moveable heavy machinery and equipment: No load model is provided by the Eurocode though it is anticipated that particular examples of this include the lifting machinery components situated in positions prior to their installation
  - Loads from parts of a structure in a temporary state: This includes parts of the structure which are present but offering no load path, such as the wet concrete poured into its permanent formwork on the approach spans
- Accidental loads during construction should also be included, such as impacts from construction vehicles, falls of equipment, and human impact loads.

The deflection of the structure in its temporary state should also be considered. It is anticipated that the structure will be lifted into place; for the approach spans this lift will be conducted with no concrete in place. The spine beams are anticipated to provide the primary load path and as such it is not anticipated that the deflections in the temporary condition should be significantly affected by the incomplete structure.

7.1.9 Any special loading not covered above

Pedestrian Dynamic Response

The response to pedestrian dynamic loading will be assessed be determined and compared to acceptable limits in accordance with Irish NA to I.S. EN1991-2.

Bridge Class = C (in accordance with Irish NA to I.S. EN1991-2 Table NA.7). Class C is defined as "Urban routes subject to significant variation in daily usage (e.g., structures serving access to offices or schools)."

The response modifiers shall be as follows:

- k1 = 1.0 corresponding to major urban centres
- k2 = 1.0 corresponding to a primary route
- k3 = 1.0 corresponding to a bridge height between 4m and 8m.

- k4 = 1.0 exposure factor

Therefore, limiting acceleration, a_{limit} = 1.0m/s^2

If calculated accelerations are greater than this value, tuned mass dampers may be specified to increase the level of damping in the structure and to control vibration amplitudes to within the above limit.

Aerodynamic Response

The dynamic response to wind loading, particularly flutter and galloping, will be considered. Such effects can be critical for the fatigue of structural elements such as the cable connections, and the stability of the bridge when it is opened. As per the pedestrian dynamics, dampers may be specified to control vibration amplitudes to ensure the effects are mitigated.

It is likely that wind tunnel testing will be required to support the design development and validate key assumptions. This will be confirmed during the next design stage.

A dynamic analysis of the counterweight under wind loading will be necessary to ensure the suspended counterweight does not move unintentionally. Physical locks via contacting steel plates have been designed to ensure the counterweight cannot move independently of the deck; these blocks exploit the double-pivot geometry to ensure the counterweight is essentially fixed in both the forward and backwards direction in case of cable failure.

Hydrodynamic Actions

Hydrodynamic actions shall be calculated based on recommendations from the hydrodynamic studies. These actions will depend on the anticipated flow speed as well as the shape and orientation of obstructions in the river.

7.2 Authorities consulted and any special conditions required

Consultation with relevant authorities is on-going. The following groups have been consulted as part of the stakeholder engagement process:

- Dublin City Council (DCC)
- Dublin Port Harbourmaster Office

7.3 Proposed Departures from Standards

None expected

7.4 Proposed methods of dealing with aspects not covered by Standards

None expected.

8 Ground Conditions

8.1 Geotechnical Classification

The Geotechnical Category for the bridge structure shall be Geotechnical Category 2 as defined in IS EN 1997-1. This is due to the structure being without no exceptional risks, difficult ground or loading conditions. Site specific quantitative geotechnical data (including both field and laboratory testing) shall be used in the design and execution of the bridge structure.

8.2 Description of the ground conditions and compatibility with proposed foundation design

A Ground Investigation Report (GIR) is not developed at this stage. However, some ground investigations at the site location and in the vicinity of the site are currently available. A Geotechnical Asset Summary Sheet (GASS) based on the available ground investigations has been prepared and included in Appendix B. The GASS presents a preliminary ground model and groundwater model for the site that shall be developed at Phase 3. Therefore, both the ground model and groundwater model shall be revised once additional site-specific ground investigation becomes available. The table below gives the summary of the preliminary ground model based on the available ground investigation.

Geological Unit	Range of Top of Stratum (m Datum)	Range of Thickness (m)
Very soft to stiff sandy silty CLAY / clayey SILTS (Estuarine Deposits)	0.11 to -2.06	9.50 to 10.90
Stiff sandy Gravelly CLAY (Port Clay)	-9.39 to -12.96	0.50 to 0.80
Very dense sandy clayey GRAVEL (Glacial Deposits)	-9.89 to -13.76	3.15 to 7.22
Medium strong to strong LIMESTONE	-16.91 to -17.11	11.98 to 13.75 (not proven)

Additional ground investigation has not yet been proposed. However, the additional ground investigation is likely to consist of rotary cored boreholes at piers and abutments. The main objectives of the additional ground investigation include but are not limited to: confirming the thickness and engineering properties of the drift and solid geology and determining the distribution and engineering properties of the strata beneath the site; determining the groundwater conditions; providing information to the substructure design and recommendation to the Geotechnical Design Report (GDR). A GIR and GDR shall be prepared and the detailed design will be carried out following the recommendations in the GDR.

Due to the preliminary proposed loading conditions for the bridge piers and the depth of the dense gravels and limestone, it is anticipated that all piers and abutments will be supported on piled foundations within the Glacial Deposits and the underlying Limestone. Preliminary assessment indicates that the pile diameter may vary from 900mm to 1200mm. However, pile diameter shall be developed at detailed design and therefore pile diameter may change.

The design of pile axial resistance will be carried out in accordance with IS EN 1997-1 (EC7). The pile axial resistance will be computed from a combination of end bearing and shaft resistance using static analysis. The design partial factors shall be selected based on Ultimate Limit State. The method of calculation of the design bearing resistance of a pile is dependent on the type of geological material through which the pile is constructed. Industry standard methods will be used to calculate the design end bearing and shaft resistance of the piles, taking into account the variability in ground/ rock strength and type through the geological profile in which a pile will be constructed.

For pile group analysis under each pier and abutment, computer analysis using commercially available software will be undertaken to assess pile group settlement and deflections (vertical, horizontal) and to determine the distribution of load effects within the individual piles in the group. Where necessary, computer outputs will be verified by hand calculation using the equivalent raft method and also from a consideration of single pile performance assessed via Fleming (1992).

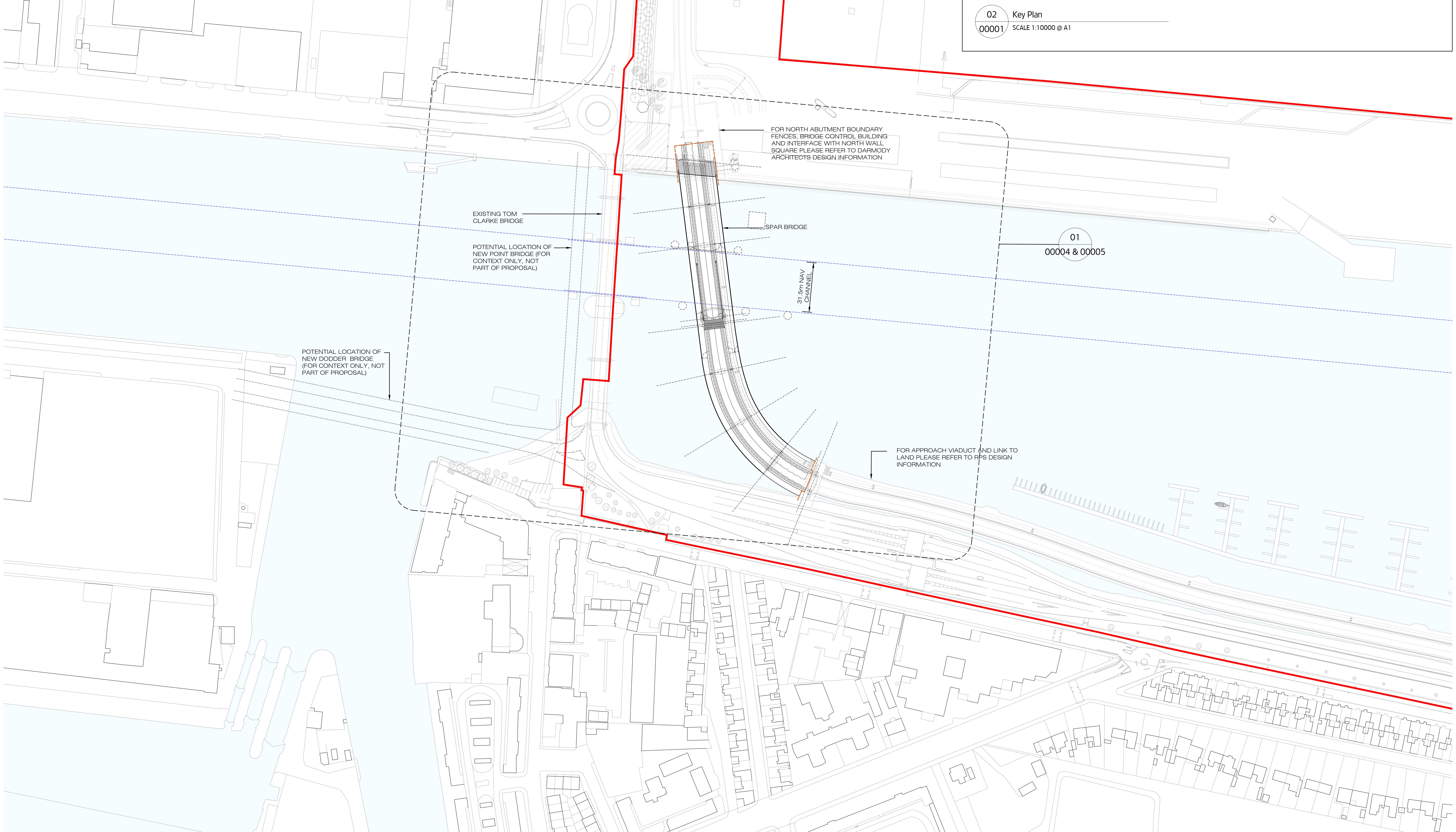
9 Drawings and Documents

9.1 List of all documents accompanying the submission

Drawings included in Appendix A:

Document Number (Project Prefix CP1901_3FM)	Drawing Title	Version
MOXON-SBR-SP-DR-A-100-00001	Proposed Context Plan	4
MOXON-SBR-SP-DR-A-100-00005	Proposed Bridge Plan	4
MOXON-SBR-SP-DR-A-100-00006	Existing Site Plan	4
MOXON-SBR-SP-DR-A-100-00010	Proposed West Elevation	4
MOXON-SBR-SP-DR-A-100-00011	Proposed West Detail Elevation	4
MOXON-SBR-SP-DR-A-100-00012	Proposed North Detail Elevation	4
MOXON-SBR-SP-DR-A-100-00020	Proposed Cross Sections - Sheet 1 of 2	4
MOXON-SBR-SP-DR-A-100-00021	Proposed Cross Sections - Sheet 2 of 2	4
MOXON-SBR-SP-DR-A-100-00030	Proposed North Abutment - - Detail Arrangement	4
MOXON-SBR-SP-DR-A-100-00031	Existing North Abutment - Detail Arrangement	4
EADON-SBR-SP-DR-M-100-00050	Deck Pivot Assembly	1
EADON-SBR-SP-DR-M-100-00051	Counterweight Pivots	1
EADON-SBR-SP-DR-M-100-00052	Upper Cylinder Mount	1
EADON-SBR-SP-DR-M-100-00053	Lower Cylinder Mount	1
COWI-SBR-SP-DR-S-100-00080	Material Distribution	3
COWI-SBR-SP-DR-S-100-00090	Bearing Articulation	3
COWI-SBR-SP-DR-S-100-00100	Opening Span - Typical Cross Section	2
COWI-SBR-SP-DR-S-100-00105	Opening Span - Longitudinal Section	2
COWI-SBR-SP-DR-S-100-00110	Counterweight Layout	3
COWI-SBR-SP-DR-S-100-00200	Approach Spans -- Typical Cross Section	2
COWI-SBR-SP-DR-S-100-00300	Active Travel Provision	2
COWI-SBR-SP-DR-S-100-00400	Piers 1, 2, 4, and 5 - Concrete Outline	3
COWI-SBR-SP-DR-S-100-00405	Pier 6 - Concrete Outline	2
COWI-SBR-SP-DR-S-100-00410	Pier 3 (Machine Pier) - - Concrete Outline	2
COWI-SBR-SP-DR-S-100-00600	Temporary Works - Indicative General Arrangement	1

Appendix A Supporting Drawings



01
00001 Context Plan
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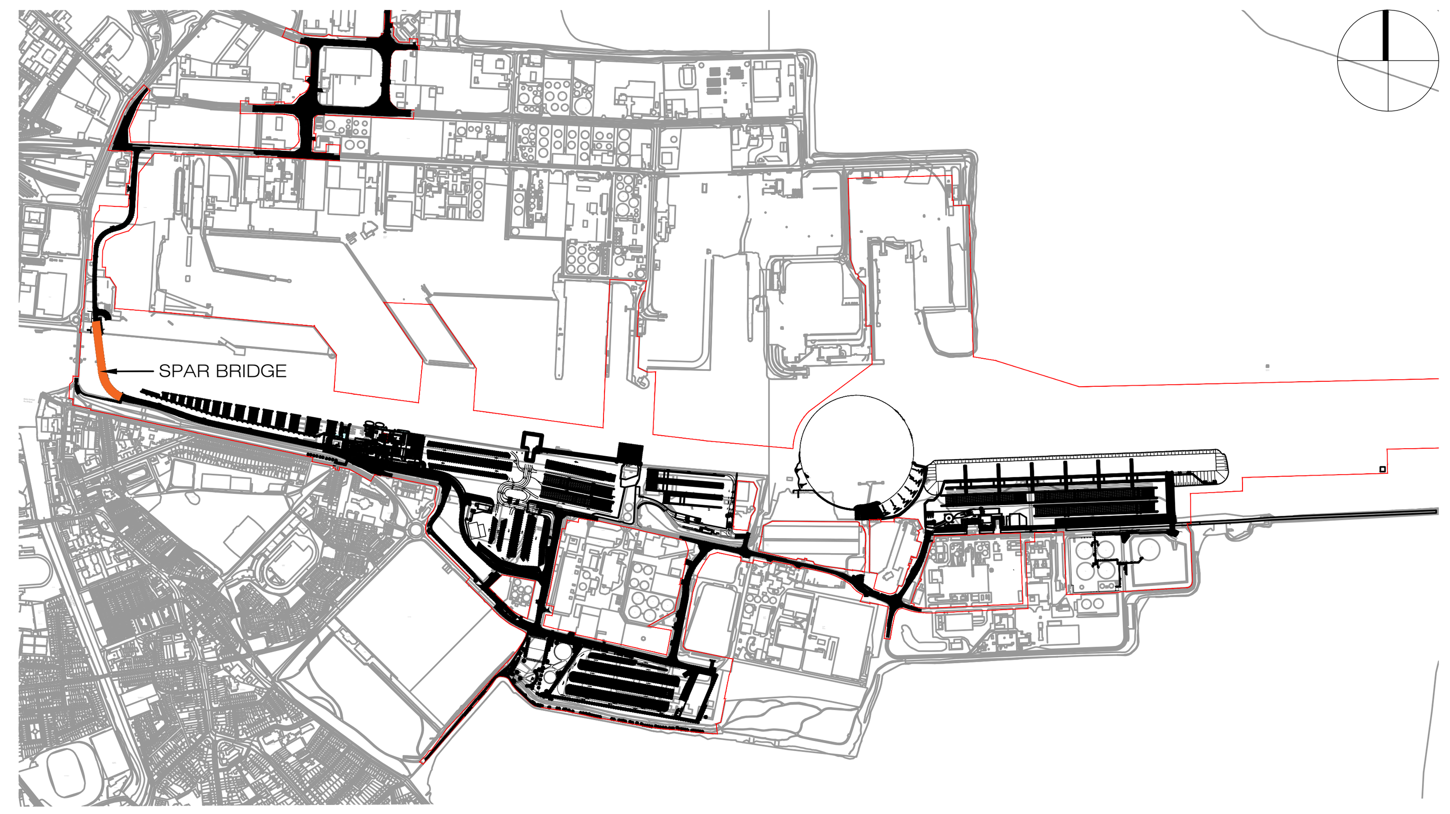

02
00001 Key Plan
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NOTES

1. Verifying Dimensions.
   The contractor shall verify dimensions against such other drawings or site conditions as pertain to this part of the work.
2. Existing Services.
   Any information concerning the location of existing services indicated on this drawing is intended for general guidance only. It shall be the responsibility of the contractor to determine and verify the exact horizontal and vertical alignment of all cables, pipes, etc. (both underground and overhead) before work commences.
3. Issue of Drawings.
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4. Datum. ITM

Legend

- Navigation Channel
- Application Boundary
- SPAR Bridge Extents

Note:

This drawing to be read in conjunction with:
CP1901_3FM-RPS_S26-PGN-XX-DR-HE-100-0001 – Existing Site Layout Plan - Sheet 1
CP1901_3FM-RPS_S26-PGN-XX-DR-HE-100-0003 – Permitted Site Layout Plan - Sheet 1
CP1901_3FM-RPS_S26-PGN-XX-DR-HE-100-0005 – Proposed Site Layout Plan - Sheet 1

rev	amendments	check	date
4	Revised for Stage Approval	EG	28/06/24
3	Revised for Stage Approval	EG	12/06/24
2	Revised for Stage Approval	EG	19/04/24
1	Issued for Review	EG	16/11/23

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Client
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DUBLIN PORT COMPANY

Project
3FMProject Bringing Dublin Port To 2040

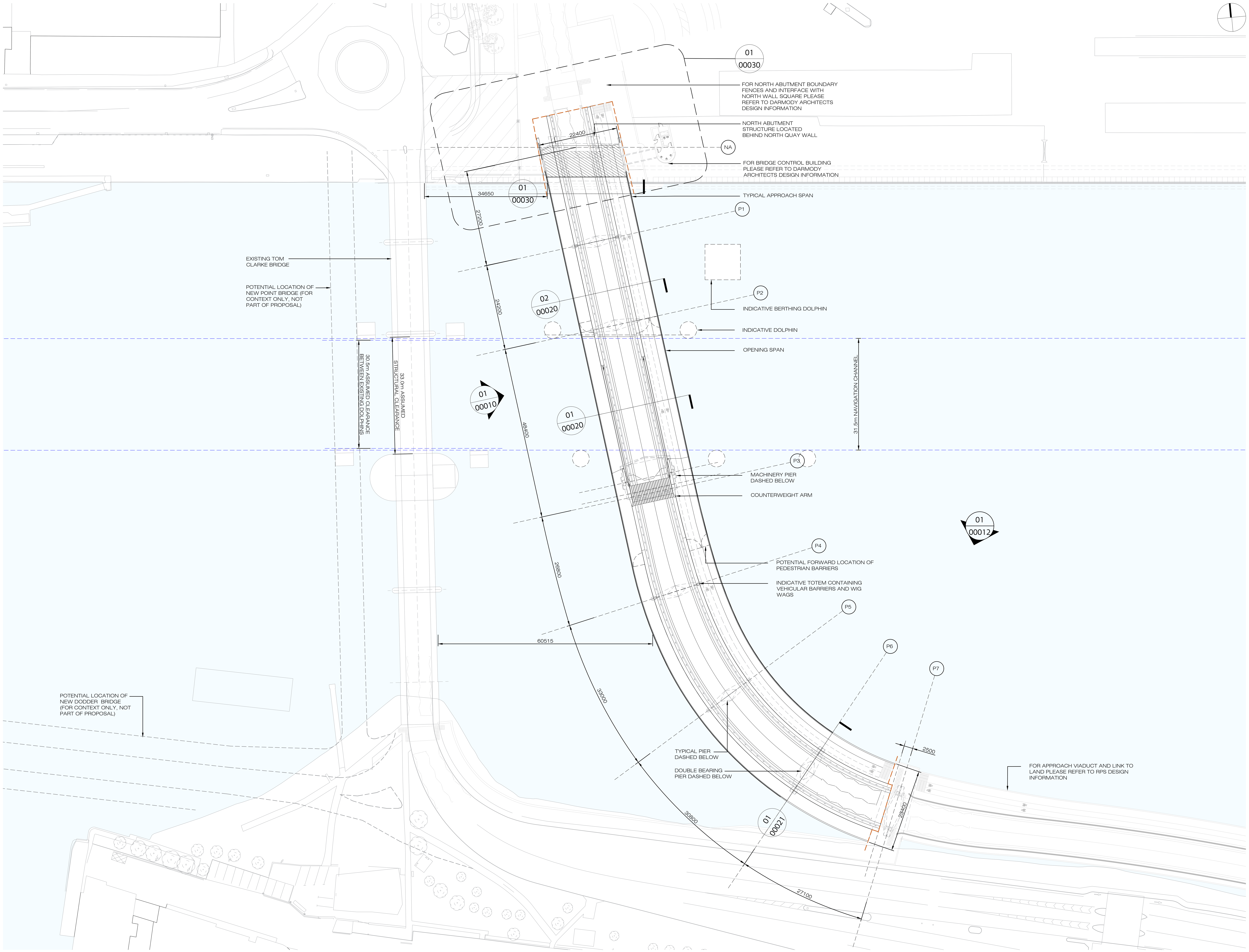
Title
SPAR Bridge
Proposed Context Plan

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	1:1250

Drawing Number
MOXON-SBR-SP-DR-A-100-00001

Drawn By	Status	Revision
R. Thebridge	S4	4

Checked By	Approved By	Date
E. Groskin	O. Stross	28/06/2024



01 Bridge Plan
00005 SCALE 1:500@ A1

NOTES

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4. Datum. ITM

Legend

- Navigation Channel
- SPAR Bridge Extents

Note:

This drawing to be read in conjunction with:
CP1901_3FM_MOXON-SBR-SP-DR-A-100-00001 – SPAR Bridge – Proposed Context Plan
CP1901_3FM-RPS_S26-PGN-XX-DR-HE-100-0001 – Existing Site Layout Plan – Sheet 1
CP1901_3FM-RPS_S26-PGN-XX-DR-HE-100-0003 – Permitted Site Layout Plan – Sheet 1
CP1901_3FM-RPS_S26-PGN-XX-DR-HE-100-0005 – Proposed Site Layout Plan – Sheet 1

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4	Revised for Stage Approval	EG	28/06/24
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Project
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Title
SPAR Bridge
Proposed Bridge Plan

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	1:500

Drawing Number
MOXON-SBR-SP-DR-A-100-00005

Drawn By	Status	Revision
R. Thebridge	S4	4

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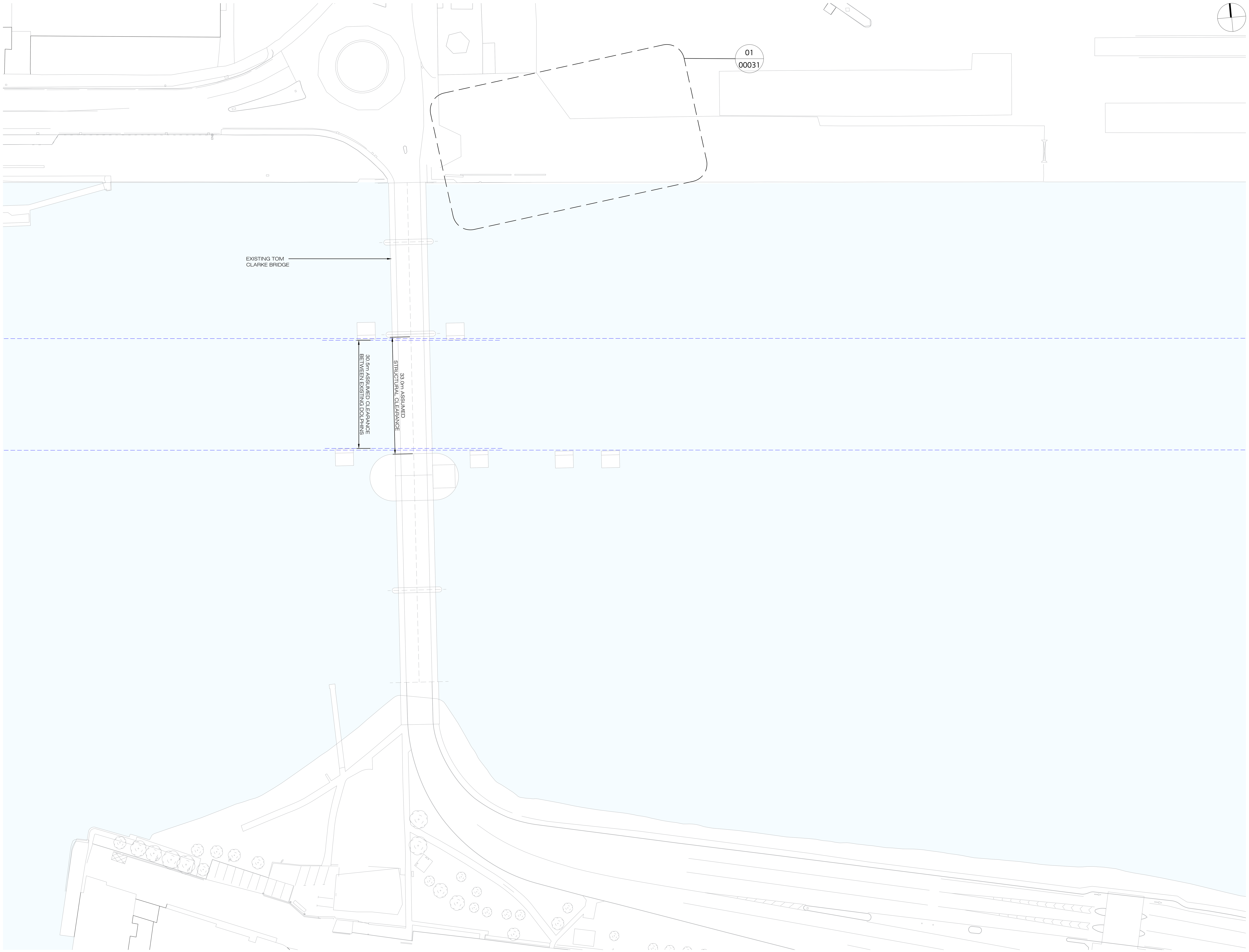

01 Site Plan
00006 SCALE 1:500@ A1

NOTES

1. Verifying Dimensions.
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2. Existing Services.
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3. Issue of Drawings.
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4. Datum. ITM

Legend

Navigation Channel

Note:

This drawing to be read in conjunction with:
CP1901_3FM_MOXON-SBR-SP-DR-A-100-00001 – SPAR Bridge – Proposed Context Plan
CP1901_3FM-RPS_S26-PGN-XX-DR-HE-100-0001 – Existing Site Layout Plan – Sheet 1
CP1901_3FM-RPS_S26-PGN-XX-DR-HE-100-0003 – Permitted Site Layout Plan – Sheet 1
CP1901_3FM-RPS_S26-PGN-XX-DR-HE-100-0005 – Proposed Site Layout Plan – Sheet 1

rev	amendments	check	date
1	Issued for Stage Approval	EG	28/06/24

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Client
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DUBLIN PORT COMPANY

Project
3FMProject Bringing Dublin Port To 2040

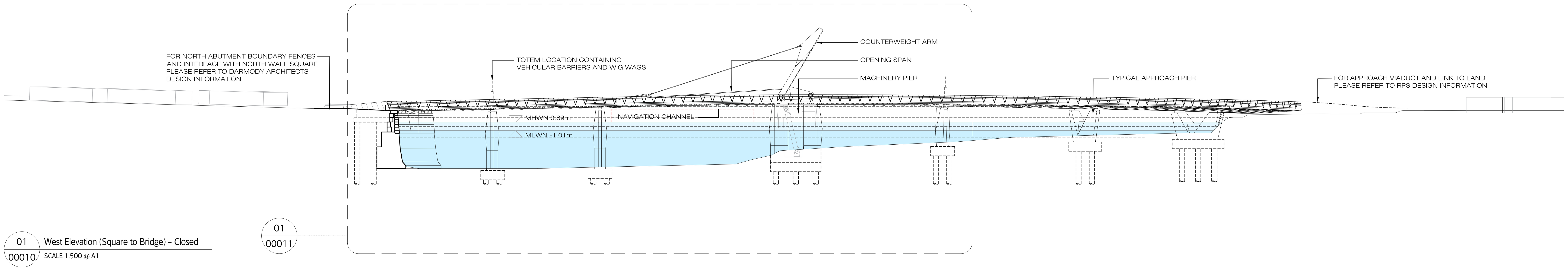
Title
SPAR Bridge
Existing Site Plan

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	1:500

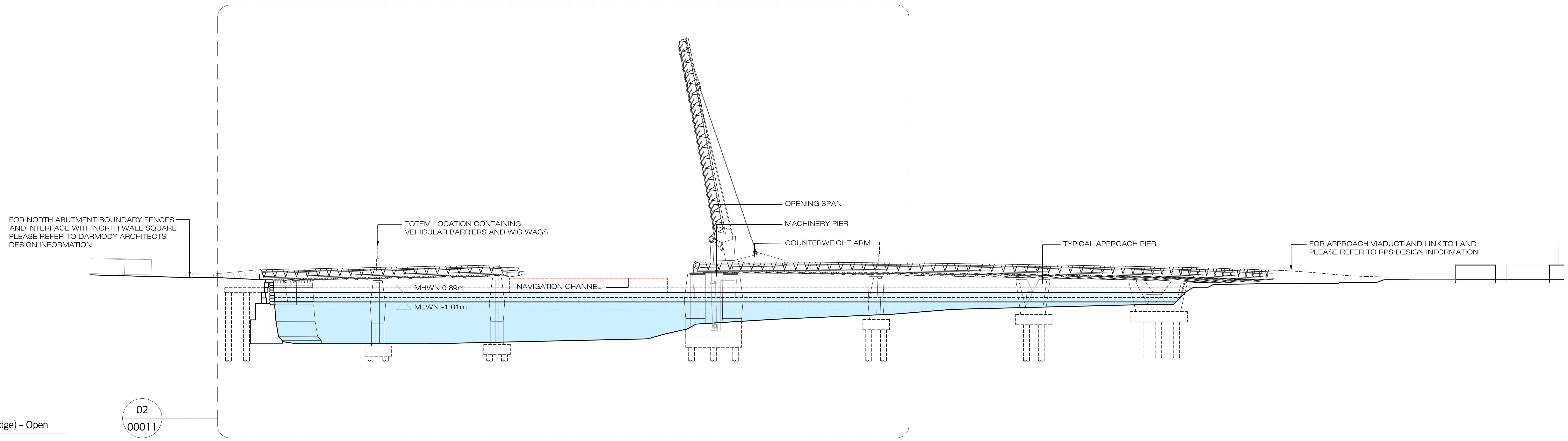
Drawing Number
MOXON-SBR-SP-DR-A-100-00006

Drawn By	Status	Revision
R. Thebridge	S4	1

Checked By	Approved By	Date
E. Groskin	O. Stross	28/06/2024



01 / 00010 West Elevation (Square to Bridge) - Closed
SCALE 1:500 @ A1



02 / 00010 West Elevation (Square to Bridge) - Open
SCALE 1:500 @ A1

NOTES

1. Verifying Dimensions.
   The contractor shall verify dimensions against such other drawings or site conditions as pertain to this part of the work.
2. Existing Services.
   Any information concerning the location of existing services indicated on this drawing is intended for general guidance only. It shall be the responsibility of the contractor to determine and verify the exact horizontal and vertical alignment of all cables, pipes, etc. (both underground and overhead) before work commences.
3. Issue of Drawings.
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4. Datum. ITM

Note:

This drawing to be read in conjunction with:
CP1901_3FM_MOXON-SBR-SP-DR-A-100-00005 - SPAR Bridge - Proposed Bridge Plan

rev	amendments	check	date
4	Revised for Stage Approval	EG	28/06/24
3	Revised for Stage Approval	EG	12/06/24
2	Revised for Stage Approval	EG	19/04/24
1	Issued for Review	EG	16/11/23

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Client
COMHLACHT CHALAFORT ÁTHA CLIATH
DUBLIN PORT COMPANY

Project
3FMProject Bringing Dublin Port To 2040

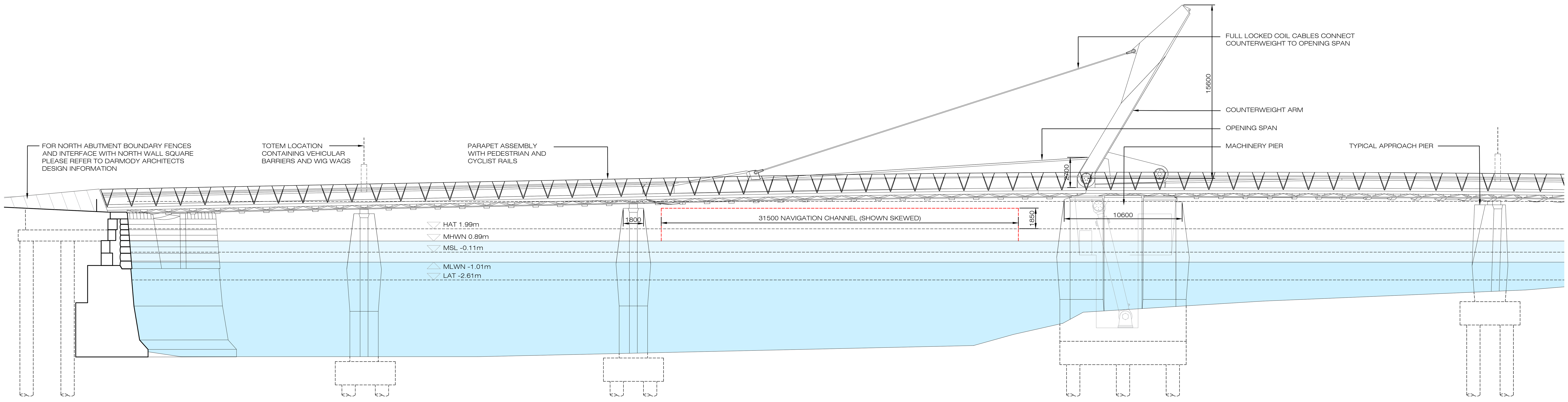
Title
SPAR Bridge
Proposed West Elevation

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	1:500

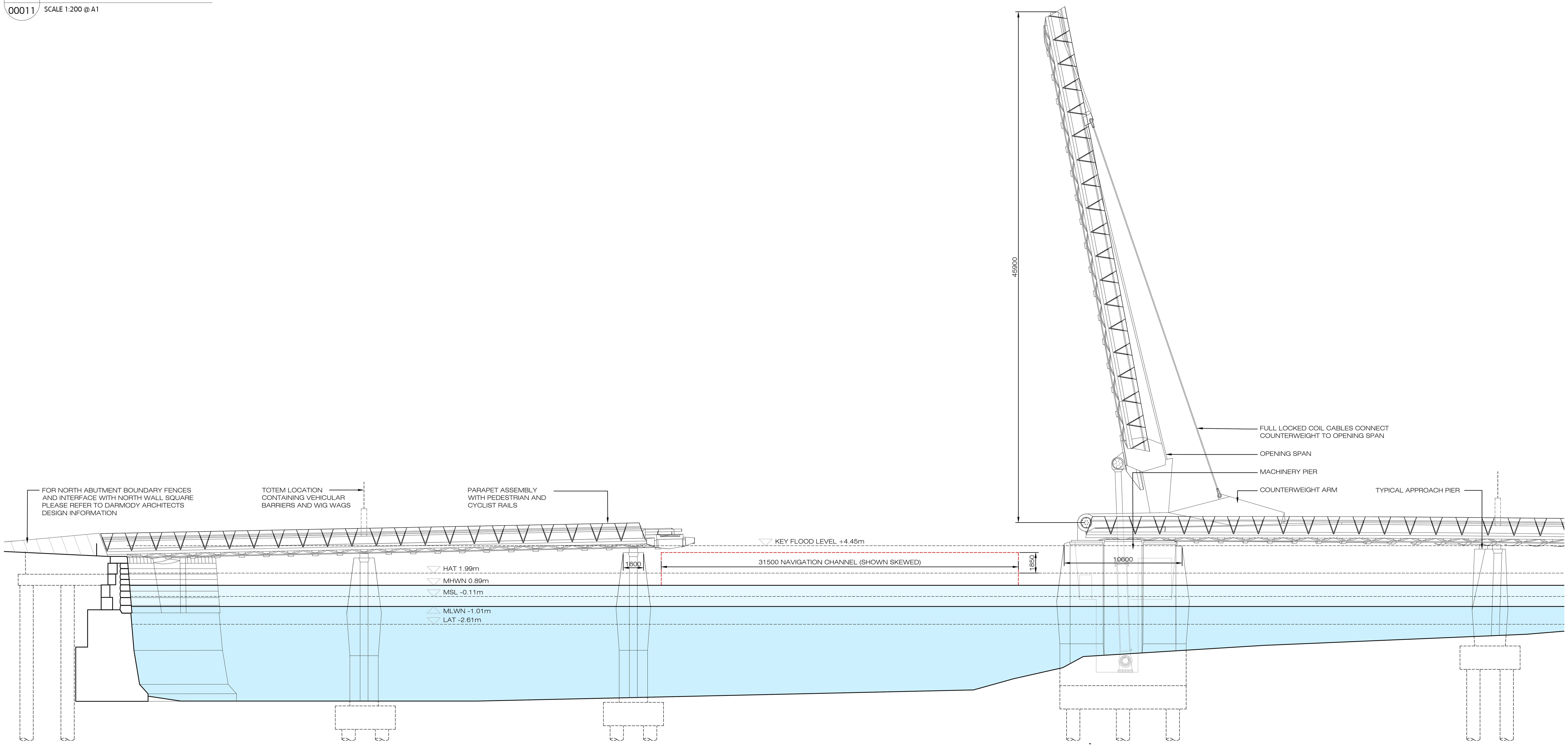
Drawing Number
MOXON-SBR-SP-DR-A-100-00010

Drawn By	Status	Revision
R. Thebridge	S4	4

Checked By	Approved By	Date
E. Groskin	O. Stross	28/06/2024



01 West Detail Elevation (Square to Bridge) - Closed
00011 SCALE 1:200 @ A1



02 West Detail Elevation (Square to Bridge) - Open
00011 SCALE 1:200 @ A1

NOTES

1. Verifying Dimensions.
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2. Existing Services.
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4. Datum. ITM

Note:

This drawing to be read in conjunction with:
CP1901_3FM_MOXON-SBR-SP-DR-A-100-00010 - SPAR Bridge - Proposed West Elevation

rev	amendments	check	date
4	Revised for Stage Approval	EG	28/06/24
3	Revised for Stage Approval	EG	12/06/24
2	Revised for Stage Approval	EG	19/04/24
1	Issued for Review	EG	16/11/23

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Client
COMHLACHT CHALAFORT ÁTHA CLIATH
DUBLIN PORT COMPANY

Project
3FMProject Bringing Dublin Port To 2040

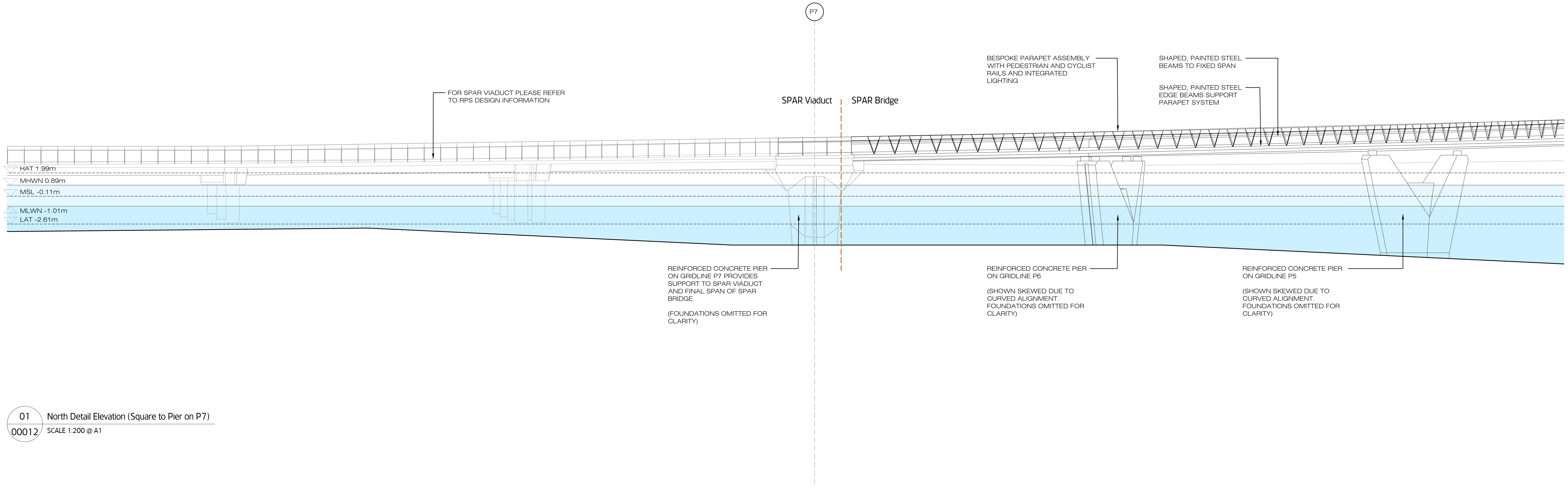
Title
SPAR Bridge
Proposed West Detail Elevation

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	1:200

Drawing Number
MOXON-SBR-SP-DR-A-100-00011

Drawn By	Status	Revision
R. Thebridge	S4	4

Checked By	Approved By	Date
E. Groskin	O. Stross	28/06/2024



01
00012
North Detail Elevation (Square to Pier on P7)
SCALE 1:200 @ A1

NOTES

1. Verifying Dimensions.
   The contractor shall verify dimensions against such other drawings or site conditions as pertain to this part of the work.

2. Existing Services.
   Any information concerning the location of existing services indicated on this drawing is intended for general guidance only. It shall be the responsibility of the contractor to determine and verify the exact horizontal and vertical alignment of all cables, pipes, etc. (both underground and overhead) before work commences.

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4. Datum. ITM

Legend

– – – SPAR Bridge Extents

Note:

This drawing to be read in conjunction with:
CP1901_3FM_MOXON-SBR-SP-DR-A-100-00005
– SPAR Bridge – Proposed Bridge Plan

rev	amendments	check	date
1	Issued for Stage Approval	EG	28/06/24

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Client
COMHLACHT CHALAFORT ÁTHA CLIATH
DUBLIN PORT COMPANY

Project
3FMProject Bringing Dublin Port To 2040

Title
SPAR Bridge
Proposed North Detail Elevation

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	1:200

Drawing Number
MOXON-SBR-SP-DR-A-100-00012

Drawn By	Status	Revision
R. Thebridge	S4	1

Checked By	Approved By	Date
E. Groskin	O. Stross	28/06/2024

NOTES

1. Verifying Dimensions.
   The contractor shall verify dimensions against such other drawings or site conditions as pertain to this part of the work.

2. Existing Services.
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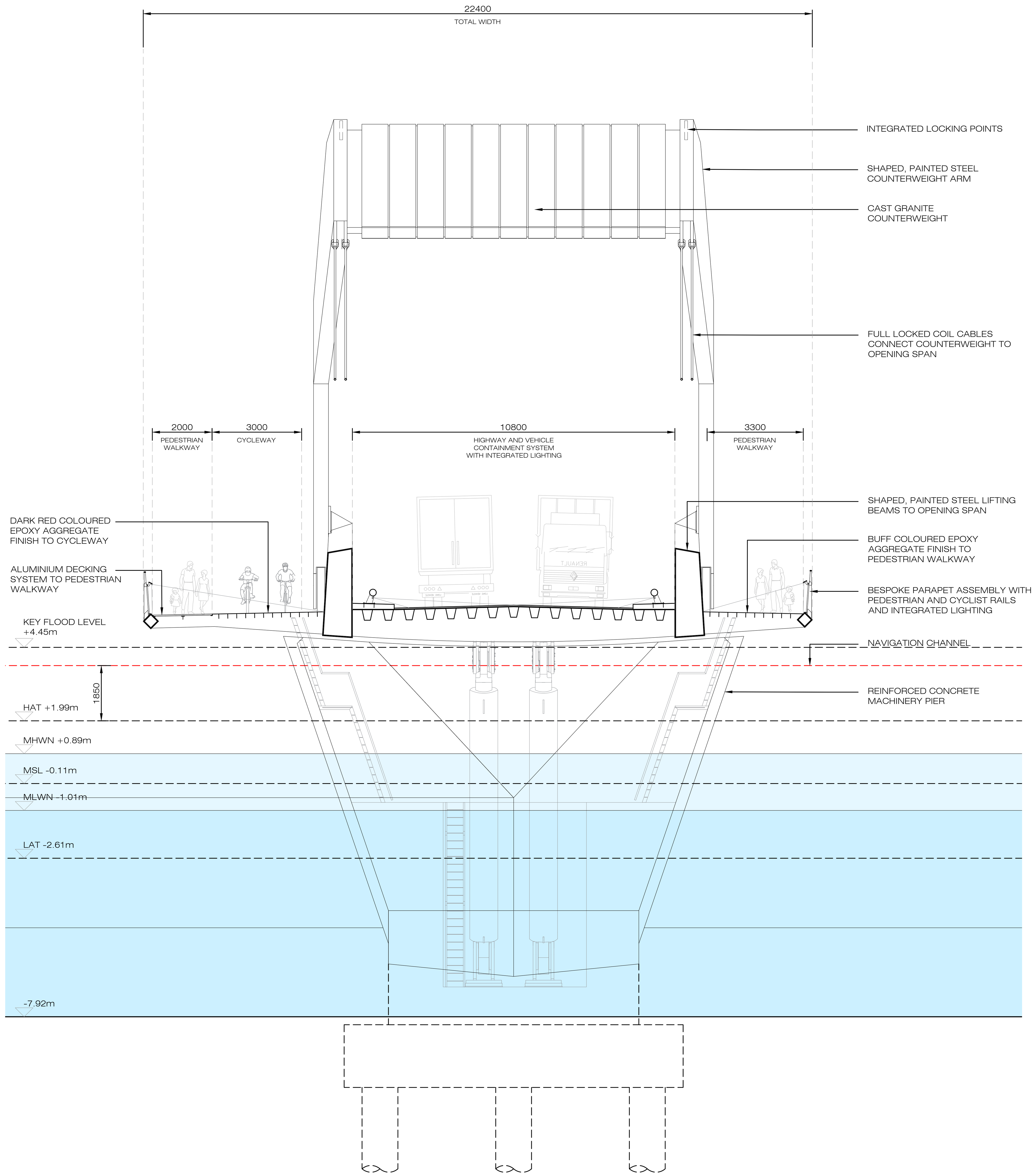
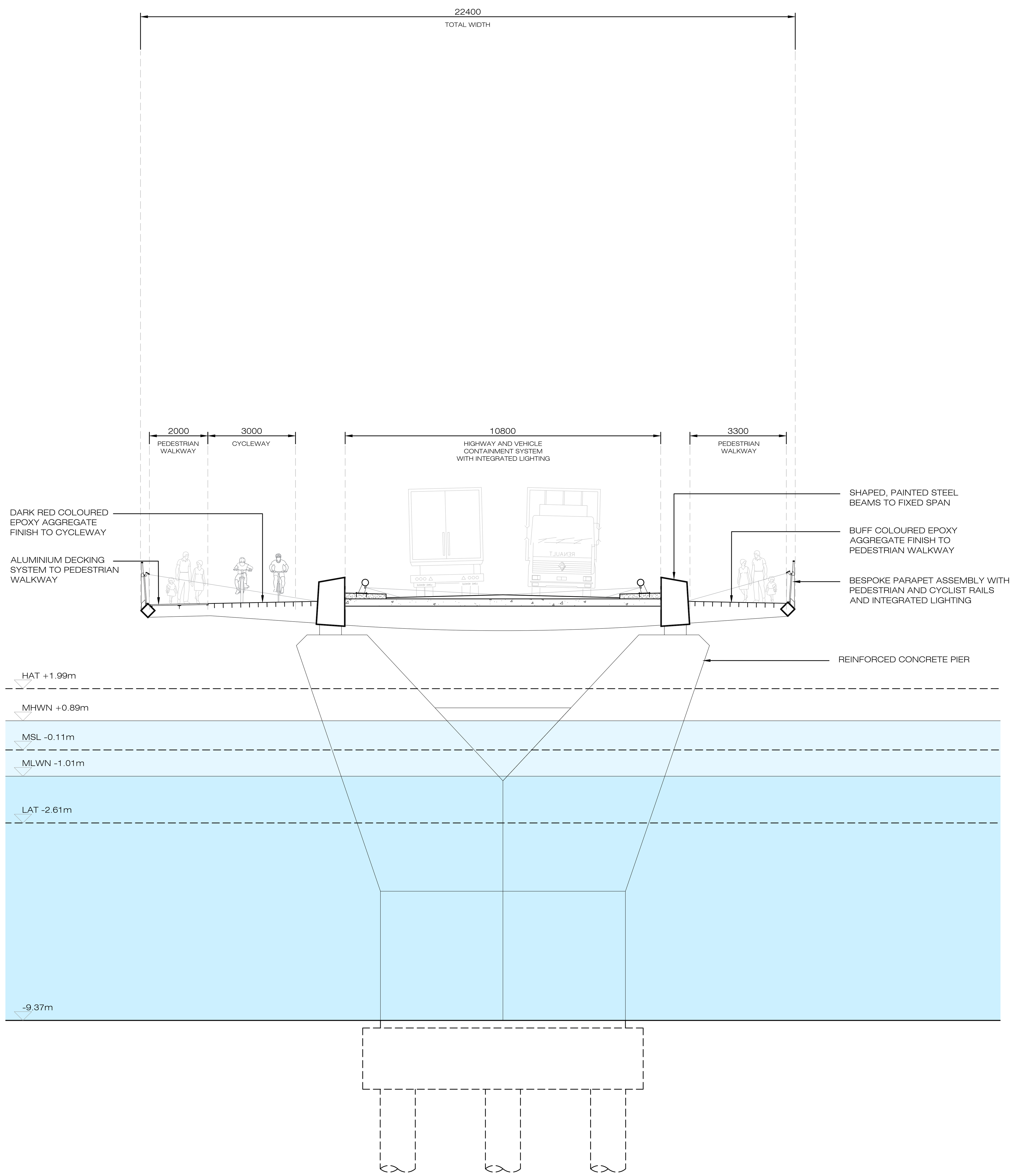
4. Datum. ITM

Note:

This drawing to be read in conjunction with:
CP1901_3FM_MOXON-SBR-SP-DR-A-100-00005 – SPAR Bridge – Proposed Bridge Plan



01 | 00020 Section at Opening Span
SCALE 1:100 @ A1



02 | 00020 Section at Approach Span
SCALE 1:100 @ A1

rev	amendments	check	date
4	Revised for Stage Approval	EG	28/06/24
3	Revised for Stage Approval	EG	12/06/24
2	Revised for Stage Approval	EG	19/04/24
1	Issued for Review	EG	16/11/23

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Client
COMHLACHT CHALAFORT ÁTHA CLIATH
DUBLIN PORT COMPANY

Project
3FMProject Bringing Dublin Port To 2040

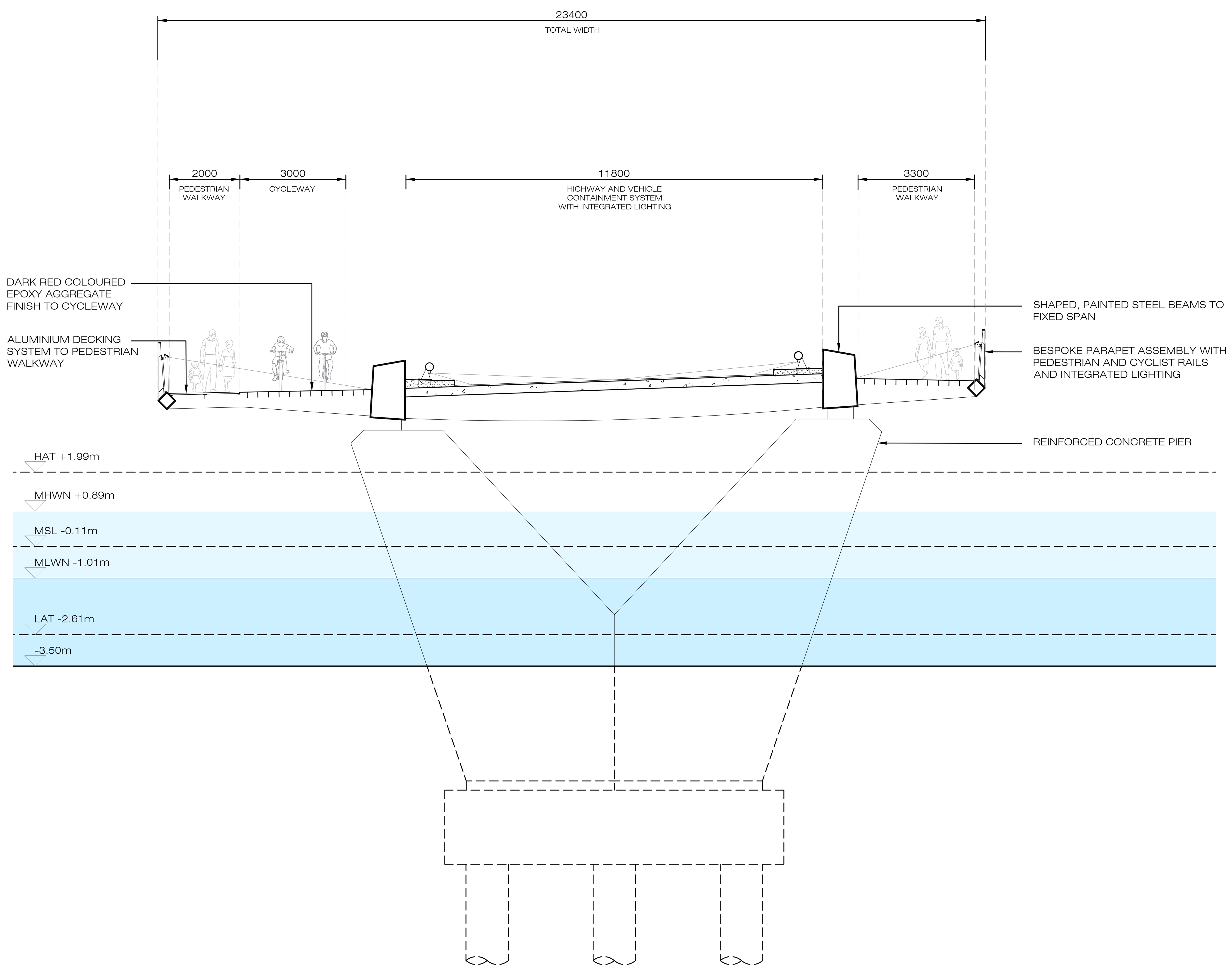
Title
SPAR Bridge
Proposed Cross Sections
Sheet 1

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	1:100

Drawing Number
MOXON-SBR-SP-DR-A-100-00020

Drawn By	Status	Revision
R. Thebridge	S4	4

Checked By	Approved By	Date
E. Groskin	O. Stross	28/06/2024



01
00021
Section at Super-elevation in Highway
SCALE 1:100 @ A1

NOTES

1. Verifying Dimensions.
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4. Datum. ITM

Note:

This drawing to be read in conjunction with:
CP1901_3FM_MOXON-SBR-SP-DR-A-100-00005 - SPAR Bridge - Proposed Bridge Plan

rev	amendments	check	date
4	Revised for Stage Approval	EG	28/06/24
3	Revised for Stage Approval	EG	12/06/24
2	Revised for Stage Approval	EG	19/04/24
1	Issued for Review	EG	16/11/23

Client
COMHLACHT CHALAFORT ÁTHA CLIATH
DUBLIN PORT COMPANY

Project
3FMProject Bringing Dublin Port To 2040

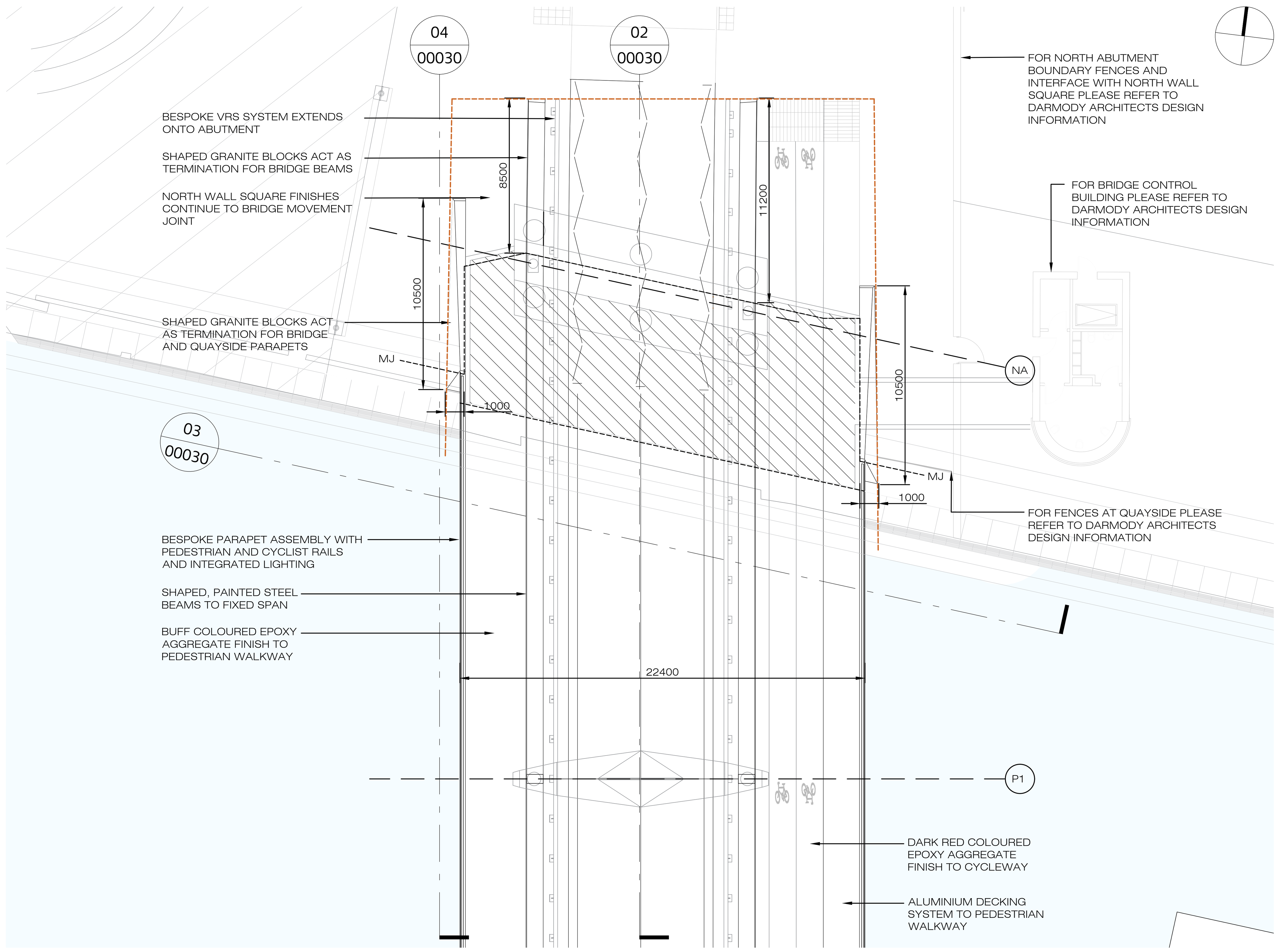
Title
SPAR Bridge
Proposed Cross Sections
Sheet 2

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	1:100

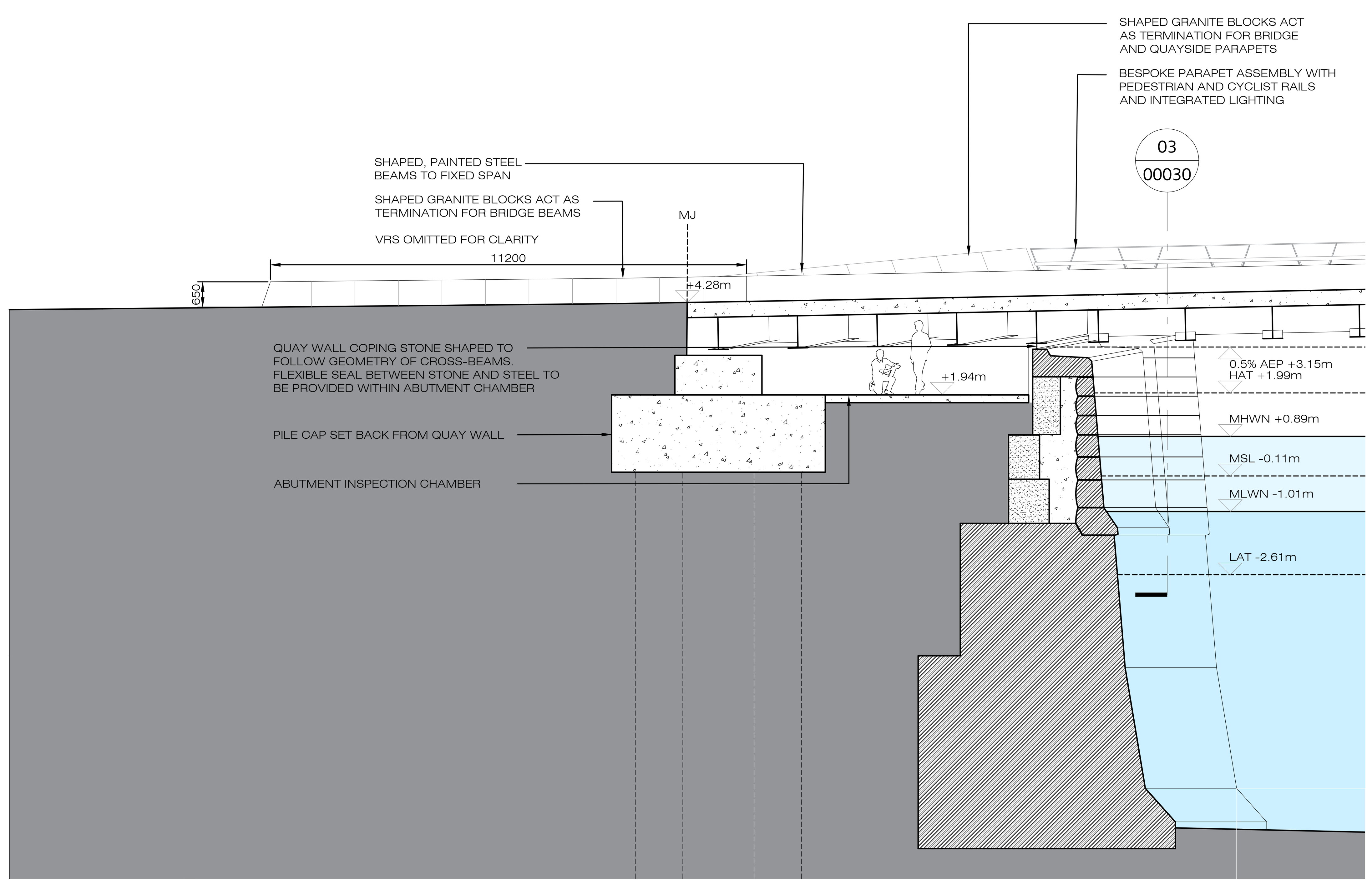
Drawing Number
MOXON-SBR-SP-DR-A-100-00021

Drawn By	Status	Revision
R. Thebridge	S4	4

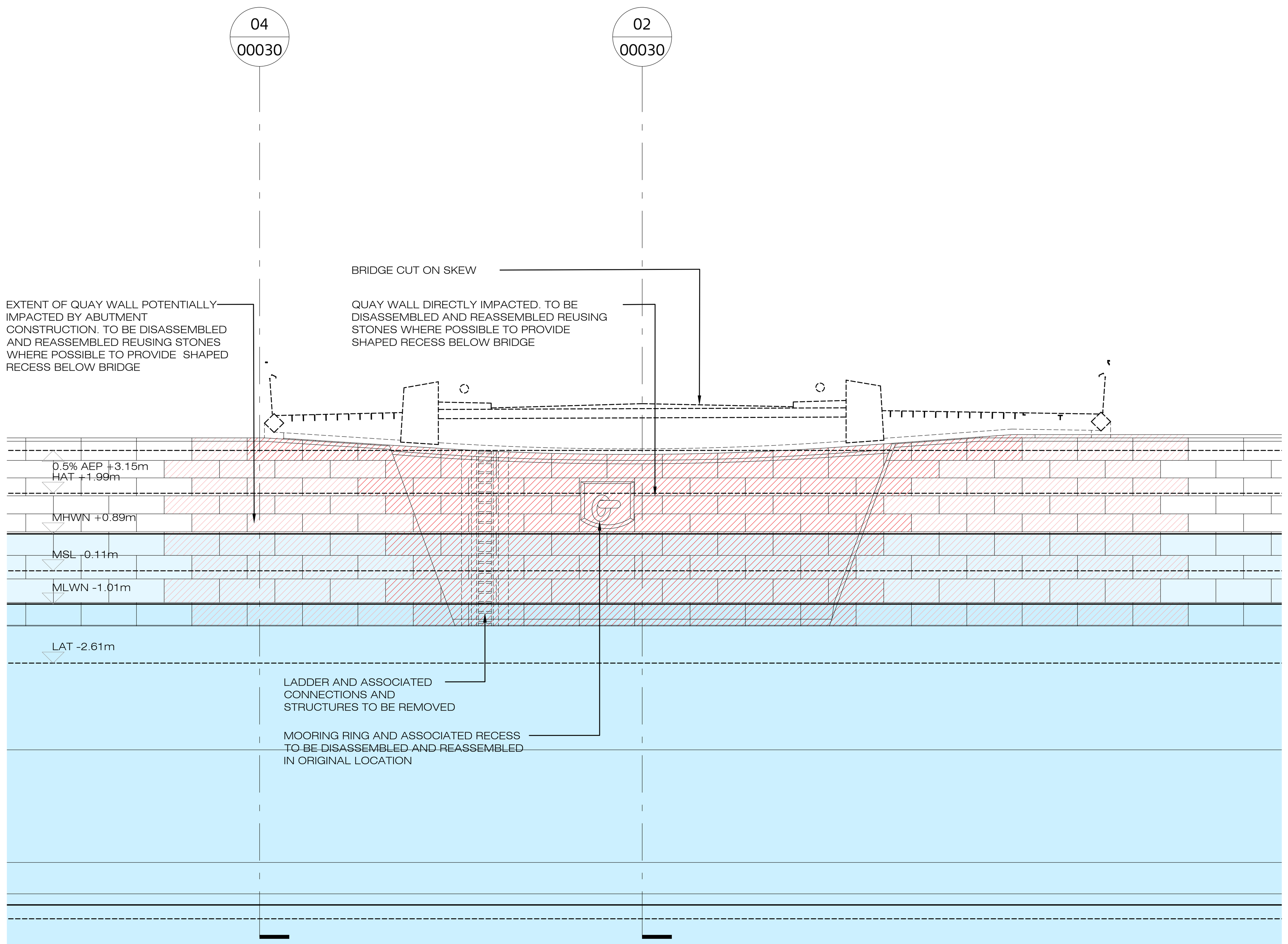
Checked By	Approved By	Date
E. Groskin	O. Stross	28/06/2024



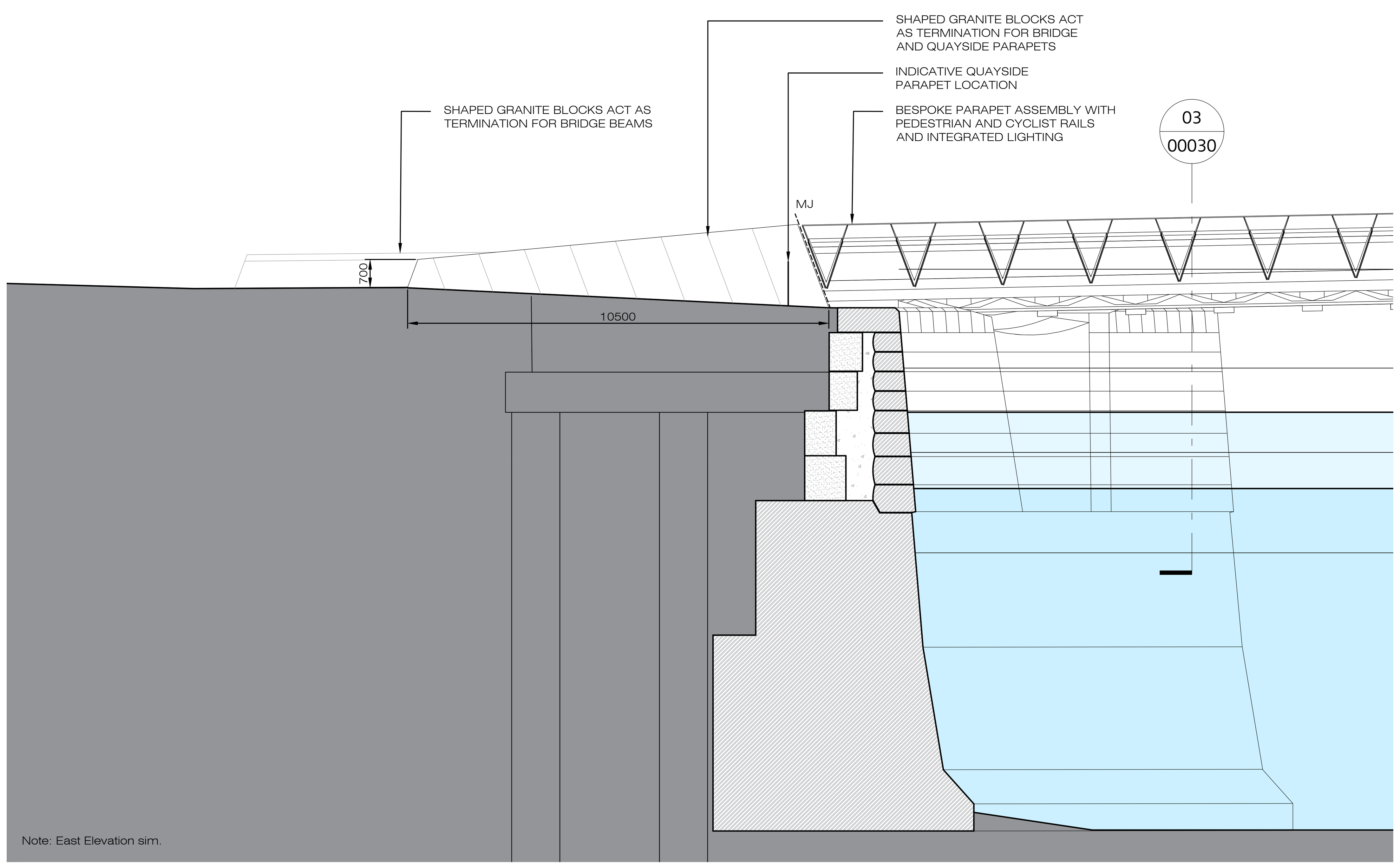
01 00030 North Quay Wall Plan
SCALE 1:200 @ A1



02 00030 North Abutment Long Section
SCALE 1:100 @ A1



03 00030 North Quay Wall South Elevation
SCALE 1:100 @ A1



04 00030 North Abutment West Elevation
SCALE 1:100 @ A1

NOTES

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4. Datum. ITM

Legend

- SPAR Bridge Extents
- Movement Joint Location (MJ)
- Abutment Inspection Chamber Below

Note:

This drawing to be read in conjunction with:
CP1901_3FM_MOXON-SBR-SP-DR-A-100-00005 – SPAR Bridge – Proposed Bridge Plan

rev	amendments	check	date
4	Revised for Stage Approval	EG	28/06/24
3	Revised for Stage Approval	EG	12/06/24
2	Revised for Stage Approval	EG	19/04/24
1	Issued for Review	EG	16/11/23

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Client
COMHLACHT CHALAFORT ÁTHA CLIATH
DUBLIN PORT COMPANY

Project
3FMProject Bringing Dublin Port To 2040

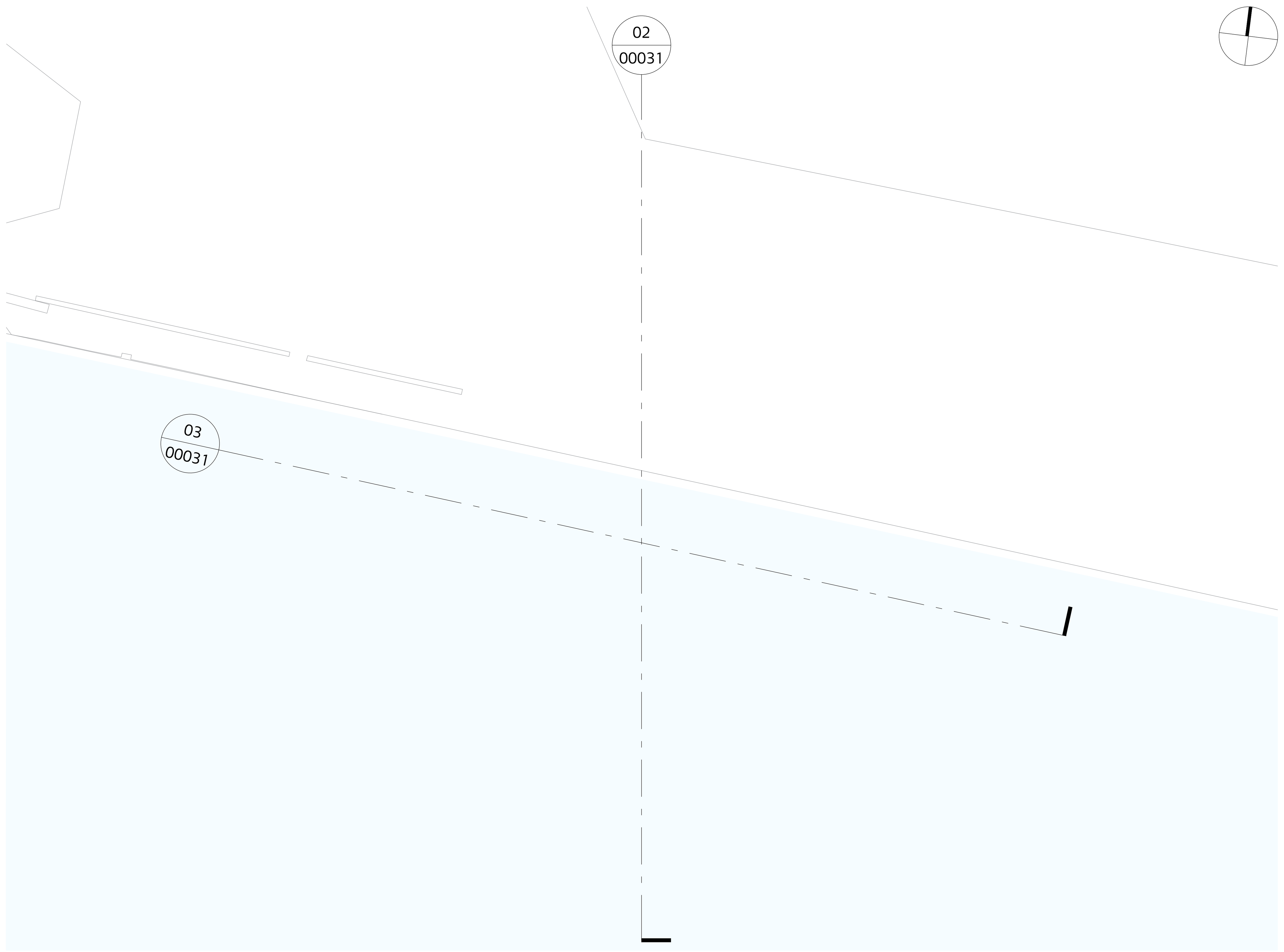
Title
SPAR Bridge
Proposed North Abutment
Detail Arrangement

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	As Shown

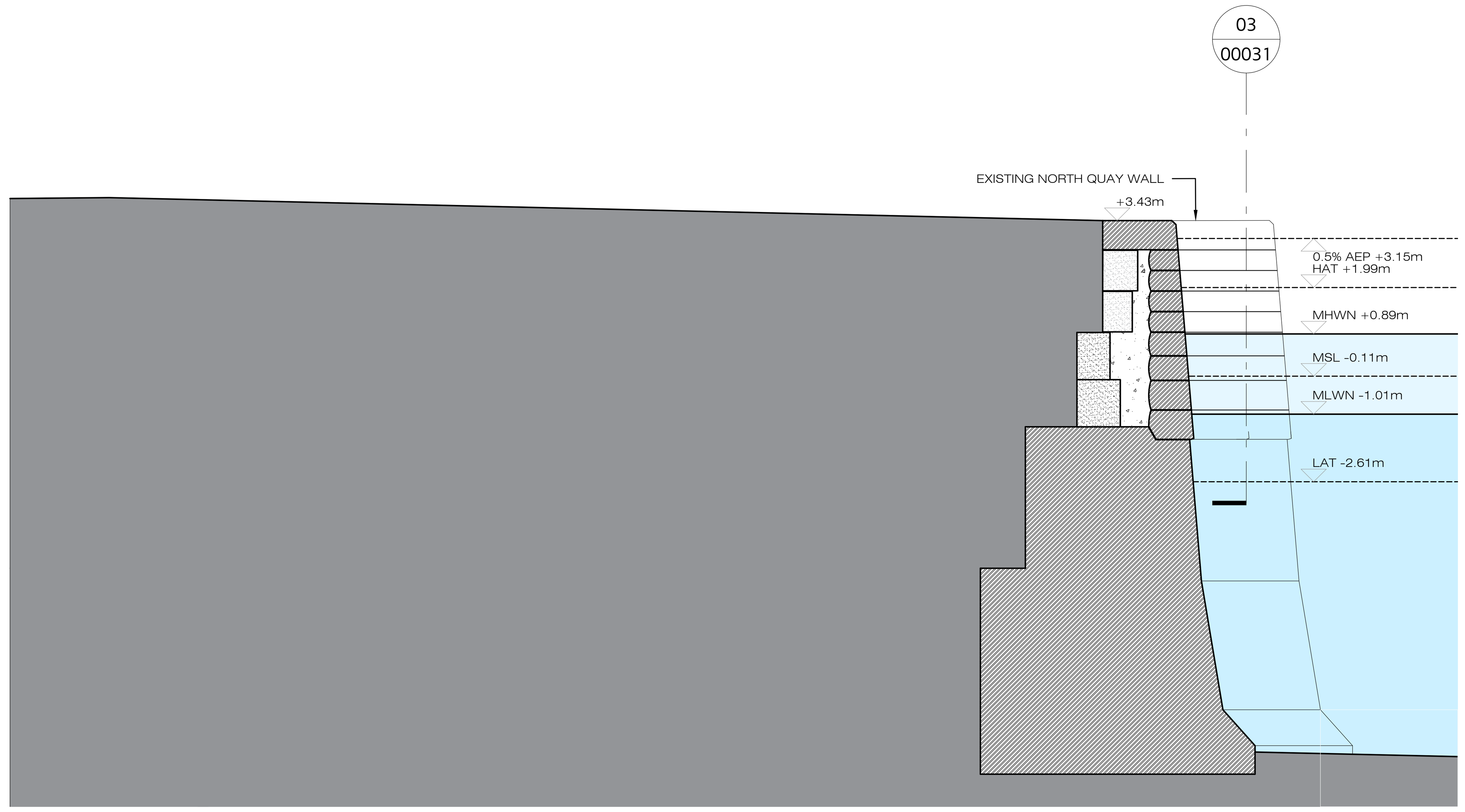
Drawing Number
MOXON-SBR-SP-DR-A-100-00030

Drawn By	Status	Revision
R. Thebridge	S4	4

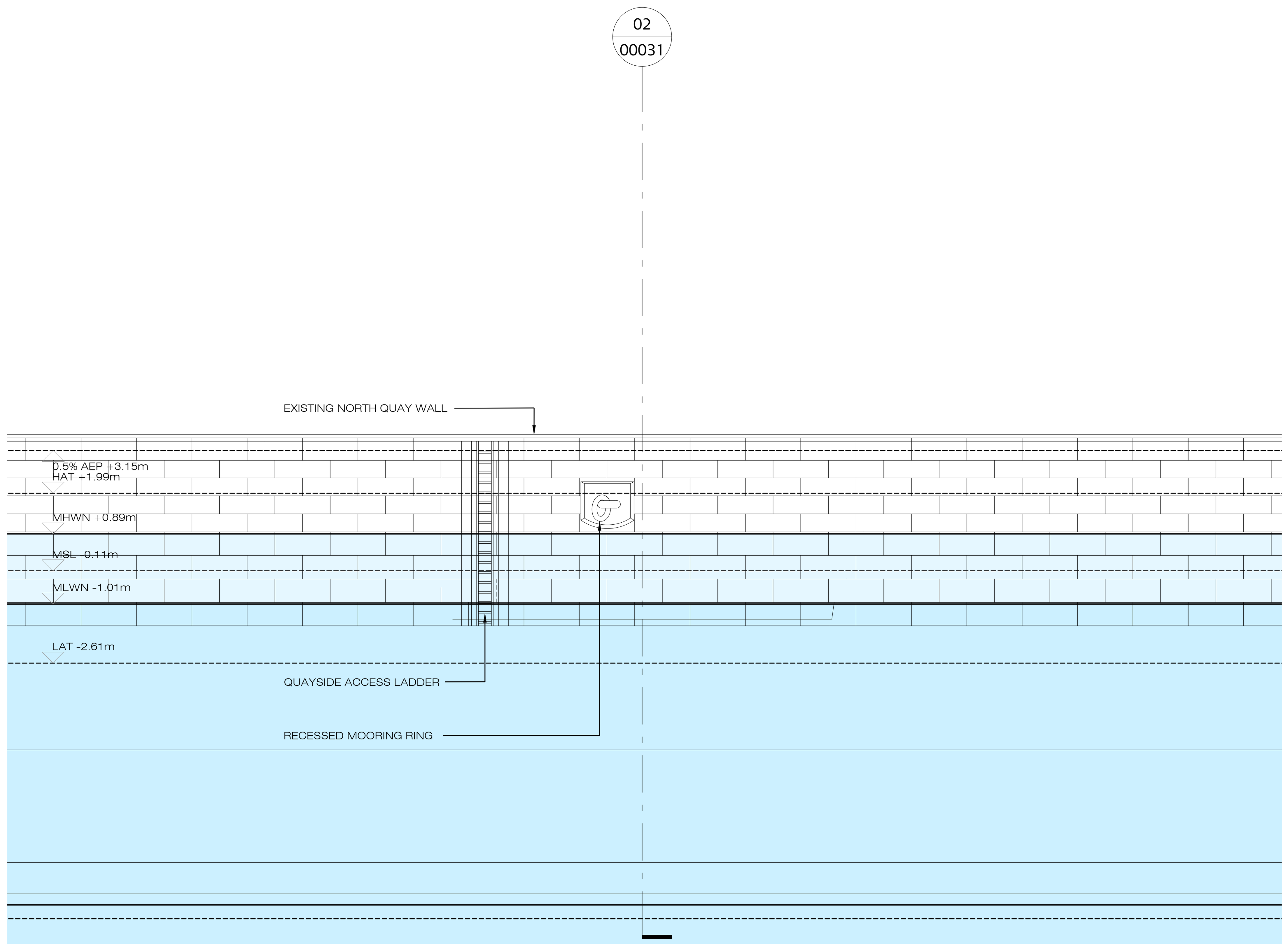
Checked By	Approved By	Date
E. Groskin	O. Stross	28/06/2024



01 00031 Existing North Quay Wall Plan
SCALE 1:200 @ A1



02 00031 Existing North Quay Wall Section
SCALE 1:100 @ A1



03 00031 Existing North Quay Wall South Elevation
SCALE 1:100 @ A1

NOTES

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4. Datum. ITM

Note:

This drawing to be read in conjunction with:
CP1901_3FM_MOXON-SBR-SP-DR-A-100-00006 - SPAR Bridge - Existing Site Plan

rev	amendments	check	date
1	Issued for Stage Approval	EG	28/06/24

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Client
COMHLACHT CHALAFORT ÁTHA CLIATH
DUBLIN PORT COMPANY

Project
3FMProject Bringing Dublin Port To 2040

Title
SPAR Bridge
Existing North Abutment
Detail Arrangement

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	As Shown

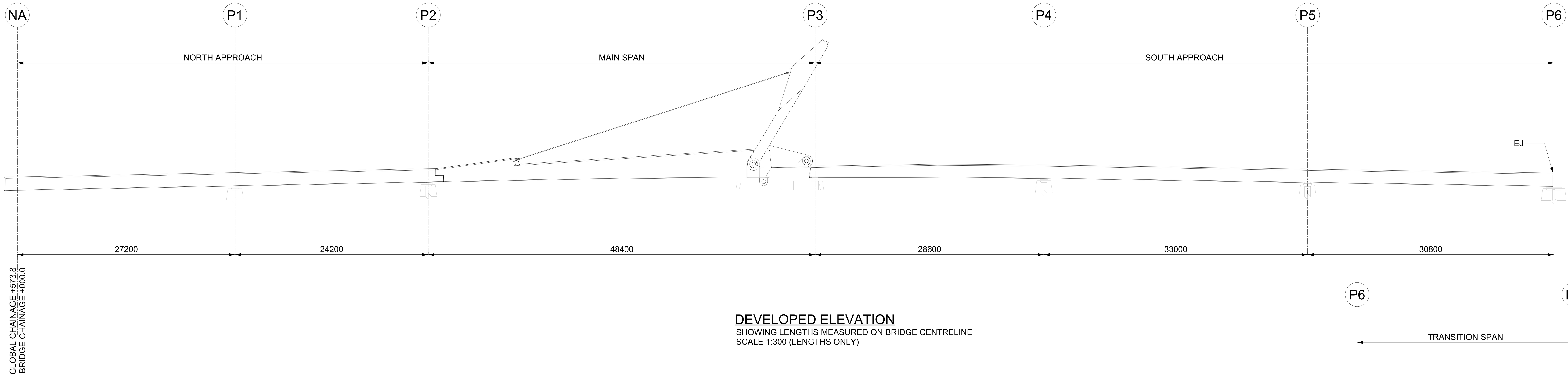
Drawing Number
MOXON-SBR-SP-DR-A-100-00031

Drawn By	Status	Revision
R. Thebridge	S4	1

Checked By	Approved By	Date
E. Groskin	O. Stross	28/06/2024

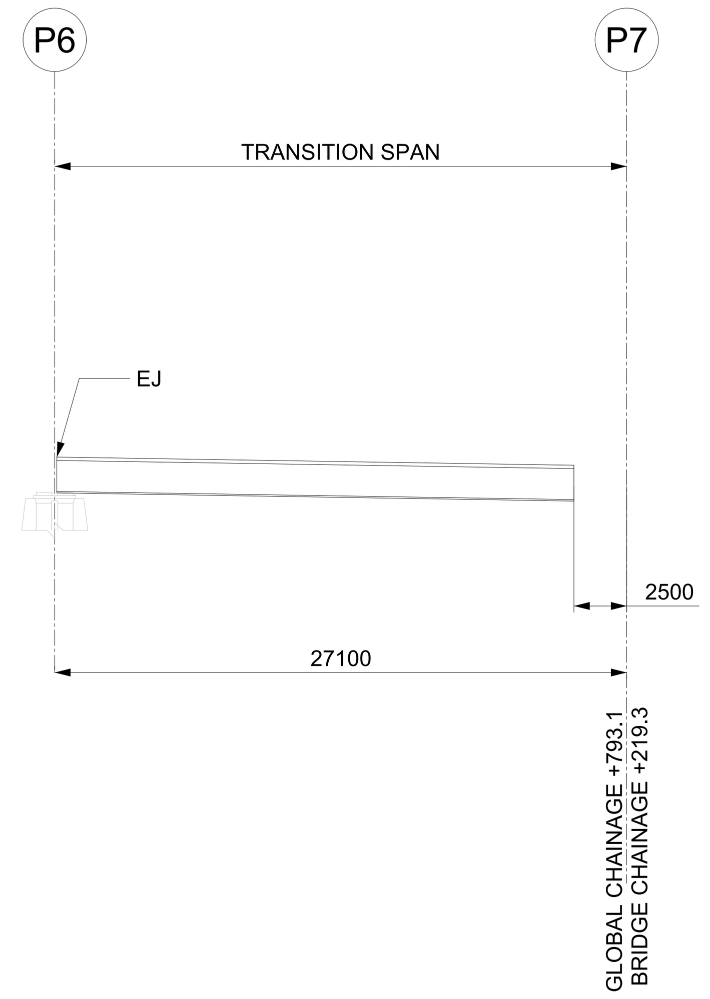
NOTES

1. These drawings shall be read in conjunction with the Preliminary Design Report, CP1901_3FM-COWI-SBR-SP-RP-S-00002
2. Structural steelwork Grade 355+W to IS EN 10025 typically.
3. Dimensions, including plate thicknesses, to be confirmed during detailed design.



DEVELOPED ELEVATION

SHOWING LENGTHS MEASURED ON BRIDGE CENTRELINE
SCALE 1:300 (LENGTHS ONLY)



NORTH APPROACH

(NA at 000.0; P1 at 027.2; P2 at 051.4; HALF JOINT at 052.8)

Item	Symbol	Unit	000.0	003.0	005.2	007.4	009.6	011.8	014.0	016.2	018.4	020.6	022.8	025.0	027.2	029.4	031.6	033.8	036.0	038.2	040.4	042.6	044.8	047.0	049.2	051.4	052.8
BRIDGE CHAINAGE		[m]	000.0	003.0	005.2	007.4	009.6	011.8	014.0	016.2	018.4	020.6	022.8	025.0	027.2	029.4	031.6	033.8	036.0	038.2	040.4	042.6	044.8	047.0	049.2	051.4	052.8
SPINE-TO-SPINE WIDTH	W	[mm]	10800													10800											
WEBS – INNER HEIGHT	H	[mm]	1700													1700											
WEBS – OUTER HEIGHT	h	[mm]	1478													1478											
WEBS – THICKNESS	t1	[mm]	TYPICALLY 20 TO 35													TYPICALLY 20 TO 40											
BOTTOM FLANGE – WIDTH	B	[mm]	1000													1000											
BOTTOM FLANGE – THICKNESS	t2	[mm]	TYPICALLY 30 TO 65													TYPICALLY 30 TO 65											
TOP FLANGE – WIDTH	b	[mm]	915													915											
TOP FLANGE – THICKNESS	t3	[mm]	TYPICALLY 30 TO 65													TYPICALLY 30 TO 65											

MAIN SPAN

(HALF JOINT at 052.8; P3 RAMS at 095.4; P3 PIVOT at 100.9)

Item	Symbol	Unit	052.8	055.8	058.0	060.2	062.4	064.6	066.8	069.0	071.2	073.4	075.6	077.8	080.0	082.2	084.4	086.6	088.8	091.0	093.2	095.4	097.6	100.9
BRIDGE CHAINAGE		[m]	052.8	055.8	058.0	060.2	062.4	064.6	066.8	069.0	071.2	073.4	075.6	077.8	080.0	082.2	084.4	086.6	088.8	091.0	093.2	095.4	097.6	100.9
SPINE-TO-SPINE WIDTH	W	[mm]	10800																			10800		
WEBS – INNER HEIGHT	H	[mm]	1700	1798	1896	1994	2092	2190	2288	2386	2484	2582	2680	2778	2876	2974	3072	3170	3268	3366	3464	3562	2504	2212
WEBS – OUTER HEIGHT	h	[mm]	1478	1577	1676	1775	1874	1973	2072	2171	2270	2369	2468	2567	2666	2765	2864	2963	3062	3161	3320	3419	2349	2055
WEBS – THICKNESS	t1	[mm]	TYPICALLY 30 TO 65																					
BOTTOM FLANGE – WIDTH	B	[mm]	1000																		750			
BOTTOM FLANGE – THICKNESS	t2	[mm]	TYPICALLY 50 TO 125																					
TOP FLANGE – WIDTH	b	[mm]	915	909	903	898	892	886	881	875	869	863	858	852	846	841	835	829	823	818	559	553	615	632
TOP FLANGE – THICKNESS	t3	[mm]	TYPICALLY 50 TO 125																					

SOUTH APPROACH

(P3 at 102.0; P4 at 130.6; P5 at 163.6; P6 and EJ at 194.4)

Item	Symbol	Unit	102.0	104.2	106.4	108.6	110.8	113.0	115.2	117.4	119.6	121.8	124.0	126.2	128.4
BRIDGE CHAINAGE		[m]	102.0	104.2	106.4	108.6	110.8	113.0	115.2	117.4	119.6	121.8	124.0	126.2	128.4
SPINE-TO-SPINE WIDTH	W	[mm]	10800		10814	10849	10899	10969	11051	11138	11246	11369	11480	11564	11637
WEBS – INNER HEIGHT	H	[mm]	1456	1468	1519	1571	1623	1674	1700						
WEBS – OUTER HEIGHT	h	[mm]	1231	1243	1295	1347	1399	1451	1478						
WEBS – THICKNESS	t1	[mm]	TYPICALLY 20 TO 50												
BOTTOM FLANGE – WIDTH	B	[mm]	1000												
BOTTOM FLANGE – THICKNESS	t2	[mm]	TYPICALLY 70 TO 85												
TOP FLANGE – WIDTH	b	[mm]	929	928	925	922	919	916	915						
TOP FLANGE – THICKNESS	t3	[mm]	TYPICALLY 70 TO 85												

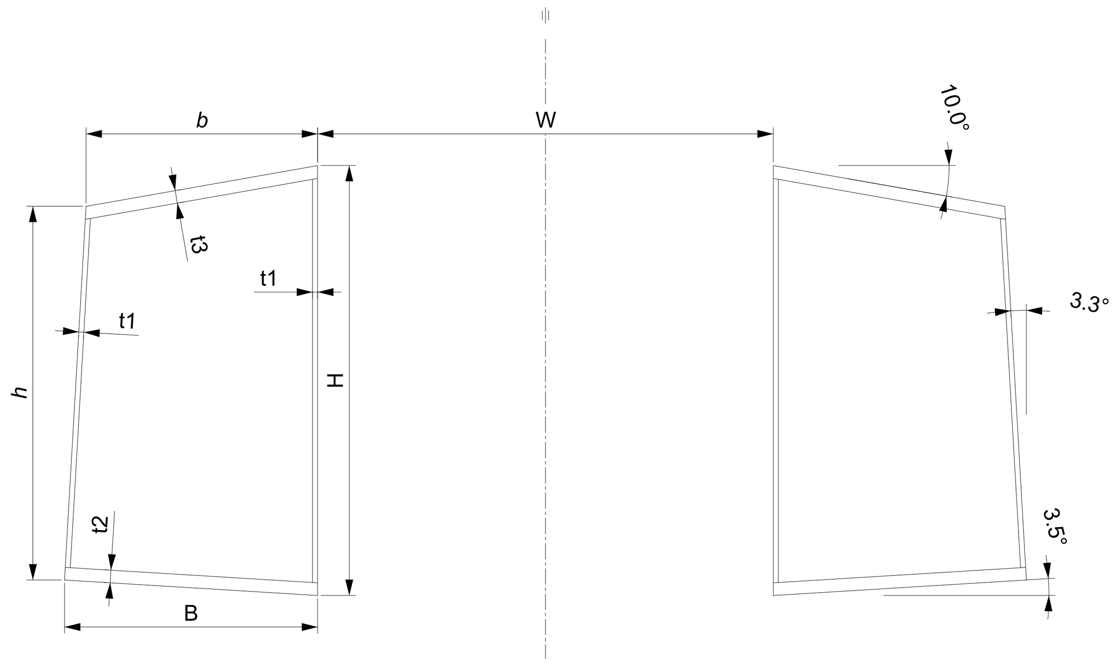
Item	Symbol	Unit	130.6	132.8	135.0	137.2	139.4	141.6	143.8	146.0	148.2	150.4	152.6	154.8	157.0	159.2	161.4
BRIDGE CHAINAGE		[m]	130.6	132.8	135.0	137.2	139.4	141.6	143.8	146.0	148.2	150.4	152.6	154.8	157.0	159.2	161.4
SPINE-TO-SPINE WIDTH	W	[mm]	11698	11750	11790	11800											
WEBS – INNER HEIGHT	H	[mm]	1700														
WEBS – OUTER HEIGHT	h	[mm]	1478														
WEBS – THICKNESS	t1	[mm]	TYPICALLY 20 TO 50														
BOTTOM FLANGE – WIDTH	B	[mm]	1000														
BOTTOM FLANGE – THICKNESS	t2	[mm]	TYPICALLY 45 TO 85														
TOP FLANGE – WIDTH	b	[mm]	915														
TOP FLANGE – THICKNESS	t3	[mm]	TYPICALLY 45 TO 85														

Item	Symbol	Unit	163.6	165.8	168.0	170.2	172.4	174.6	176.8	179.0	181.2	183.4	185.6	187.8	190.0	192.2	194.4
BRIDGE CHAINAGE		[m]	163.6	165.8	168.0	170.2	172.4	174.6	176.8	179.0	181.2	183.4	185.6	187.8	190.0	192.2	194.4
SPINE-TO-SPINE WIDTH	W	[mm]	11800														
WEBS – INNER HEIGHT	H	[mm]	1700														
WEBS – OUTER HEIGHT	h	[mm]	1478														
WEBS – THICKNESS	t1	[mm]	TYPICALLY 20 TO 50														
BOTTOM FLANGE – WIDTH	B	[mm]	1000														
BOTTOM FLANGE – THICKNESS	t2	[mm]	TYPICALLY 20 TO 100														
TOP FLANGE – WIDTH	b	[mm]	915														
TOP FLANGE – THICKNESS	t3	[mm]	TYPICALLY 20 TO 100														

TRANSITION SPAN

(EJ and P6 at 194.4; P7 at 216.8)

Item	Symbol	Unit	194.4	196.6	198.8	201.0	203.2	205.4	207.6	209.8	212.0	214.2	216.4	216.8
BRIDGE CHAINAGE		[m]	194.4	196.6	198.8	201.0	203.2	205.4	207.6	209.8	212.0	214.2	216.4	216.8
SPINE-TO-SPINE WIDTH	W	[mm]	11800											
WEBS – INNER HEIGHT	H	[mm]	1700											
WEBS – OUTER HEIGHT	h	[mm]	1478											
WEBS – THICKNESS	t1	[mm]	TYPICALLY 20 TO 40											
BOTTOM FLANGE – WIDTH	B	[mm]	1000											
BOTTOM FLANGE – THICKNESS	t2	[mm]	TYPICALLY 30 TO 50								TYPICALLY 60 TO 80			
TOP FLANGE – WIDTH	b	[mm]	915											
TOP FLANGE – THICKNESS	t3	[mm]	TYPICALLY 30 TO 50								TYPICALLY 60 TO 80			



INDICATIVE SECTION THROUGH SPINE BEAMS

NOT TO SCALE. DIMENSIONS GIVEN IN TABLES

rev	amendments	check	date
3	Revised for Planning Comments	OLSS	28/06/24
2	Revised for Stage Approval	OLSS	19/04/24
1	Transition Span Added	OLSS	09/11/23
0	First Issue	OLSS	31/05/23

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24 Bevis Marks
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Client
COMHLACHT CHALAFORT ÁTHA CLIATH
DUBLIN PORT COMPANY

Project
3FMProject Bringing Dublin Port To 2040

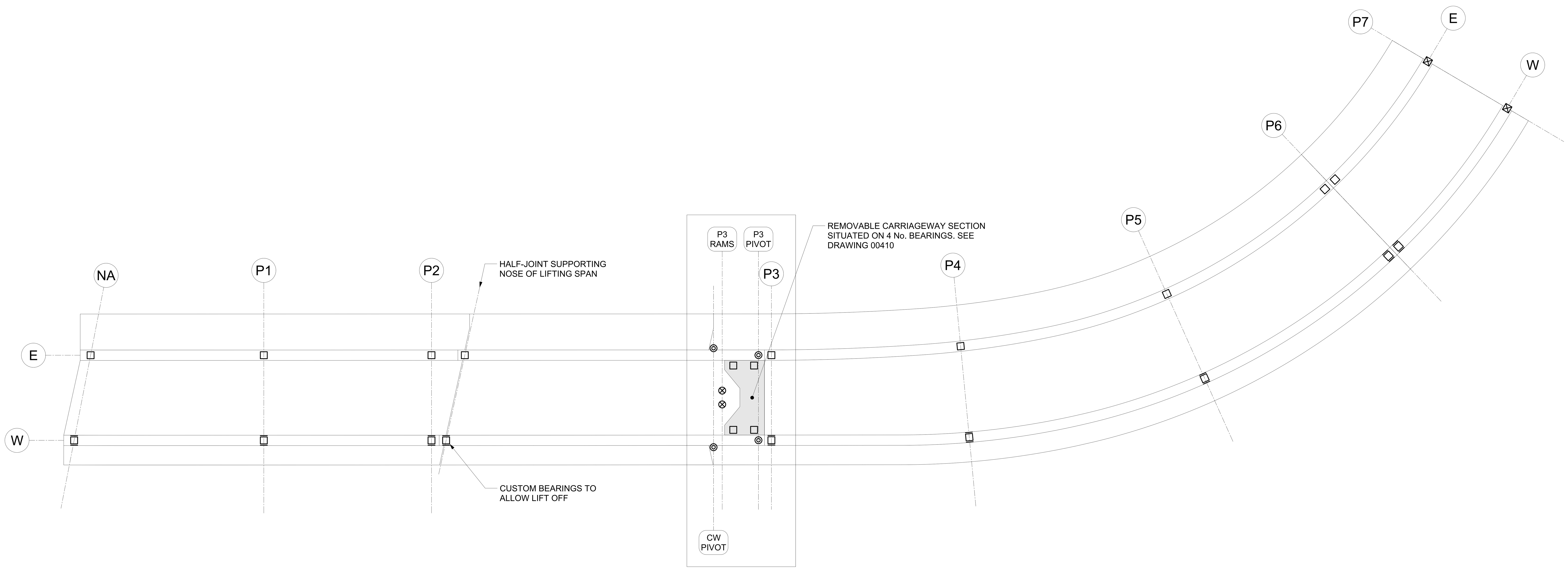
Title
SPAR Bridge
Material Distribution

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	As Shown

Drawing Number
COWI-SBR-SP-DR-S-100-00080

Drawn By	Status	Revision
C. Fleming	S4	3

Checked By	Approved By	Date
O. Stross	O. Stross	28/06/2024



ARTICULATION PLAN

NOT TO SCALE

LEGEND

BEARING TYPES (WHERE STATED) AS PER BS EN 1337-1

- TYPE 1.1 - ELASTOMERIC BEARING
- TYPE 1.2 - ELASTOMERIC BEARING WITH RESTRAINTS FOR ONE AXIS
- INTEGRAL CONNECTION
- MECHANICAL RAMS
- MECHANICAL PIVOT - SPHERICAL BEARING

NOTES

1. These drawings shall be read in conjunction with the Preliminary Design Report, CP1901_3FM-COWI-SBR-SP-RP-S-00002

2. Bearings assumed to be reinforced elastomeric bearings. Shear keys may be required to increase horizontal capacities.

rev	amendments	check	date
3	Revised for Planning Comments	OLSS	28/06/24
2	Revised for Stage Approval	OLSS	19/04/24
1	Transition Span Added	OLSS	09/11/23
0	First Issue	OLSS	31/05/23

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Client: COMHLACHT CHALAFORT ÁTHA CLIATH DUBLIN PORT COMPANY

Project: 3FMProject Bringing Dublin Port To 2040

Title: SPAR Bridge Bearing Articulation

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	NOT TO SCALE

Drawing Number: COWI-SBR-SP-DR-S-100-00090

Drawn By	Status	Revision
C. Fleming	S4	3

Checked By	Approved By	Date
O. Stross	O. Stross	28/06/2024

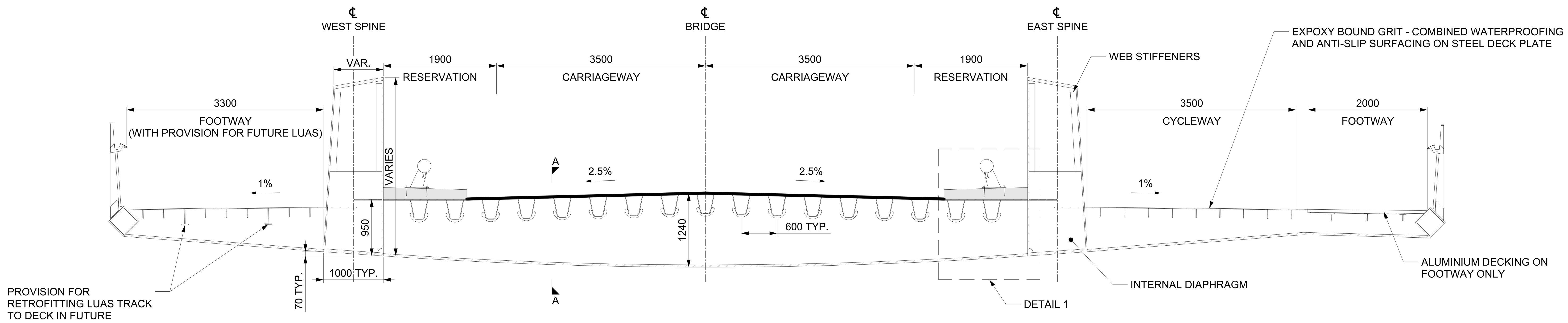
NOTES

1. These drawings shall be read in conjunction with the Preliminary Design Report, CP1901_3FM-COWI-SBR-SP-RP-S-00002

2. Refer to drawing CP1901_3FM-MOXON-SBR-SP-DR-A-00005 for location of opening span.

3. Structural steelwork Grade 355+W to IS EN 10025 typically.

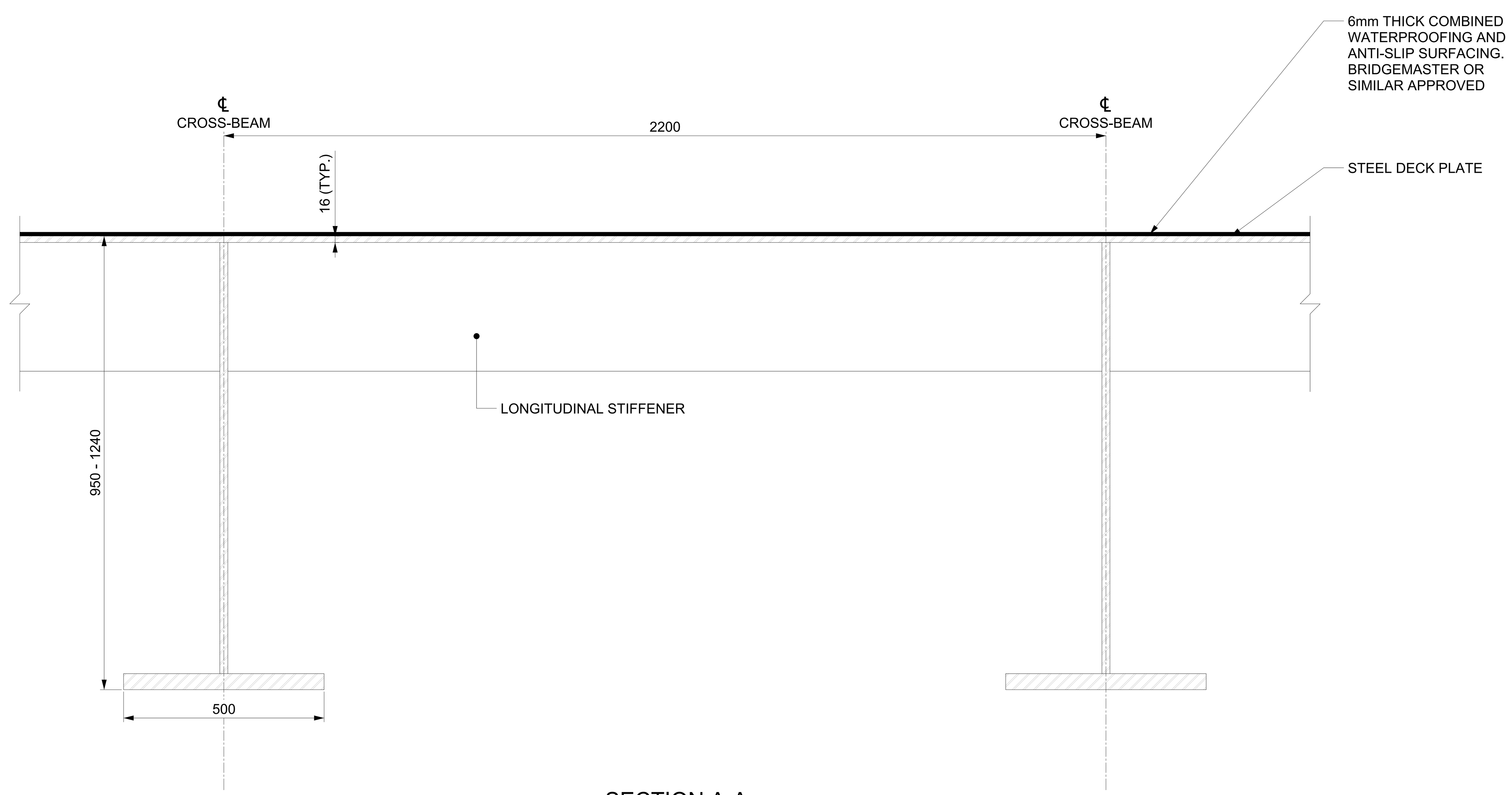
4. Custom VRS shown, subject to Road Authority approval during Detailed Design.



TYPICAL CROSS SECTION ON OPENING SPAN

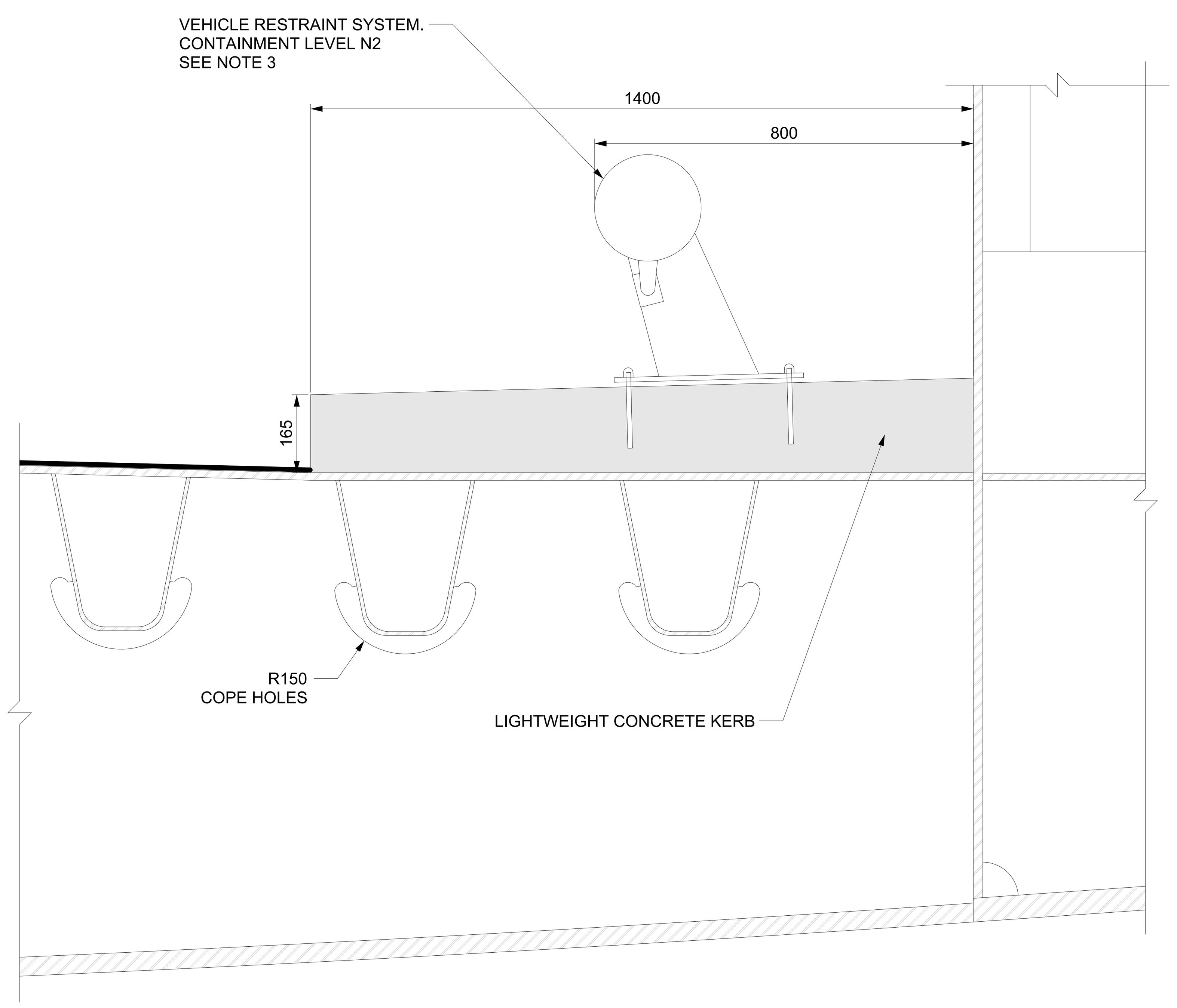
SCALE 1:50

SEE DRAWING 00080 FOR VARIABLE DIMENSIONS



SECTION A-A

SCALE 1:10



DETAIL 1

SCALE 1:10

rev	amendments	check	date
2	Revised for Planning Comments	OLSS	28/06/24
1	Revised for Stage Approval	OLSS	19/04/24
0	First Issue	OLSS	31/05/23

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Project

3FMProject Bringing Dublin Port To 2040

Title

SPAR Bridge
Opening Span
Typical Cross Section

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	As Shown

Drawing Number

COWI-SBR-SP-DR-S-100-00100

Drawn By	Status	Revision
C. Fleming	S4	2

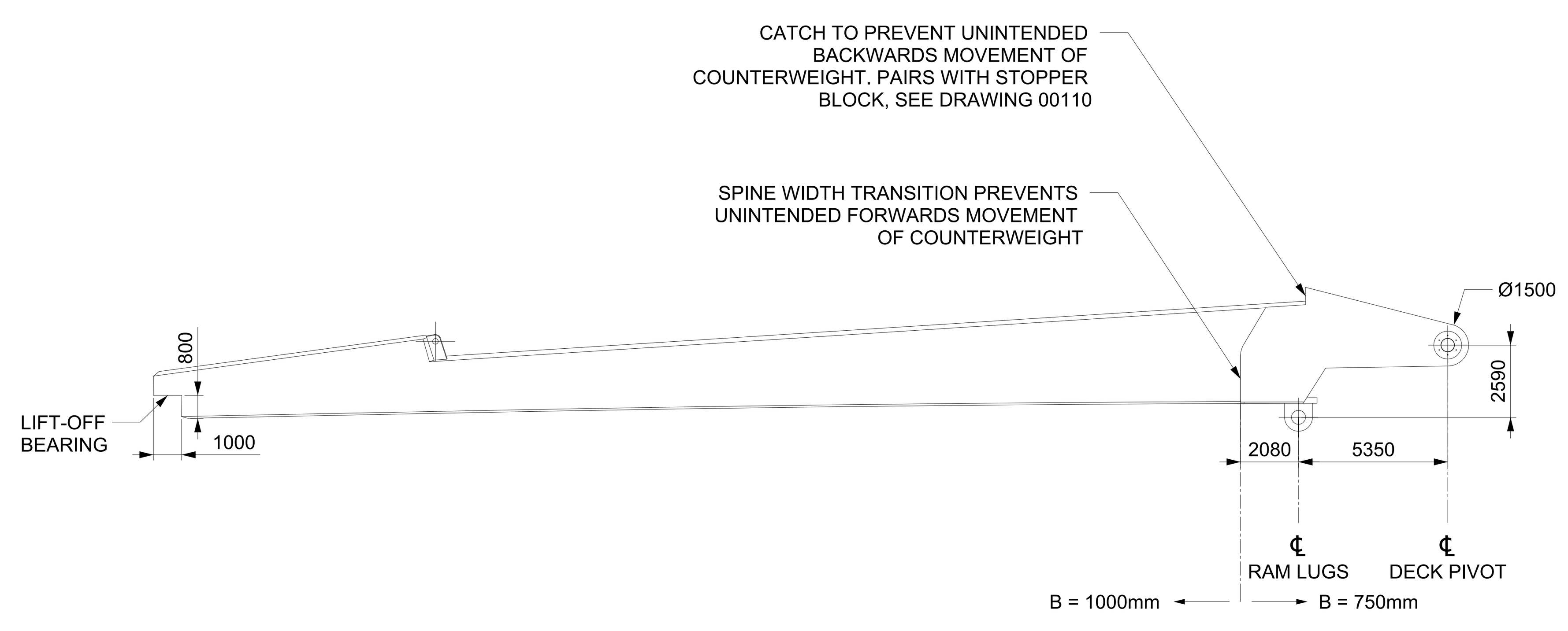
Checked By	Approved By	Date
O. Stross	O. Stross	28/06/2024

NOTES

1. These drawings shall be read in conjunction with the Preliminary Design Report, CP1901_3FM-COWI-SBR-SP-RP-S-00002

2. Refer to drawing CP1901_3FM-MOXON-SBR-SP-DR-A-00005 for location of opening span

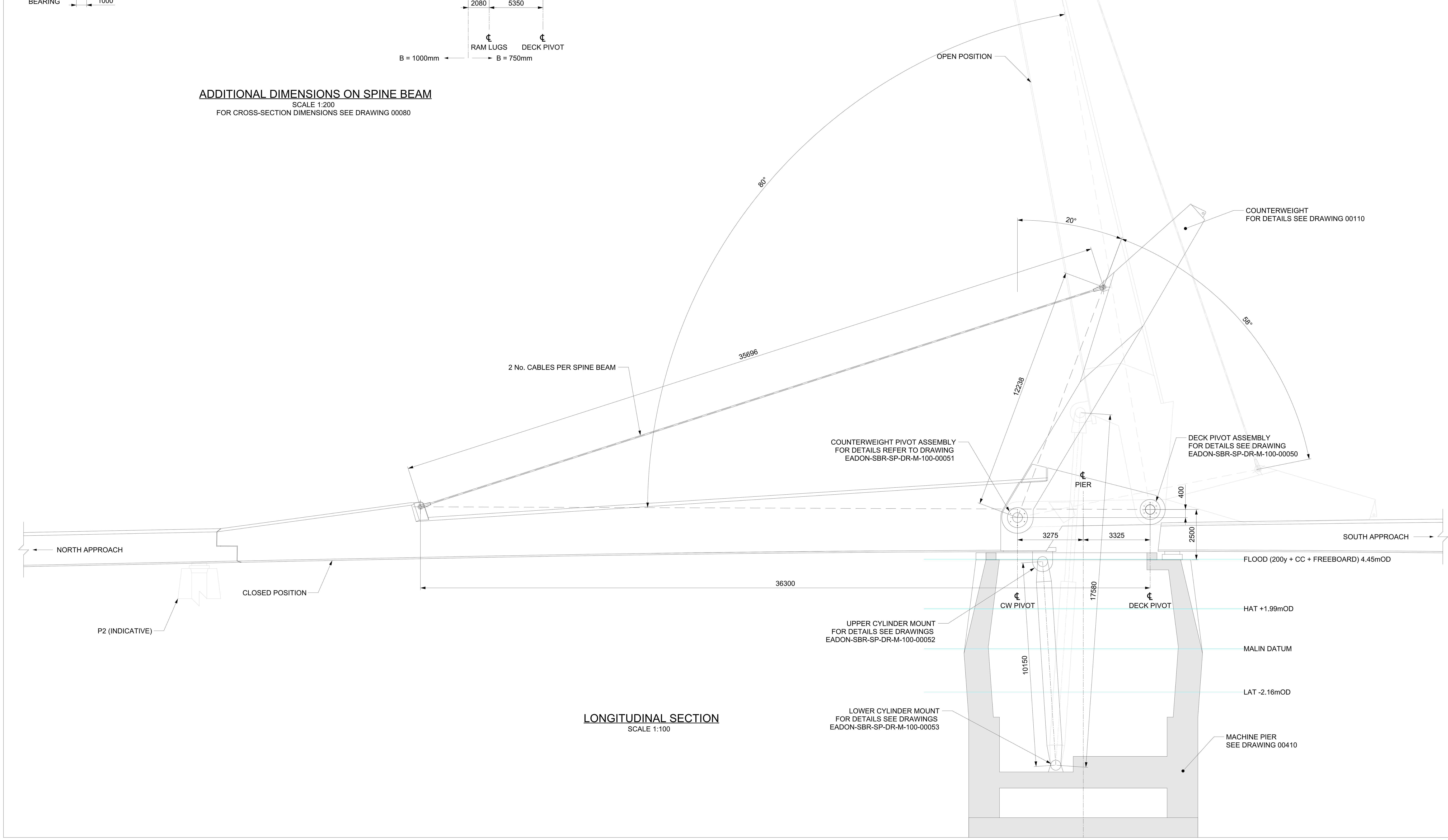
3. Flood level shown is for a 200-year return period, plus 1 m climate change allowance, plus freeboard allowance. Levels shown as mOD refer to Malin Head OD datum



ADDITIONAL DIMENSIONS ON SPINE BEAM

SCALE 1:200

FOR CROSS-SECTION DIMENSIONS SEE DRAWING 00080



LONGITUDINAL SECTION

SCALE 1:100

rev	amendments	check	date
2	Revised for Planning Comments	OLSS	28/06/24
1	Revised for Stage Approval	OLSS	19/04/24
0	First Issue	OLSS	31/05/23

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DUBLIN PORT COMPANY

Project

3FMProject Bringing Dublin Port To 2040

Title

SPAR Bridge
Opening Span
Longitudinal Section

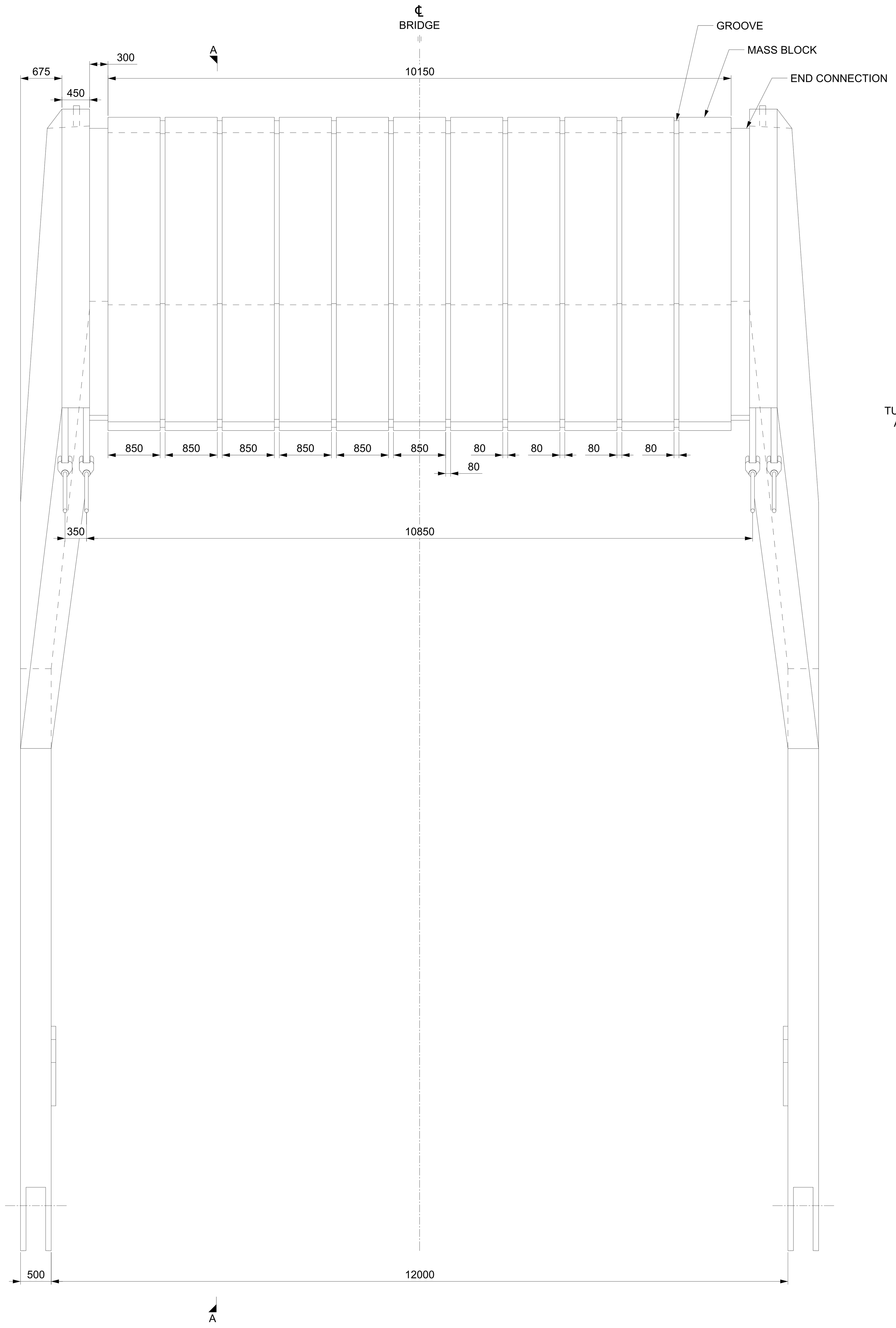
Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	As Shown

Drawing Number

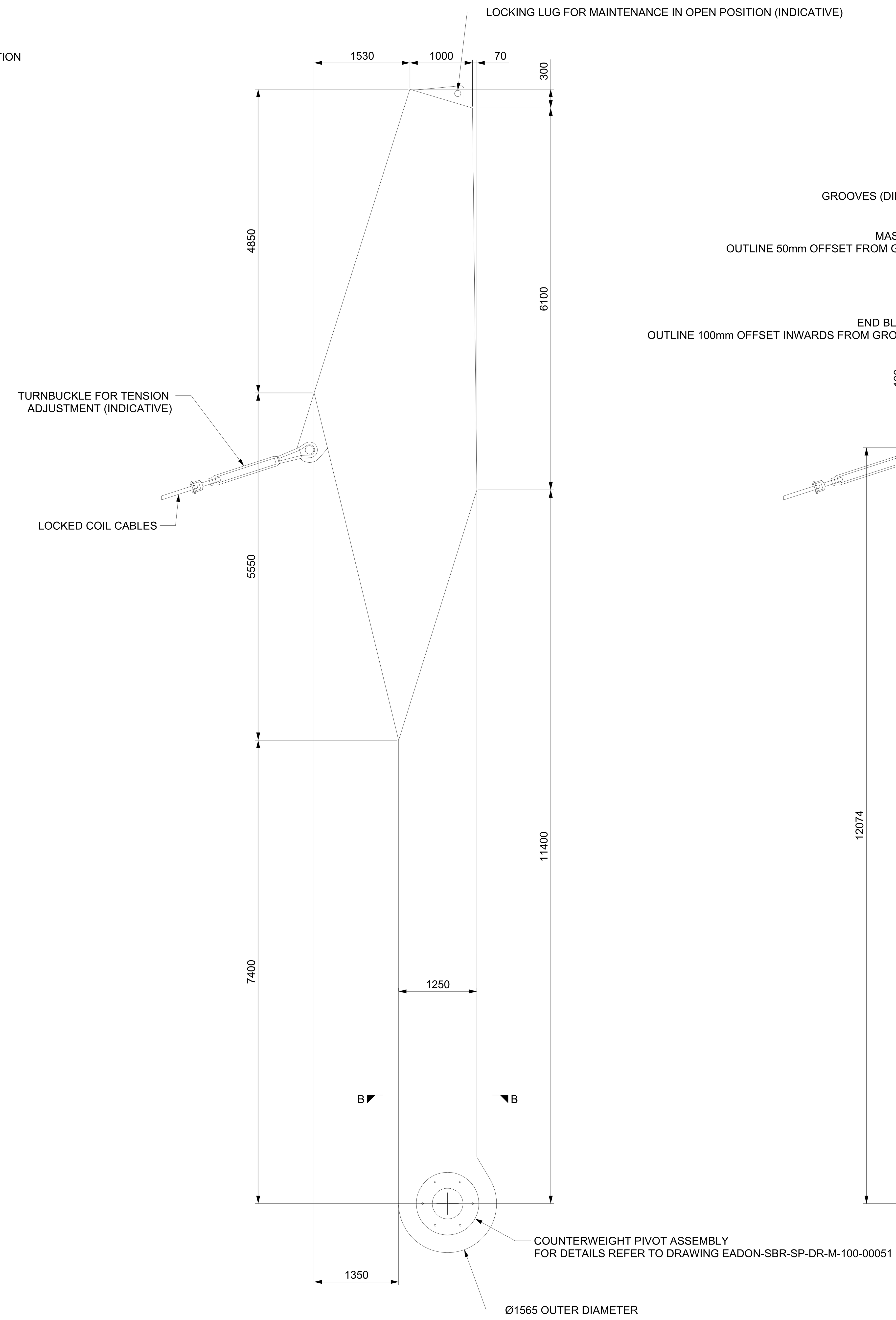
COWI-SBR-SP-DR-S-100-00105

Drawn By	Status	Revision
C. Fleming	S4	2

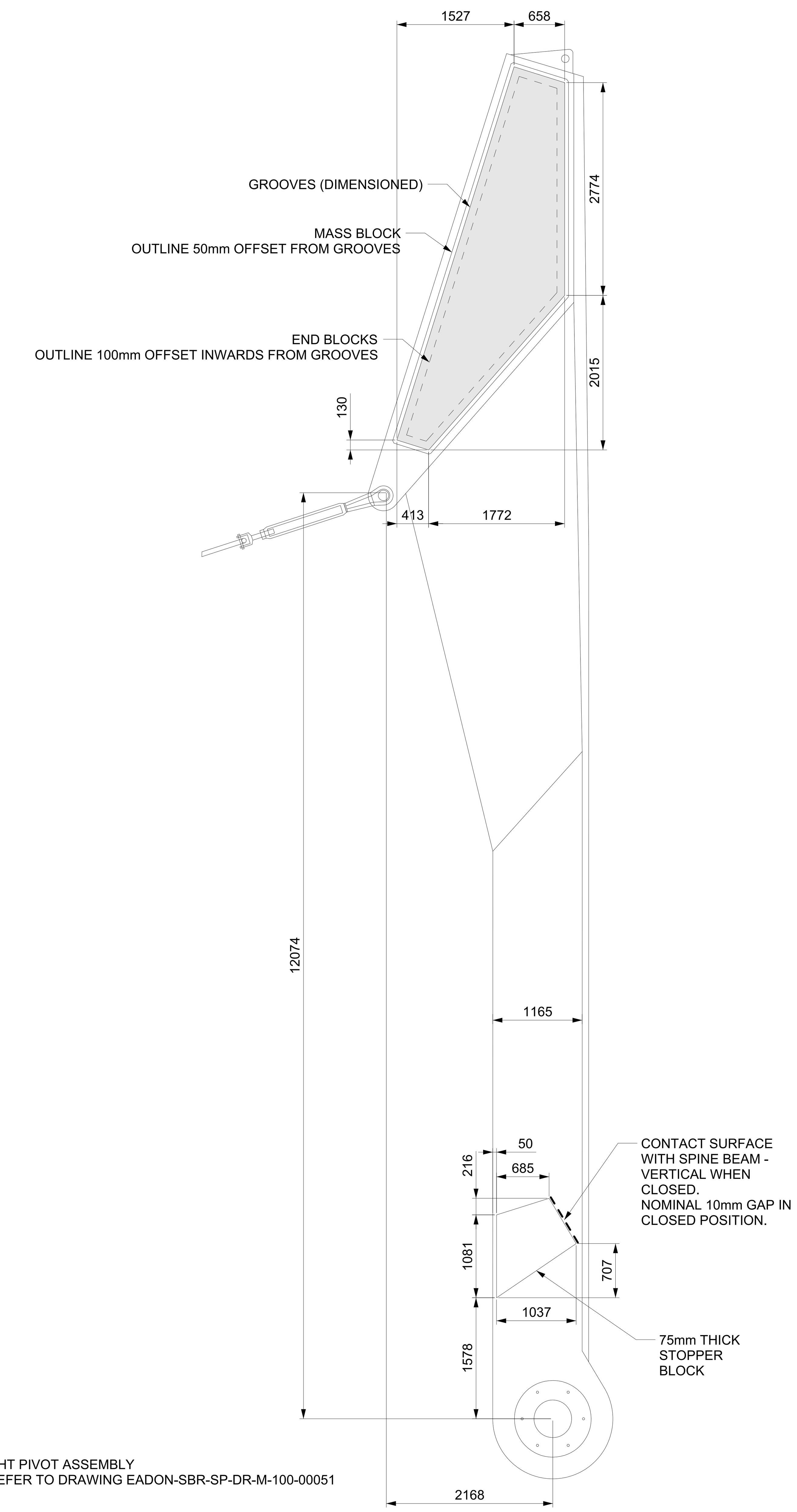
Checked By	Approved By	Date
O. Stross	O. Stross	28/06/2024



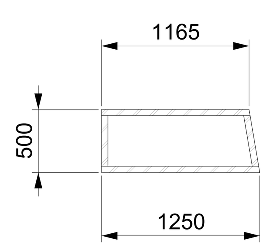
VIEW ON COUNTERWEIGHT FRAME



ELEVATION ON COUNTERWEIGHT FRAME



SECTION A-A



SECTION B-B

NOTES

1. These drawings shall be read in conjunction with the Preliminary Design Report, CP1901_3FM-COWI-SBR-SP-RP-S-00002

2. Refer to drawing CP1901_3FM-MOXON-SBR-SP-DR-A-00005 for location of counterweight

3. Structural steelwork Grade 355+W to IS EN 10025 typically.

4. Counterweight mass to be constructed from granite-effect reconstituted stone or granite slabs, achieving an intended mass of 150 t.

5. Counterweight material and structural system to be determined during detailed design.

rev	amendments	check	date
3	Revised for Planning Comments	OLSS	28/06/24
2	Revised for Stage Approval	OLSS	19/04/24
1	Design Updated	OLSS	06/11/23
0	First Issue	OLSS	31/05/23

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DUBLIN PORT COMPANY

Project
3FMProject Bringing Dublin Port To 2040

Title
SPAR Bridge
Opening Span
Counterweight Layout

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	1:50

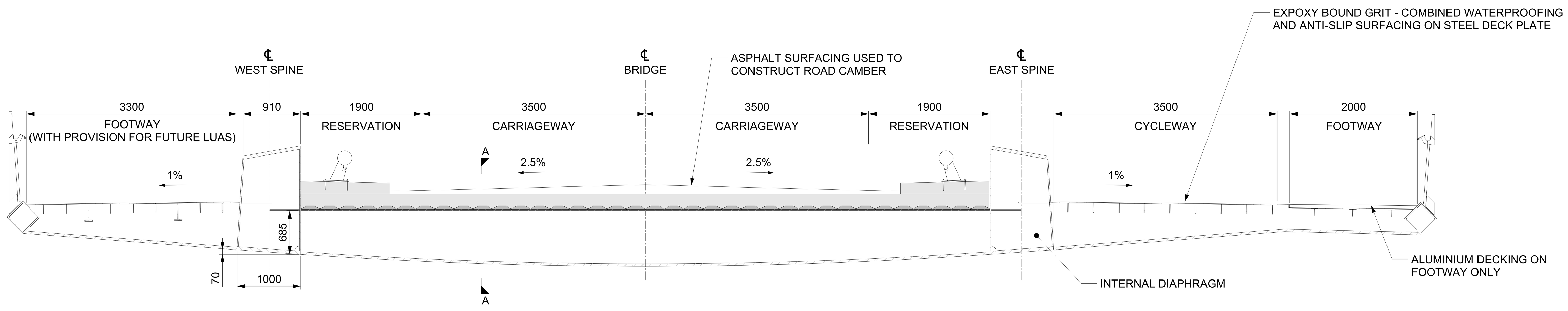
Drawing Number
COWI-SBR-SP-DR-S-100-00110

Drawn By	Status	Revision
C. Fleming	S4	3

Checked By	Approved By	Date
O. Stross	O. Stross	28/06/2024

NOTES

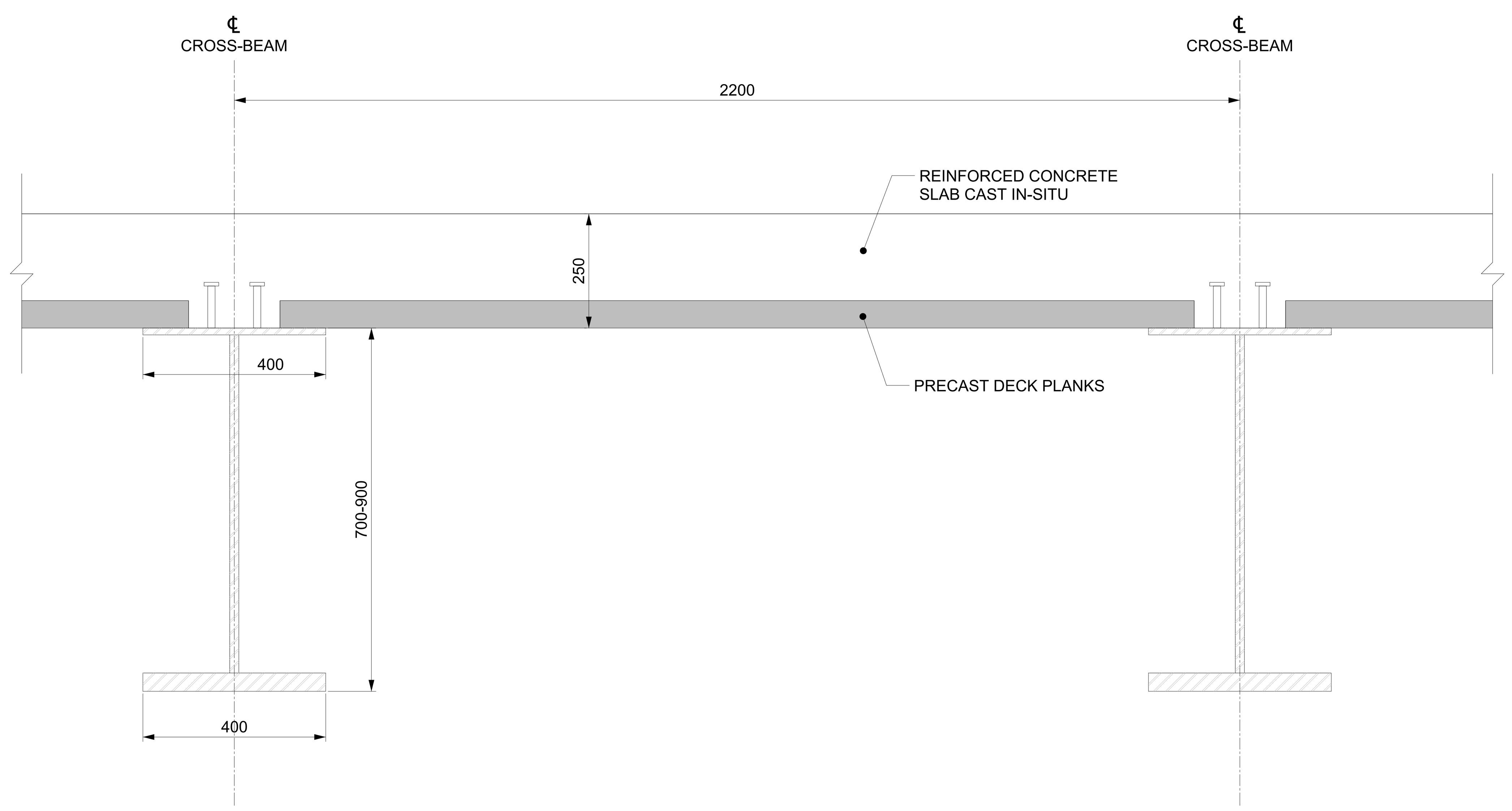
1. These drawings shall be read in conjunction with the Preliminary Design Report, CP1901_3FM-COWI-SBR-SP-RP-S-00002
2. Refer to drawing CP1901_3FM-MOXON-SBR-SP-DR-A-00005 for location of approach spans
3. Structural steelwork Grade 355+W to IS EN 10025 typically.
4. Structural concrete Grade C45/55 to be confirmed at detailed design



TYPICAL CROSS SECTION ON APPROACH SPANS

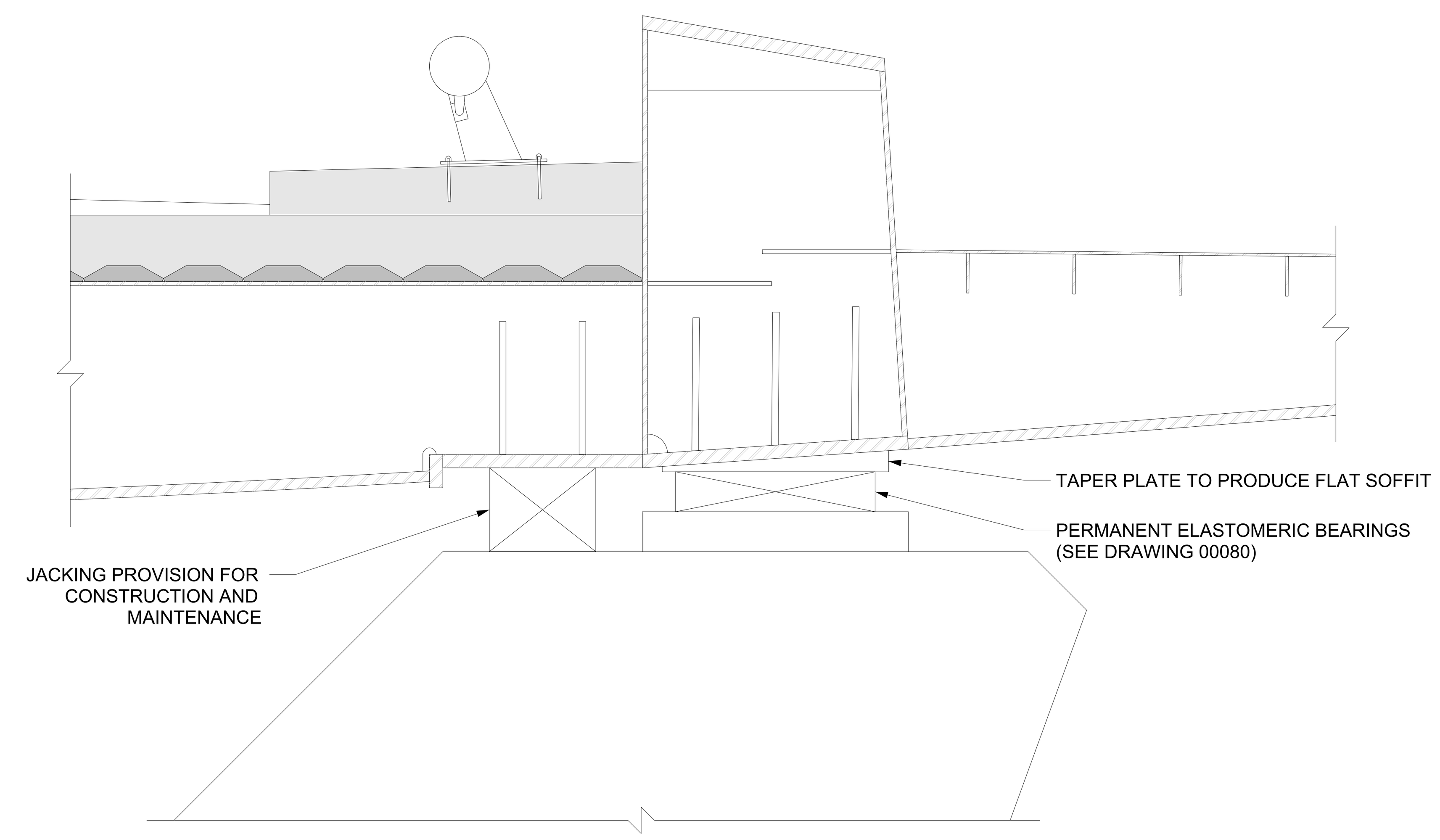
SCALE 1:50

SEE DRAWING 00080 FOR VARIABLE DIMENSIONS



SECTION A-A

SCALE 1:10



DETAIL AT PIERS

SCALE 1:10

rev	amendments	check	date
2	Revised for Planning Comments	OLSS	28/06/24
1	Revised for Stage Approval	OLSS	19/04/24
0	First Issue	OLSS	29/06/23

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COMHLACHT CHALAFORT ÁTHA CLIATH
DUBLIN PORT COMPANY

Project

3FMProject Bringing Dublin Port To 2040

Title

SPAR Bridge
Approach Spans
Typical Cross Section

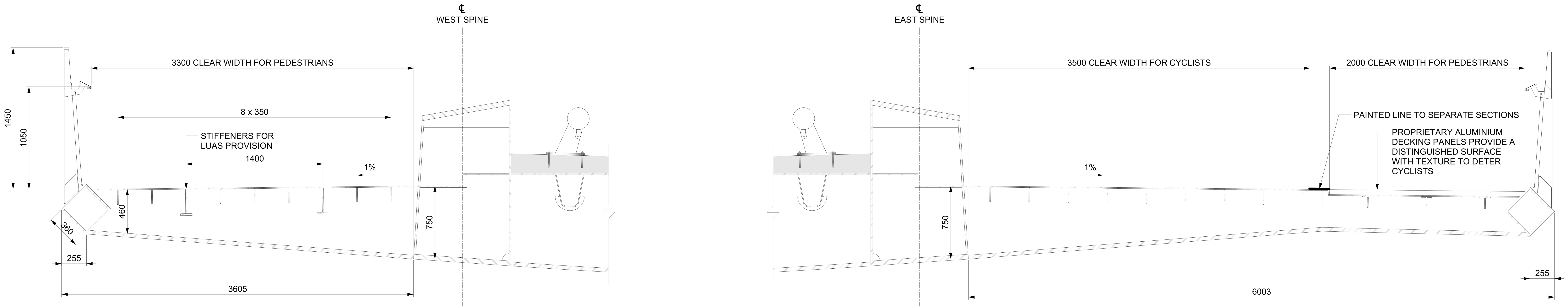
Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	As Shown

Drawing Number

COWI-SBR-SP-DR-S-100-00200

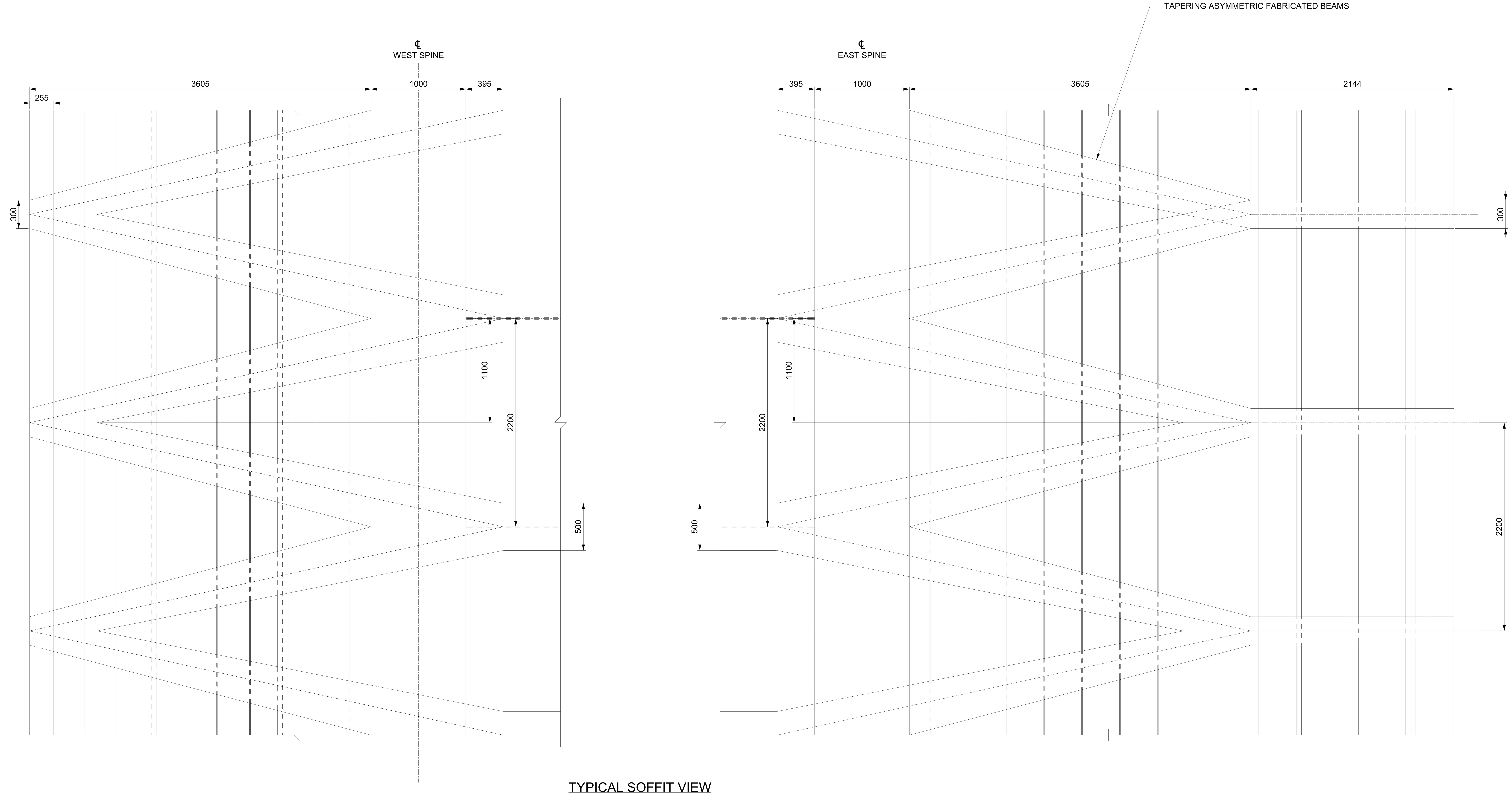
Drawn By	Status	Revision
C. Fleming	S4	2

Checked By	Approved By	Date
O. Stross	O. Stross	28/06/2024



TYPICAL CROSS SECTION

LIFTING SPAN SHOWN, APPROACH SPAN SIMILAR



TYPICAL SOFFIT VIEW

LIFTING SPAN SHOWN, APPROACH SPAN SIMILAR

NOTES

1. These drawings shall be read in conjunction with the Preliminary Design Report, CP1901_3FM-COWI-SBR-SP-RP-S-00002

2. Structural steelwork Grade 355+W to IS EN 10025 typically.

3. Typical active travel details applicable for both lifting and approach spans. Some modification will be required for access to Pier 4, to be determined at detailed design stage.

rev	amendments	check	date
2	Revised for Planning Comments	OLSS	28/06/24
1	Revised for Stage Approval	OLSS	19/04/24
0	First Issue	OLSS	28/06/23

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DUBLIN PORT COMPANY

Project

3FMProject Bringing Dublin Port To 2040

Title

SPAR Bridge
Active Travel Provision

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	1:25

Drawing Number

COWI-SBR-SP-DR-S-100-00300

Drawn By	Status	Revision
C. Fleming	S4	2

Checked By	Approved By	Date
O. Stross	O. Stross	28/06/2024

NOTES

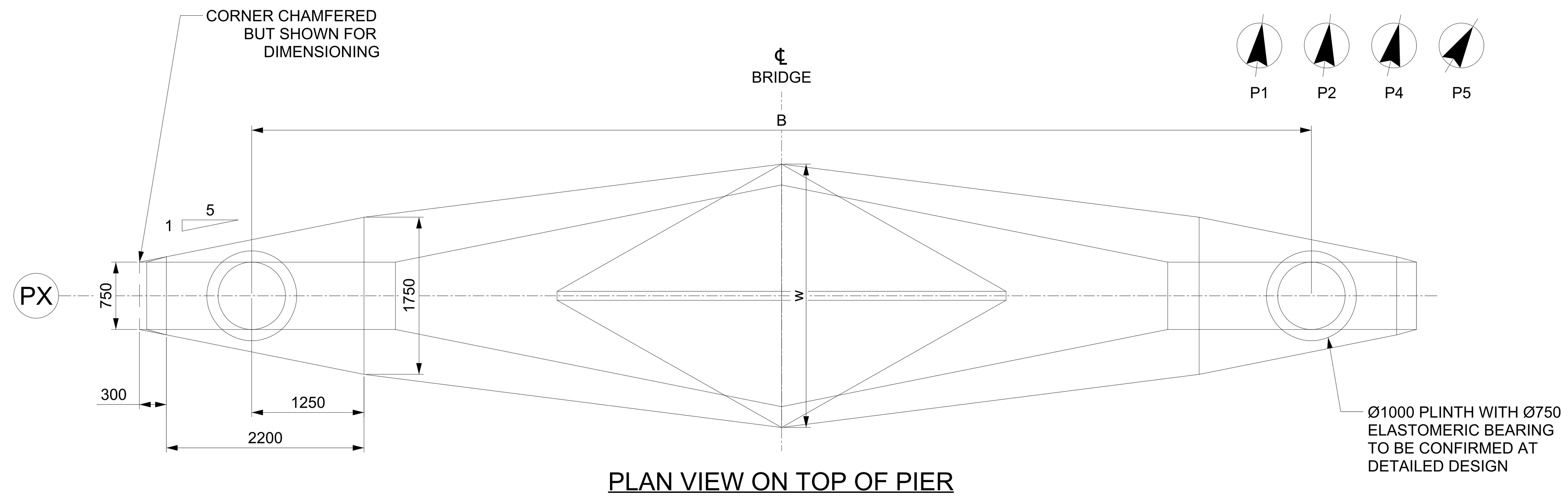
1. These drawings shall be read in conjunction with the Preliminary Design Report, CP1901_3FM-COWI-SBR-SP-RP-S-00002

2. Refer to drawing CP1901_3FM-MOXON-SBR-SP-DR-A-00005 for pier locations.

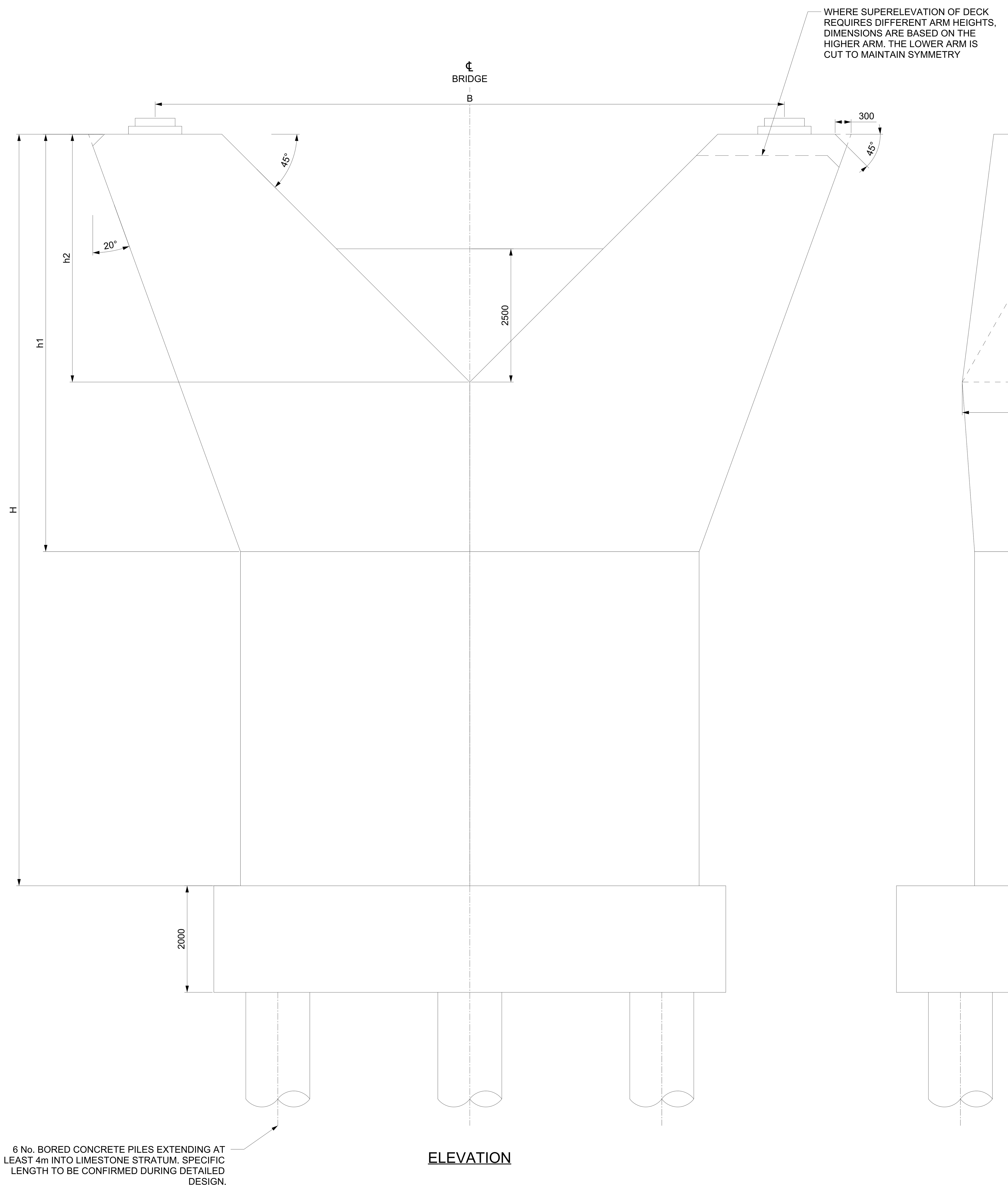
3. Structural concrete grade C40/50, to be confirmed at detailed design.

4. Pier heights to ensuer sufficient ground cover of pile caps. River bed scour protection details to be confirmed at detailed design.

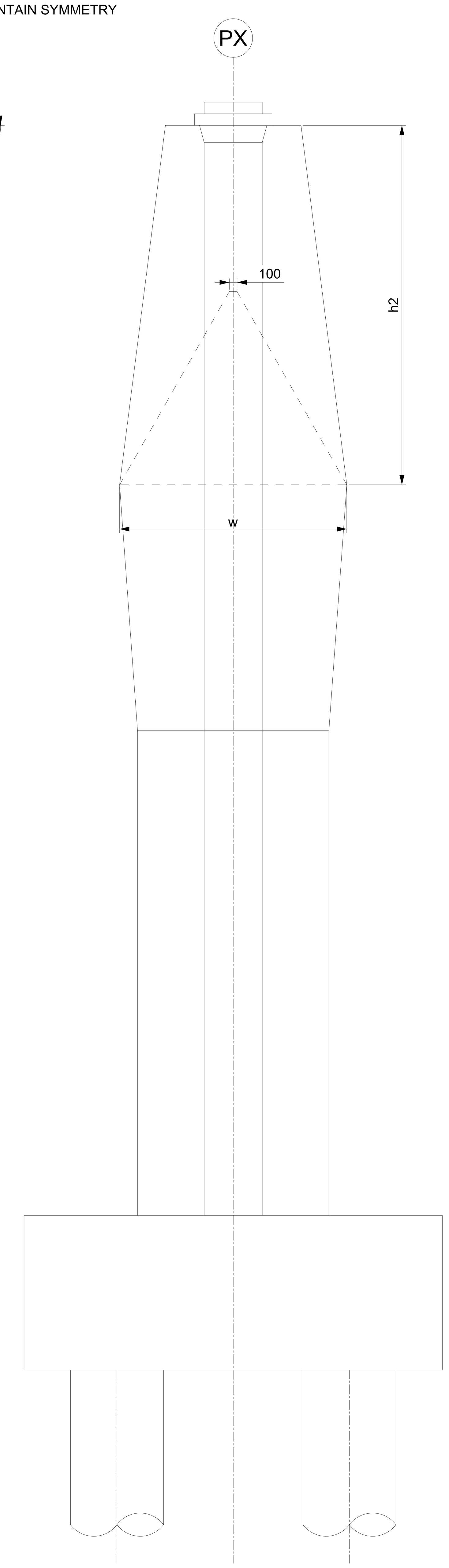
5. Pile depths to be confirmed after detailed ground investigations have been conducted at pier locations.



PLAN VIEW ON TOP OF PIER



ELEVATION

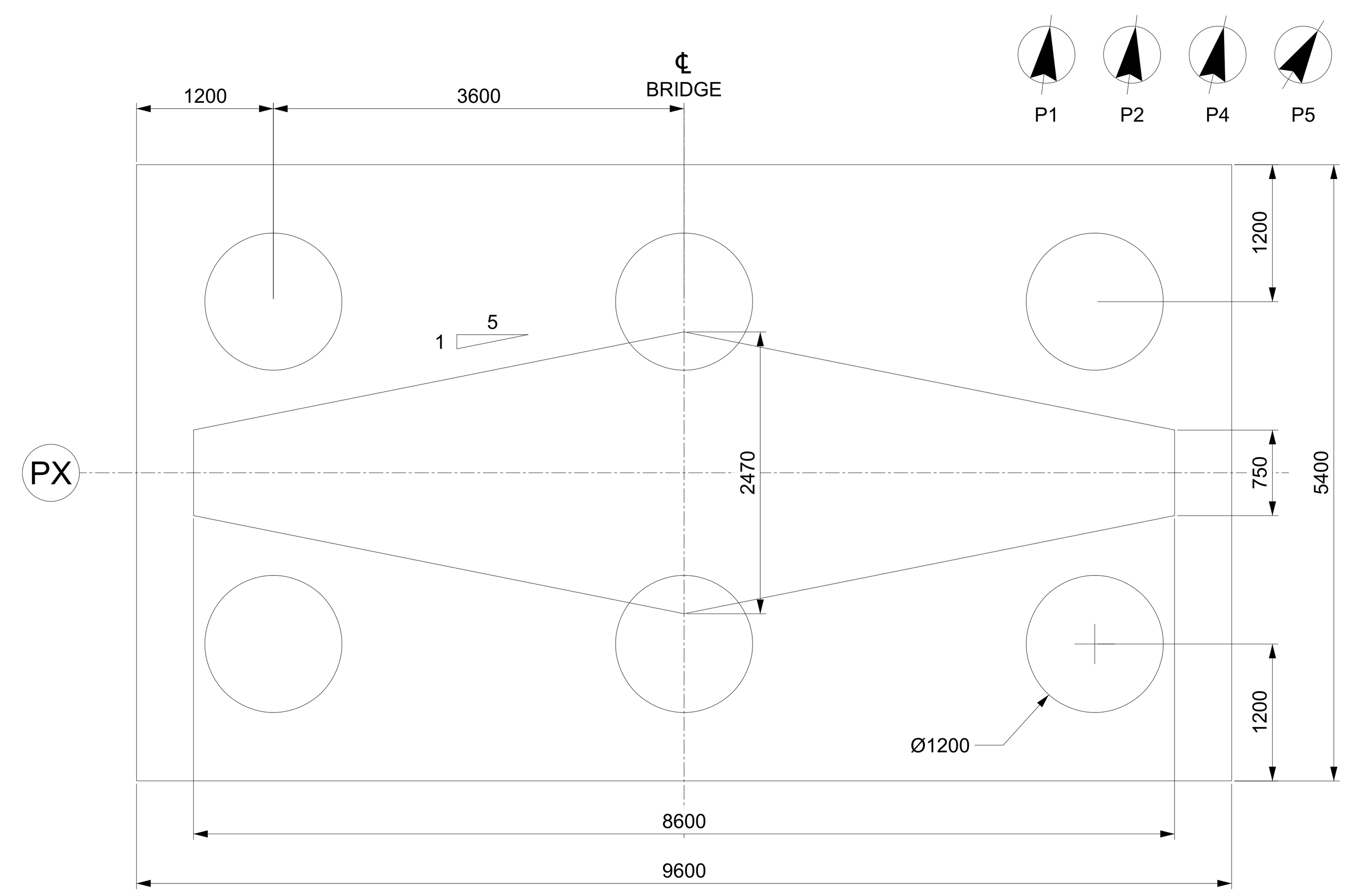


PROFILE

PIER X	B	H	h1*	h2*	w*
P1	11800	14100	7830	4650	2933
P2	11800	14100	7830	4650	2933
P4	12750	10700	9135	5125	3054
P5	12840	10000	9259	5170	3065

DIMENSIONS MARKED WITH AN ASTERISK (*) ARE DEPENDENT ON DIMENSIONS "B" AND "H" BUT ARE GIVEN FOR CLARITY

TABLE OF DIMENSIONS



PLAN VIEW ON PILE CAP

rev	amendments	check	date
3	Revised for Planning Comments	OLSS	28/06/24
2	Revised for Stage Approval	OLSS	19/04/24
1	Revised Dimensions	OLSS	07/11/23
0	First Issue	OLSS	31/05/23

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COMHLACHT CHALAFORT ÁTHA CLIATH
DUBLIN PORT COMPANY

Project

3FMProject Bringing Dublin Port To 2040

Title

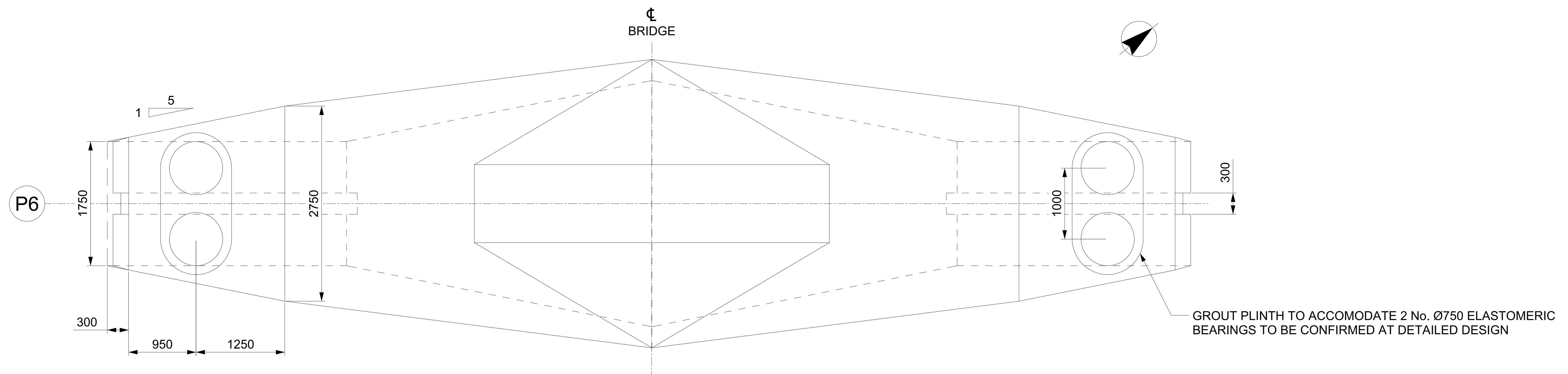
SPAR Bridge
Piers 1, 2, 4, and 5
Concrete Outline

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	1:50

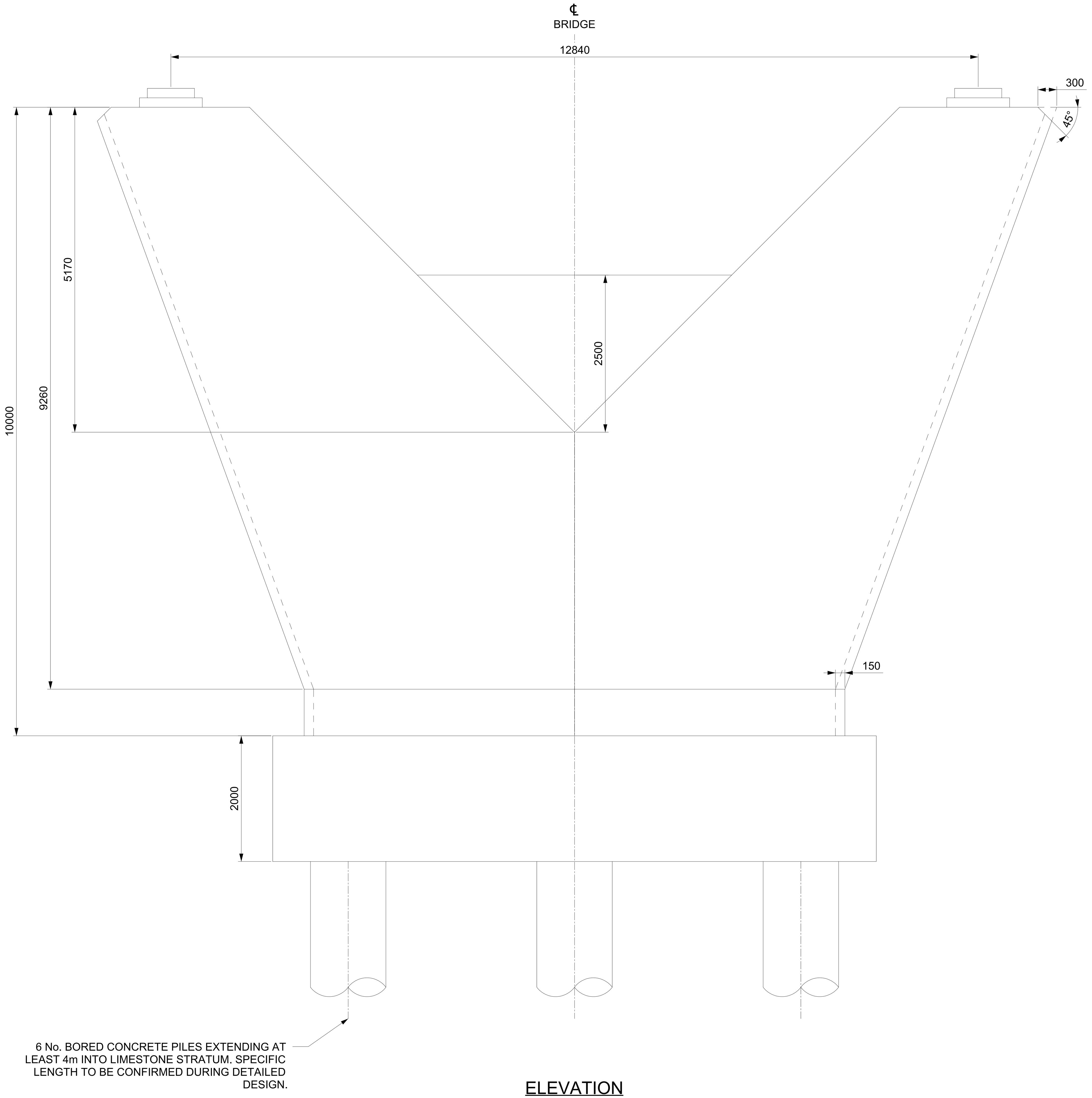
Drawing Number
COWI-SBR-SP-DR-S-100-00400

Drawn By	Status	Revision
C. Fleming	S4	3

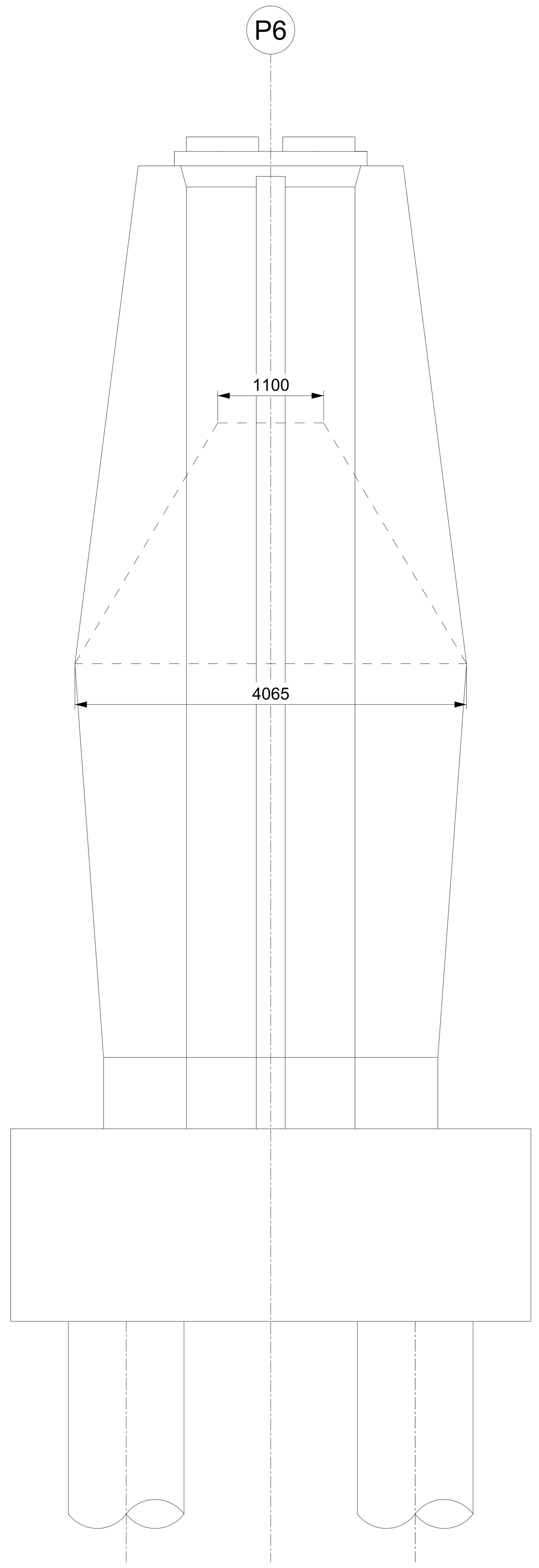
Checked By	Approved By	Date
O. Stross	O. Stross	28/06/2024



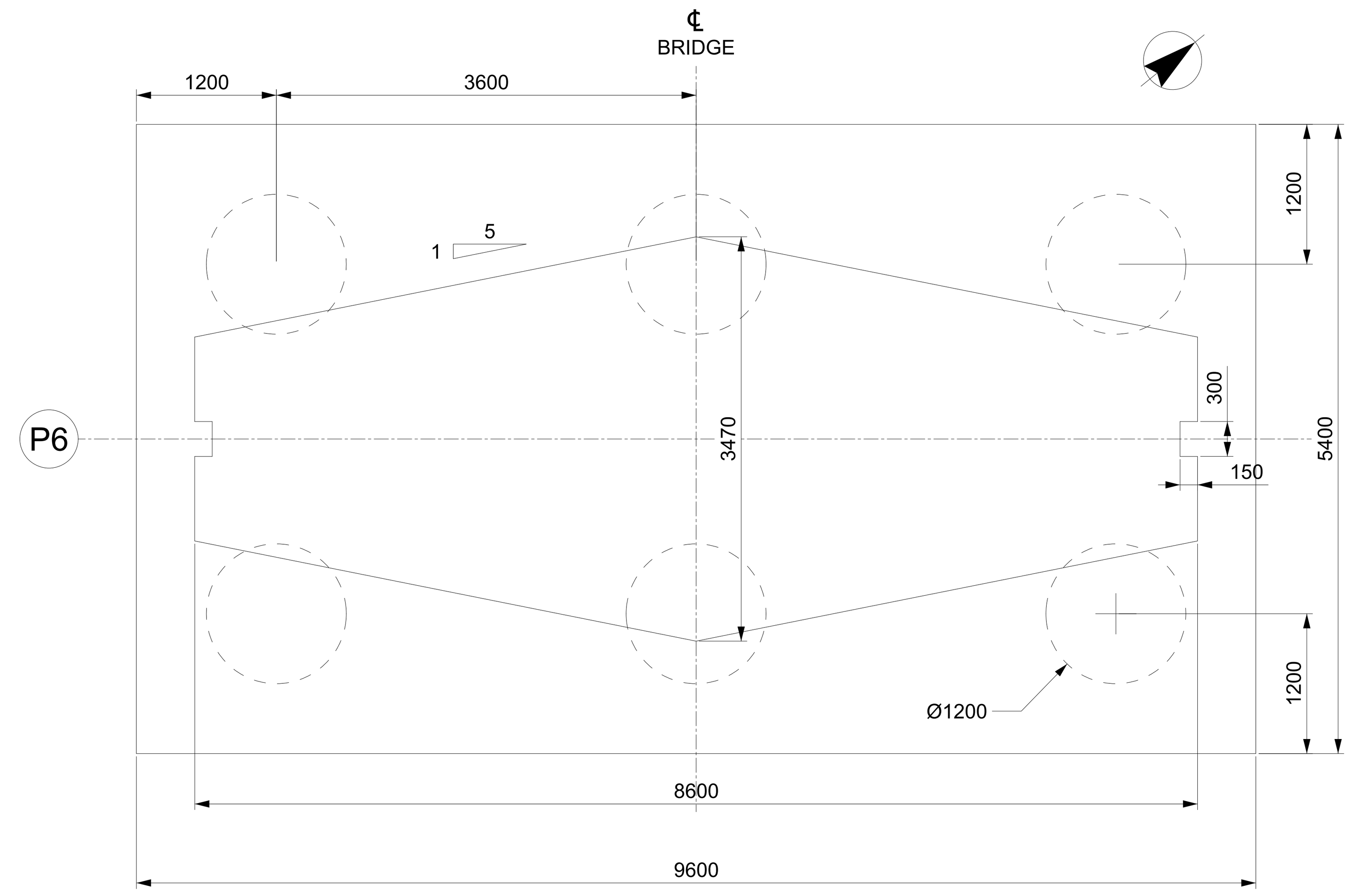
PLAN VIEW ON TOP OF PIER



ELEVATION



PROFILE



PLAN VIEW ON PILE CAP

NOTES

1. These drawings shall be read in conjunction with the Preliminary Design Report, CP1901_3FM-COWI-SBR-SP-RP-S-00002

2. Refer to drawing CP1901_3FM-MOXON-SBR-SP-DR-A-00005 for location of pier.

3. Structural concrete grade C40/50, to be confirmed at detailed design.

4. Pier heights to ensuer sufficient ground cover of pile caps. River bed scour protection details to be confirmed at detailed design.

5. Pile depths to be confirmed after detailed ground investigations have been conducted at pier locations.

rev	amendments	check	date
2	Revised for Planning Comments	OLSS	28/06/24
1	Revised for Stage Approval	OLSS	19/04/24
0	First Issue	OLSS	07/11/23

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Client

COMHLACHT CHALAFORT ÁTHA CLIATH DUBLIN PORT COMPANY

Project

3FMProject Bringing Dublin Port To 2040

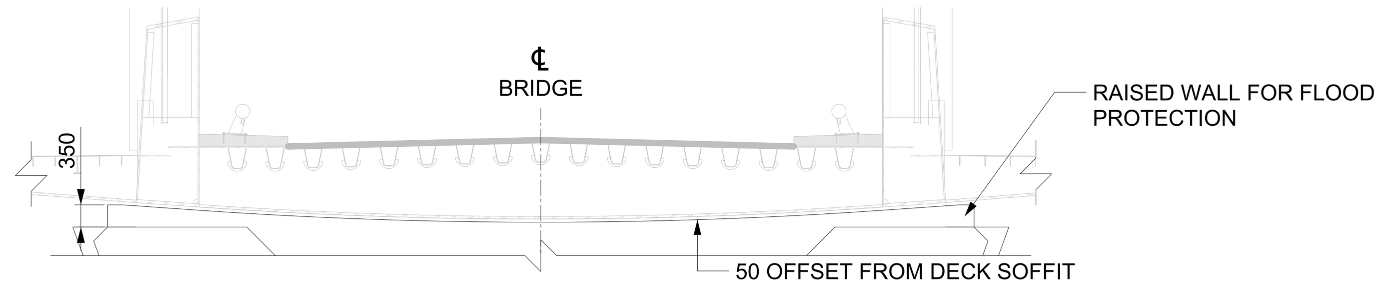
Title
SPAR Bridge
Pier 6
Concrete Outline

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	1:50

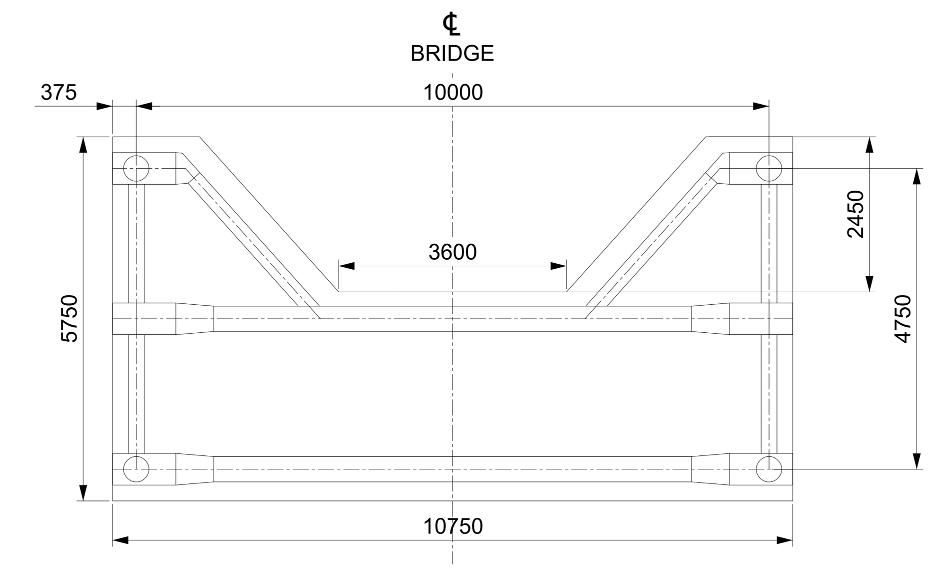
Drawing Number
COWI-SBR-SP-DR-S-100-00405

Drawn By	Status	Revision
C. Fleming	S4	2

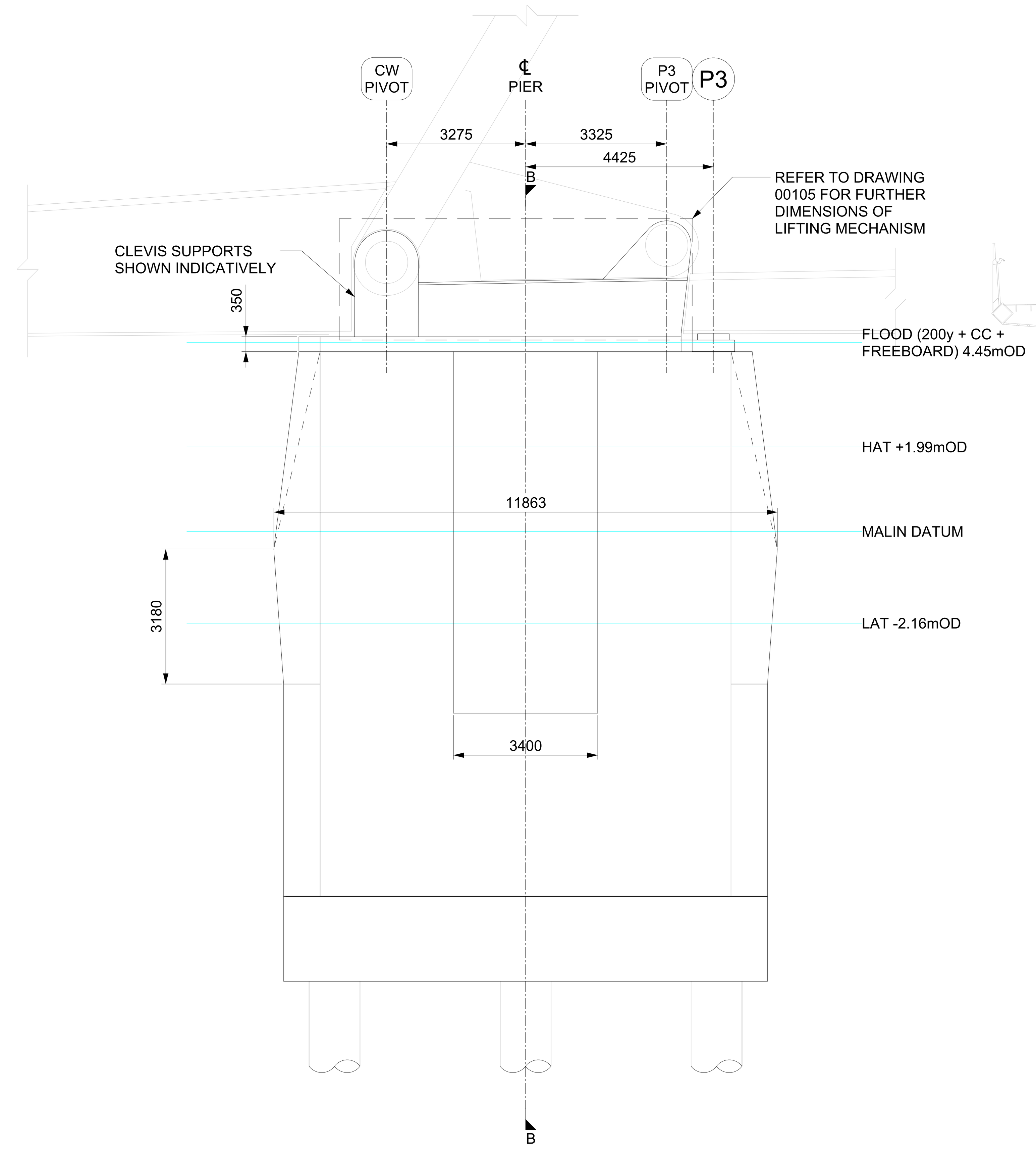
Checked By	Approved By	Date
O. Stross	O. Stross	28/06/2024



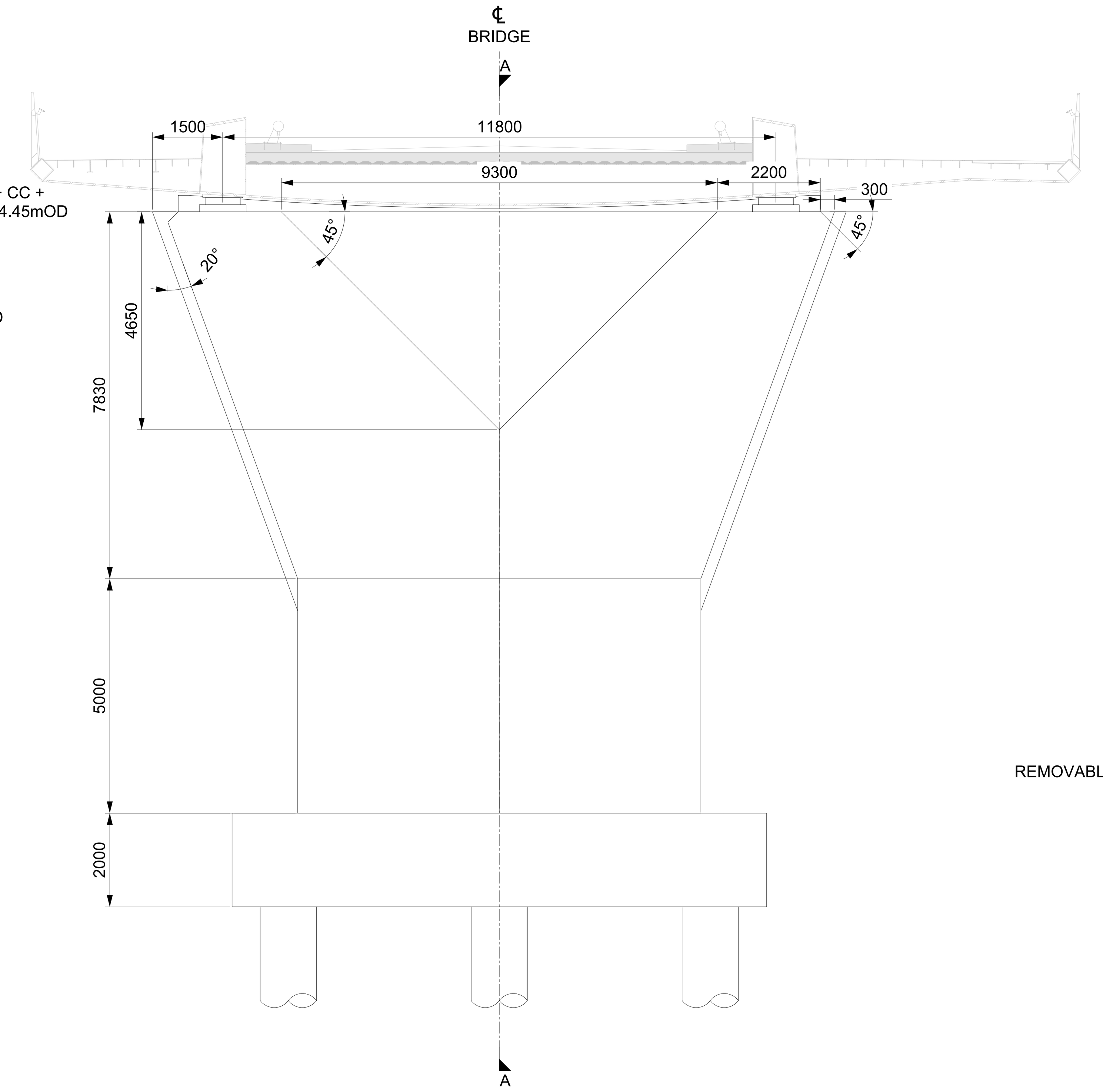
ELEVATION ON PIER TOP FROM NORTH
OTHER DETAILS SIMILAR TO SOUTH FACE



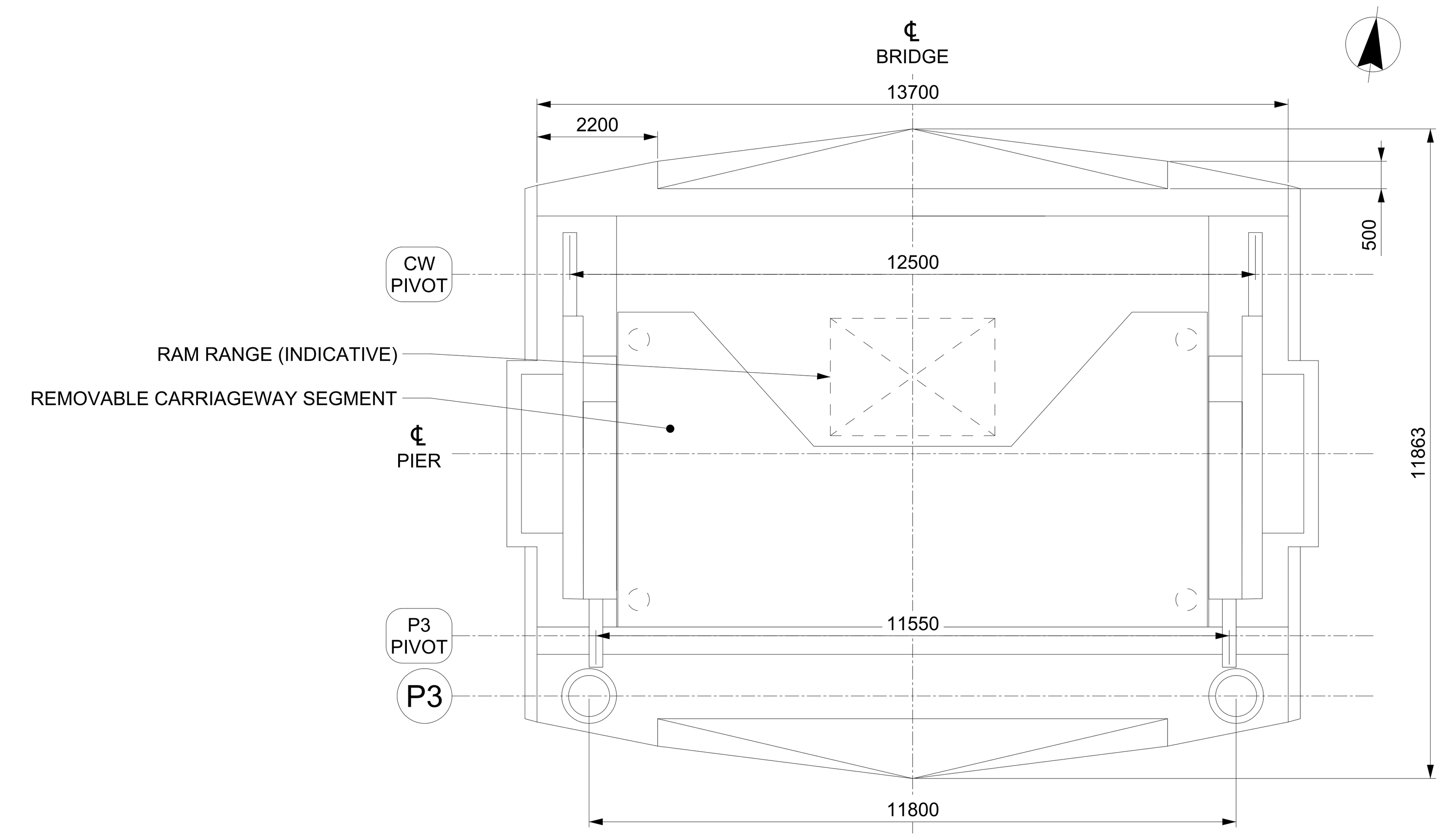
SOFFIT PLAN ON REMOVABLE CARRIAGEWAY SEGMENT



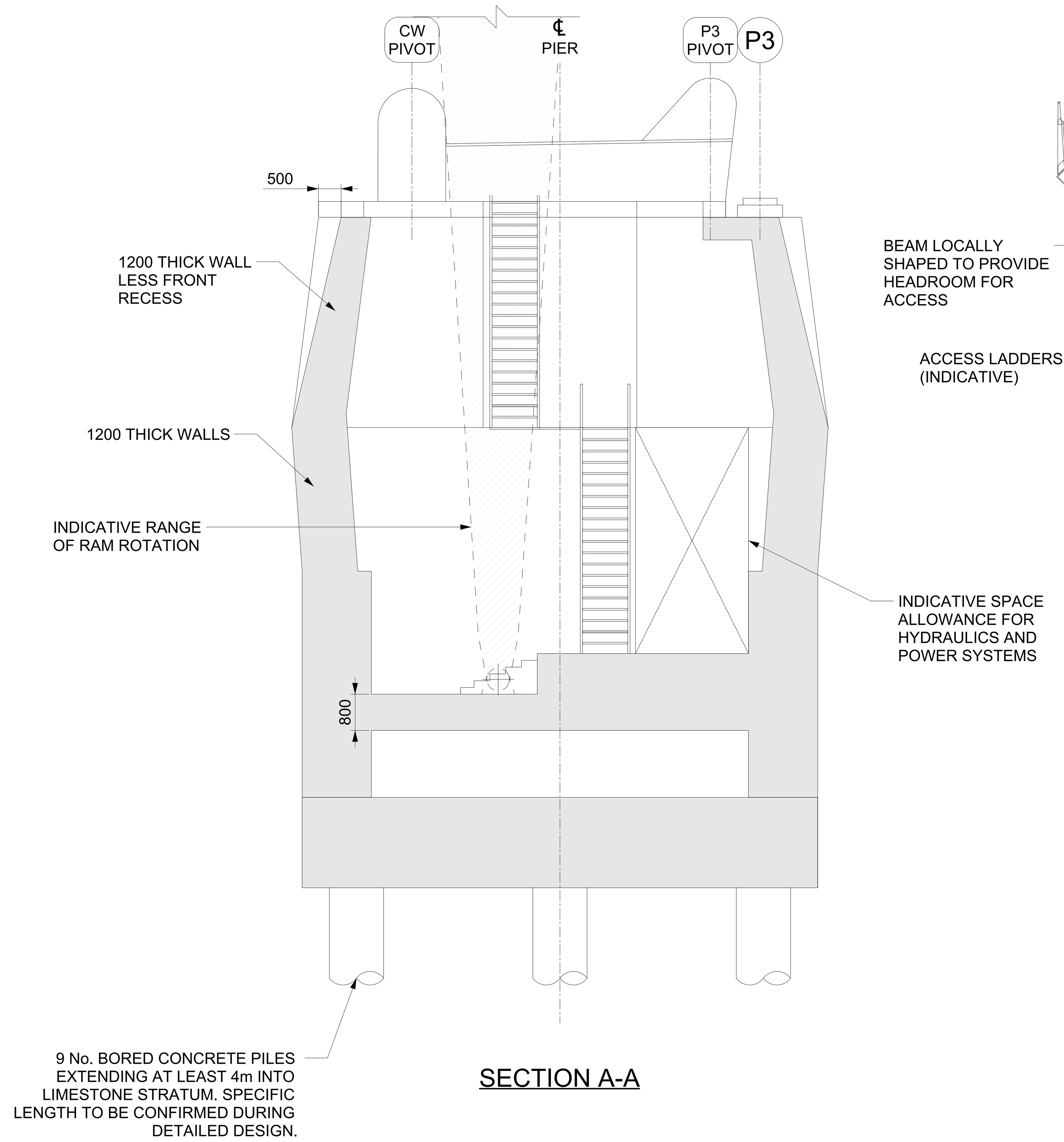
ELEVATION FROM WEST
ACTIVE TRAVEL PATHS OMITTED



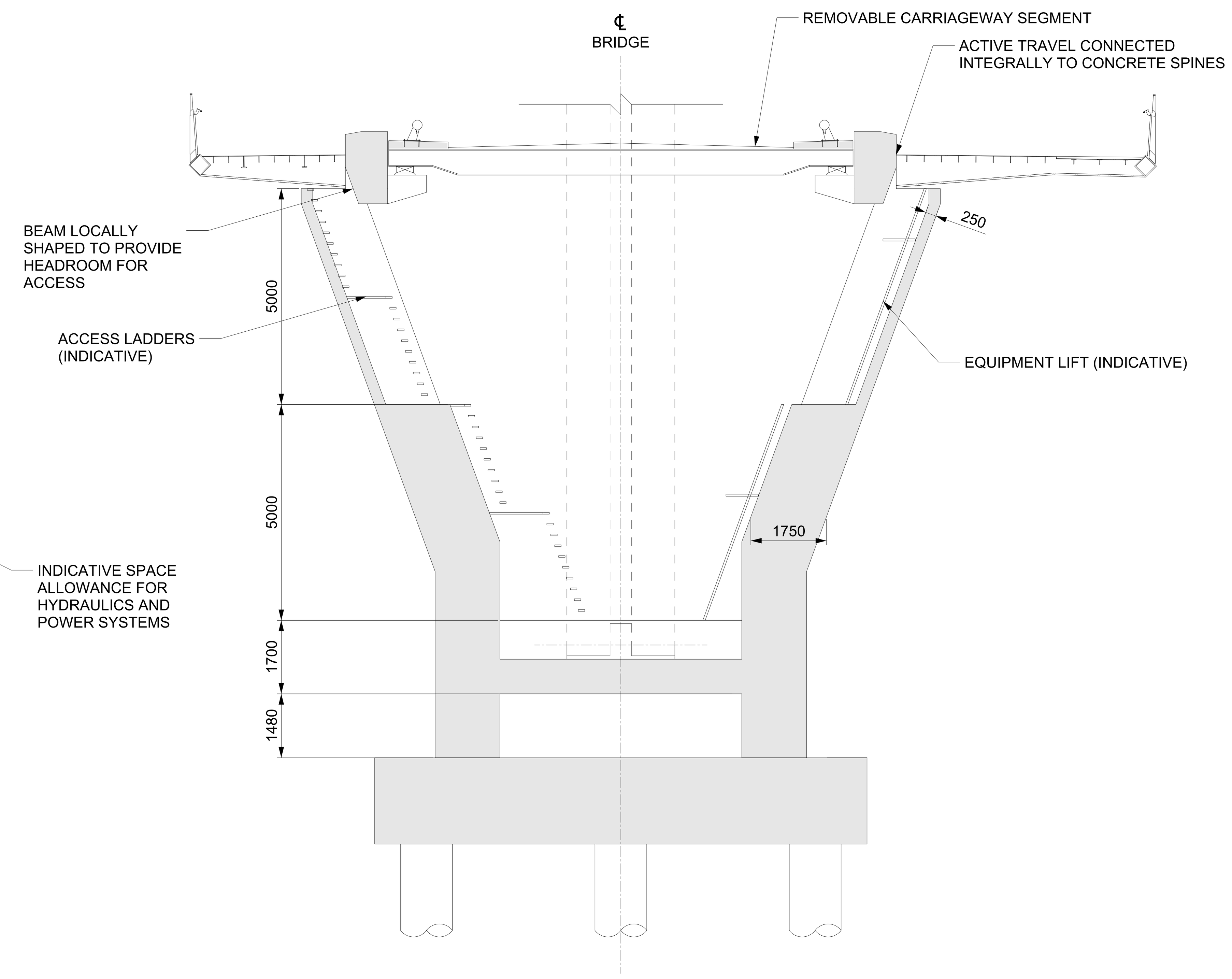
ELEVATION FROM SOUTH



PLAN ON PIER TOP



SECTION A-A



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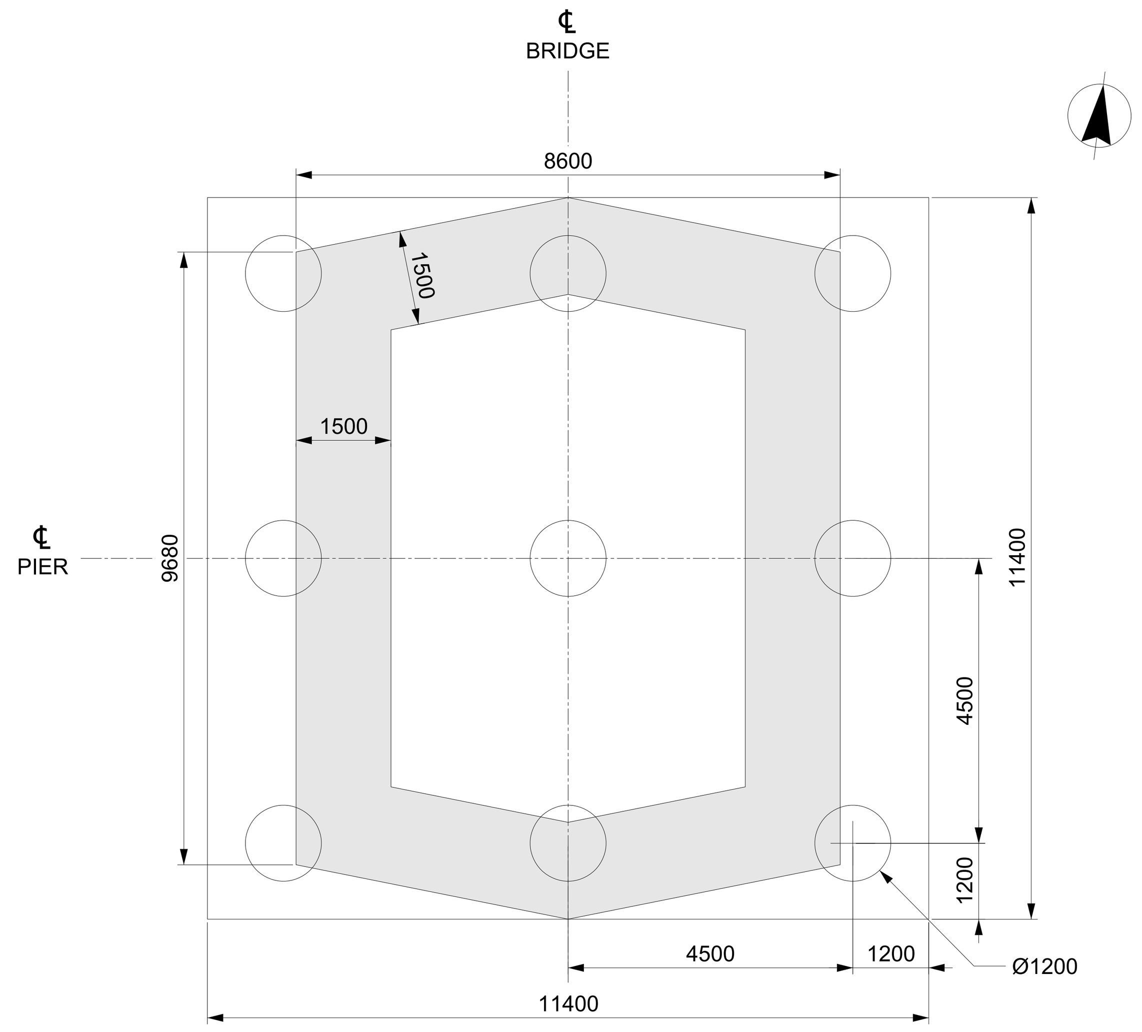

PLAN ON PIER STEM AND PILECAP

NOTES

1. These drawings shall be read in conjunction with the Preliminary Design Report, CP1901_3FM-COWI-SBR-SP-RP-S-00002.

2. Refer to drawing CP1901_3FM-MOXON-SBR-SP-DR-A-00005 for location of pier.

3. Structural concrete grade C40/50, to be confirmed at detailed design.

4. Pier heights to ensure sufficient ground cover of pile caps. River bed scour protection details to be confirmed at detailed design.

5. Pile depths to be confirmed after detailed ground investigations have been conducted at pier locations.

6. Access arrangements and provision for mechanical and electrical systems are shown indicatively and shall be reviewed at detailed design.

rev	amendments	check	date
2	Revised for Planning Comments	OLSS	28/06/24
1	Revised for Stage Approval	OLSS	19/04/24
0	First Issue	OLSS	07/11/23

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COMHLACHT CHALAFORT ÁTHA CLIATH
DUBLIN PORT COMPANY

Project
3FMProject Bringing Dublin Port To 2040

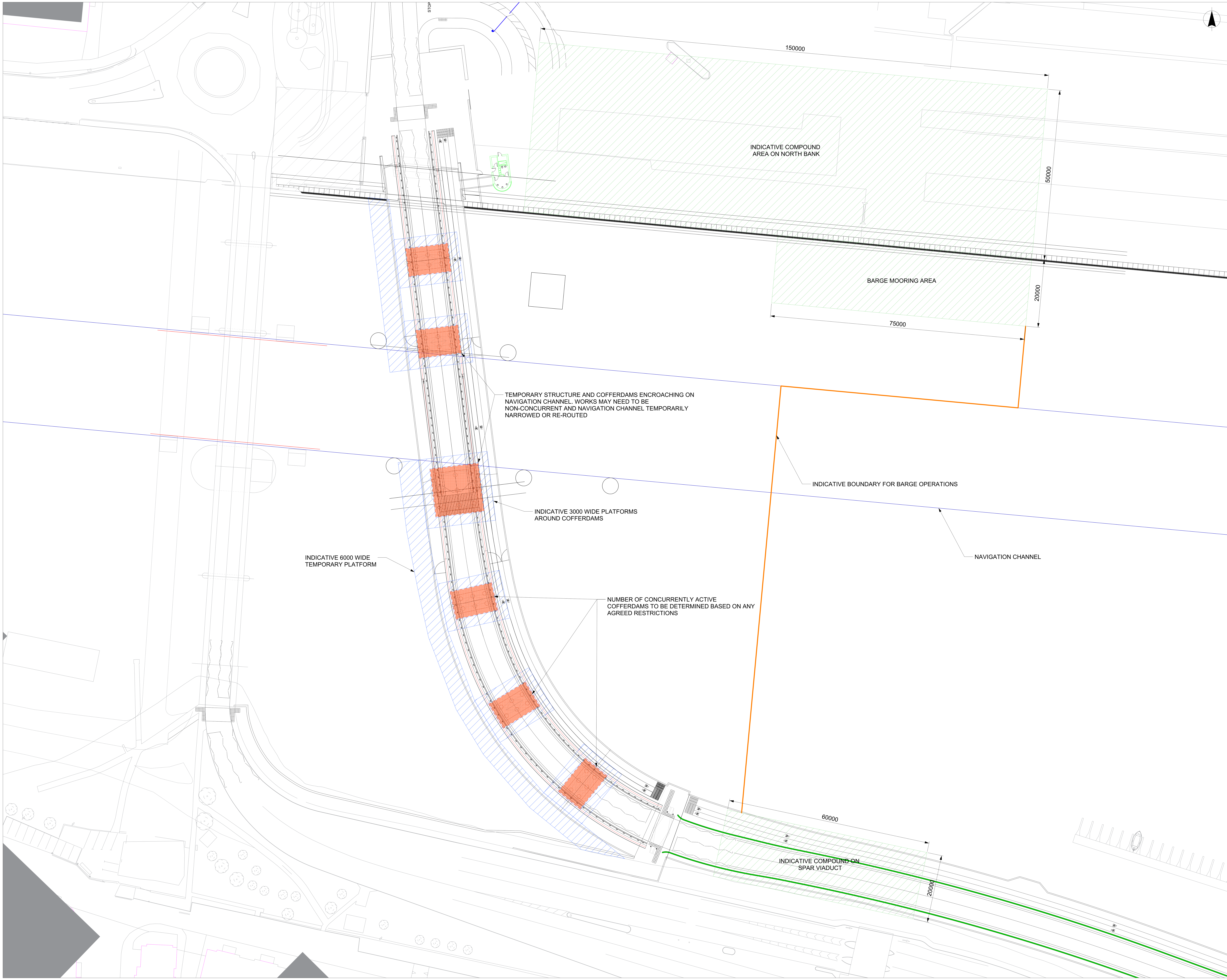
Title
SPAR Bridge
Pier 3 (Machine Pier)
Concrete Outline

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	1:100

Drawing Number
COWI-SBR-SP-DR-S-100-00410

Drawn By	Status	Revision
C. Fleming	S4	2

Checked By	Approved By	Date
O. Stross	O. Stross	28/06/2024



NOTES

1. These drawings shall be read in conjunction with the Preliminary Design Report, CP1901_3FM-COWI-SBR-SP-RP-S-00002

rev	amendments	check	date
1	Revised for Planning Comments	OLSS	28/06/24
0	First Issue	OLSS	11/06/24

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DUBLIN PORT COMPANY

Project

3FMProject Bringing Dublin Port To 2040

Title

SPAR Bridge
Temporary Works
Indicative General Arrangement

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	1:500

Drawing Number

COWI-SBR-SP-DR-S-100-00090

Drawn By	Status	Revision
C. Fleming	S4	1

Checked By	Approved By	Date
O. Stross	O. Stross	28/06/2024

NOTES

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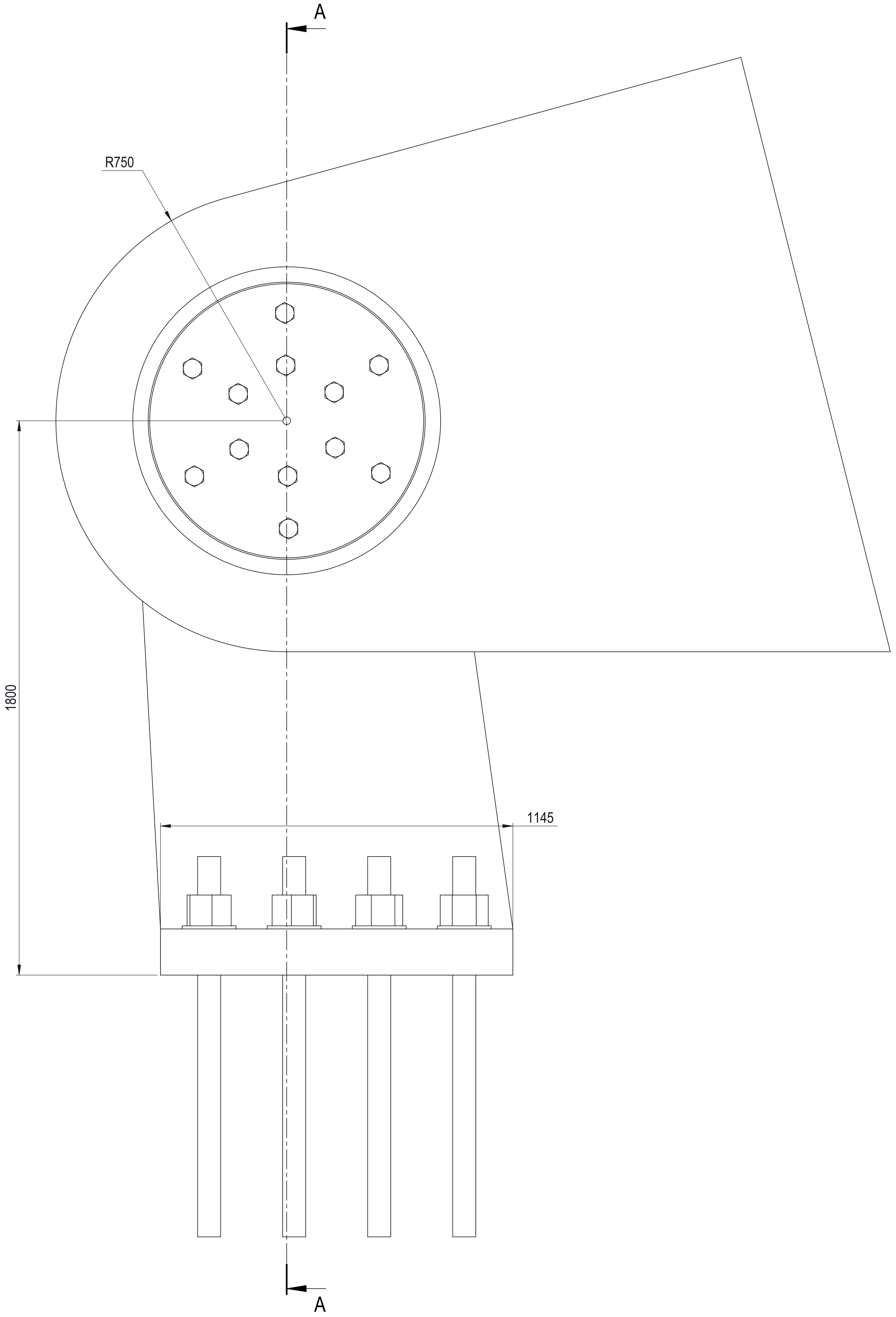
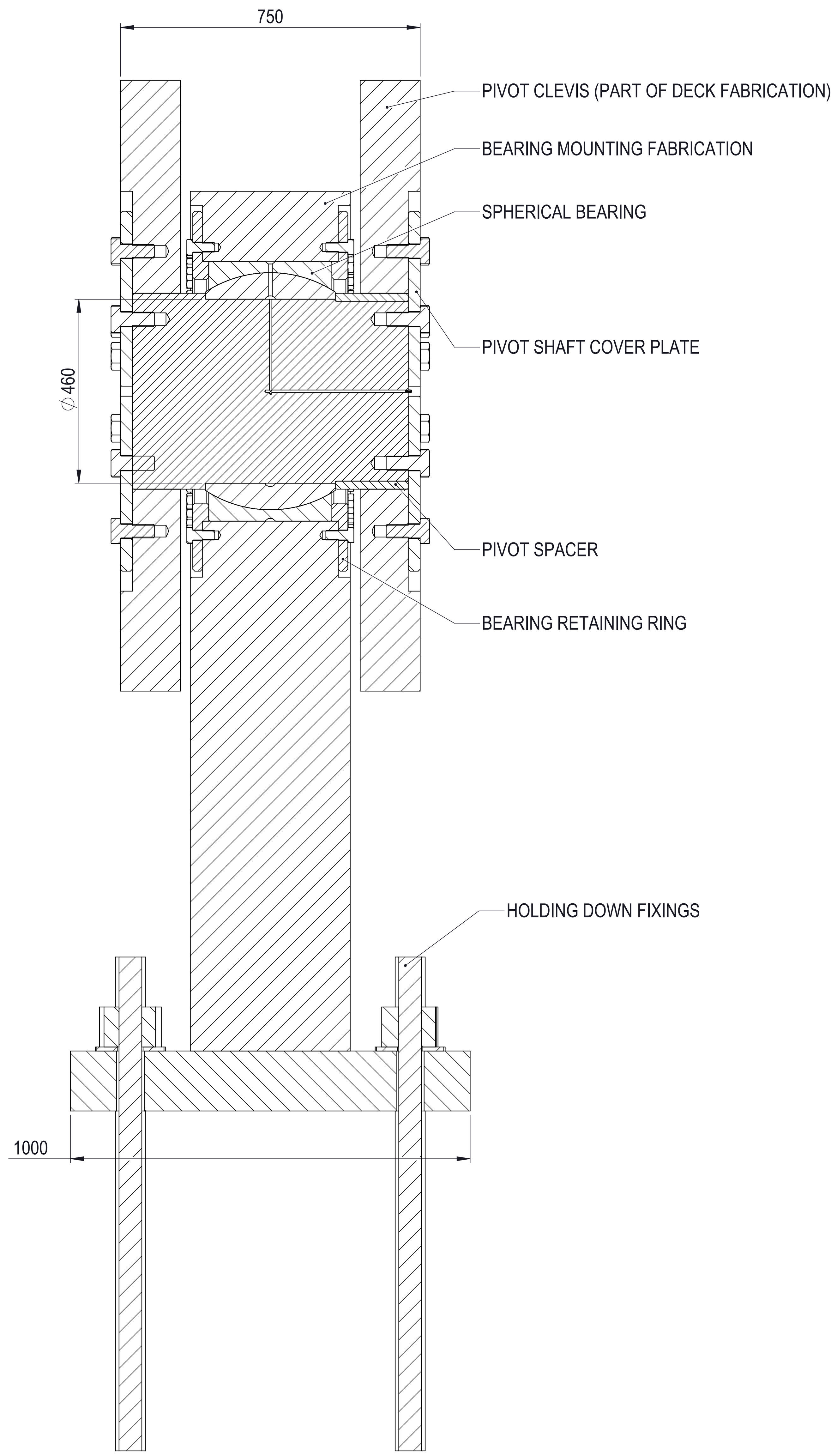
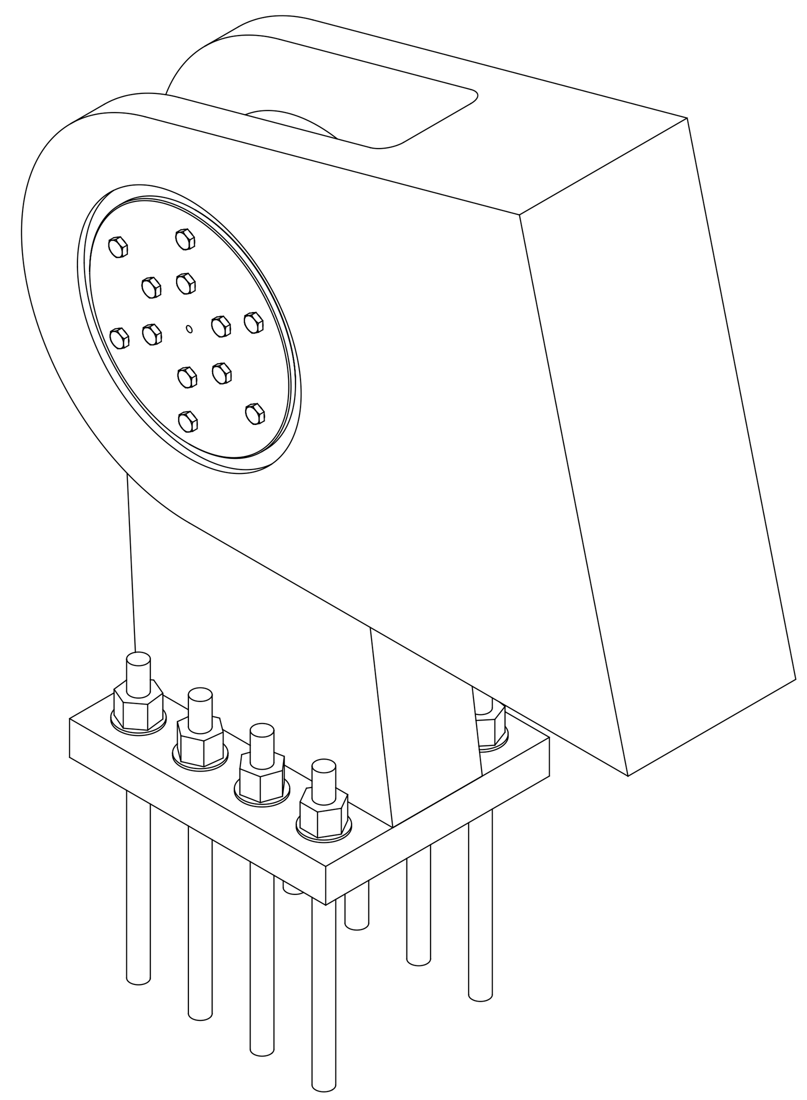
2. DIMENSIONS ARE INDICATIVE AND REQUIRE FURTHER VERIFICATION.

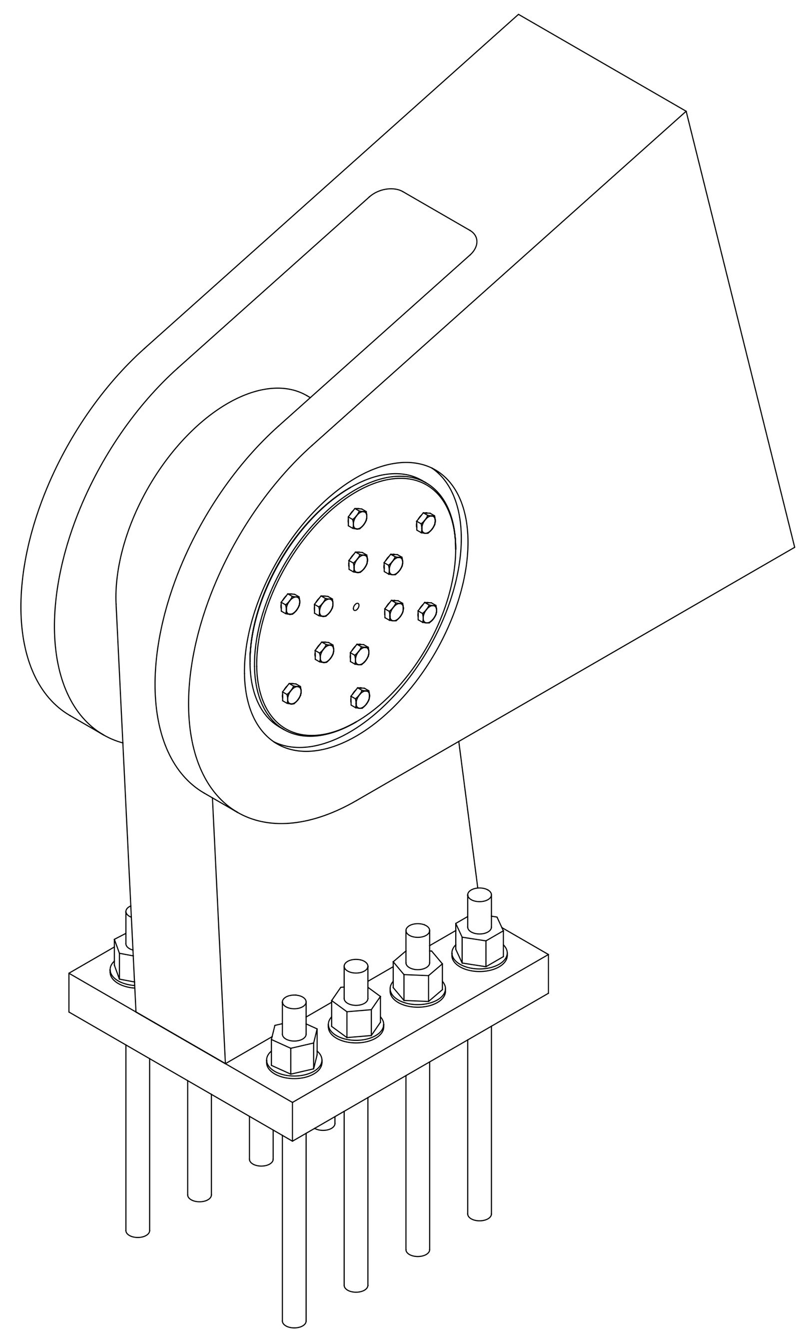
3. NOT FOR MANUFACTURE.





SECTION A-A





rev	amendments	check	date

AMP Technology Centre
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Client

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DUBLIN PORT COMPANY

Project

3FMProject Bringing Dublin Port To 2040

Title

SPAR Bridge
Deck Pivot Assembly

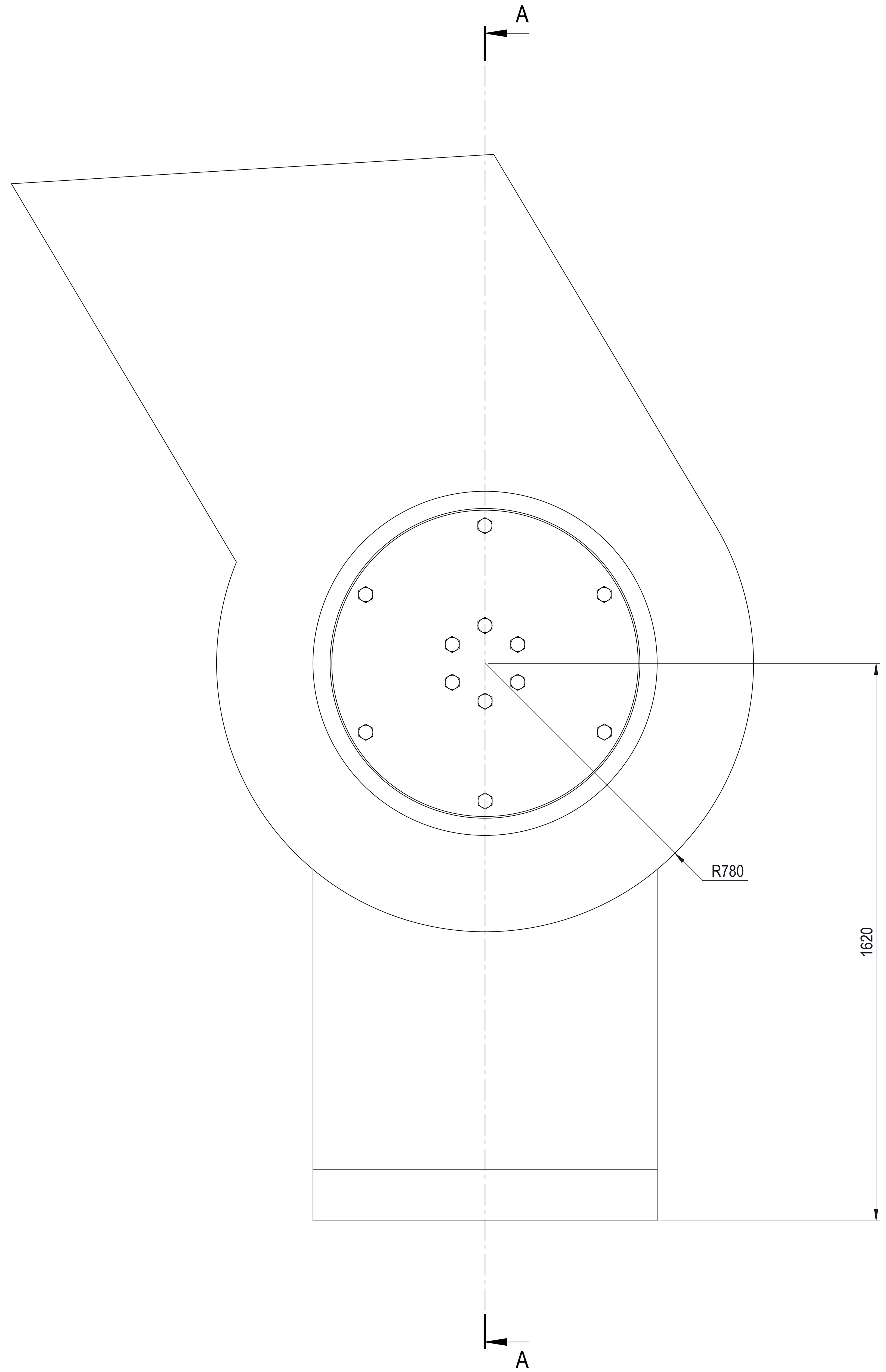
Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	1:10

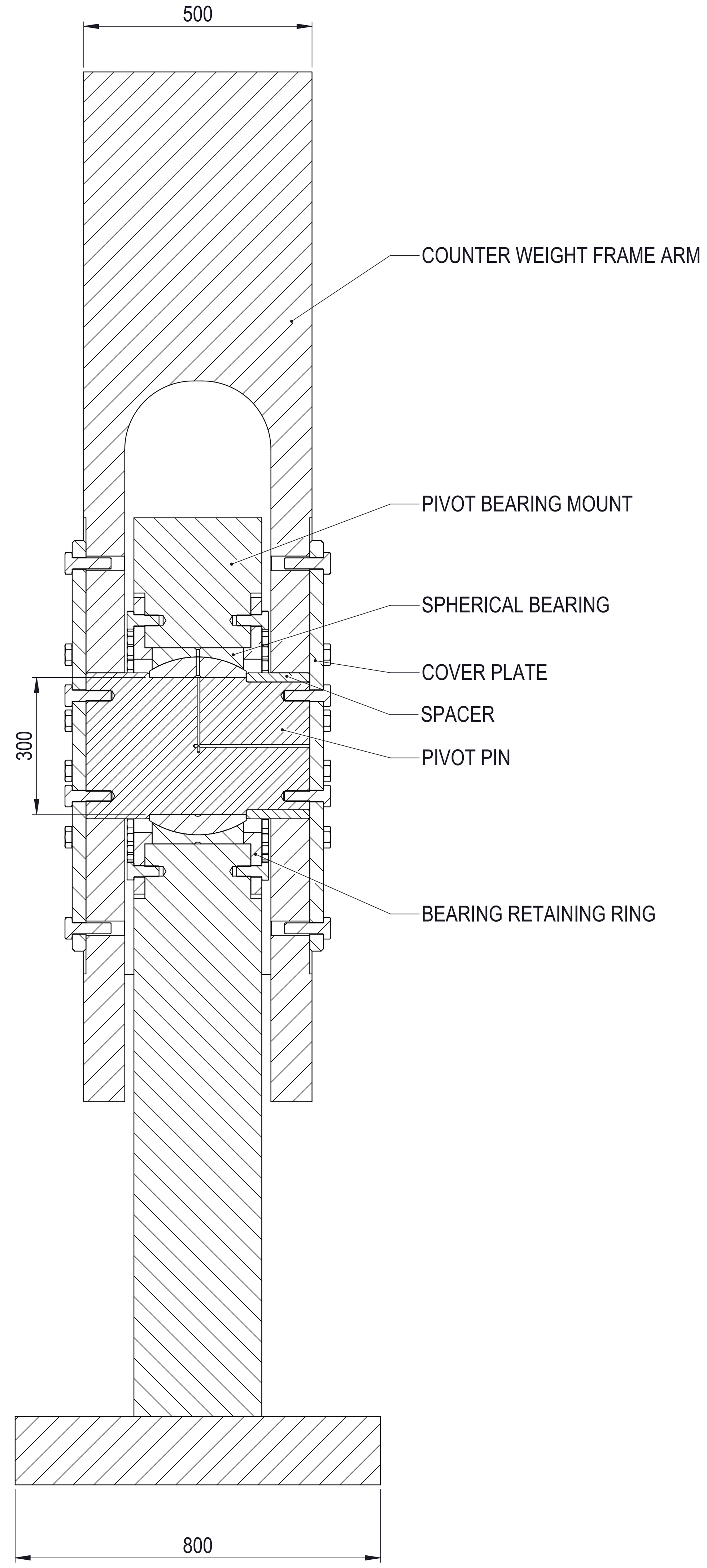
Drawing Number

EADON-SBR-SP-DR-M-100-00050

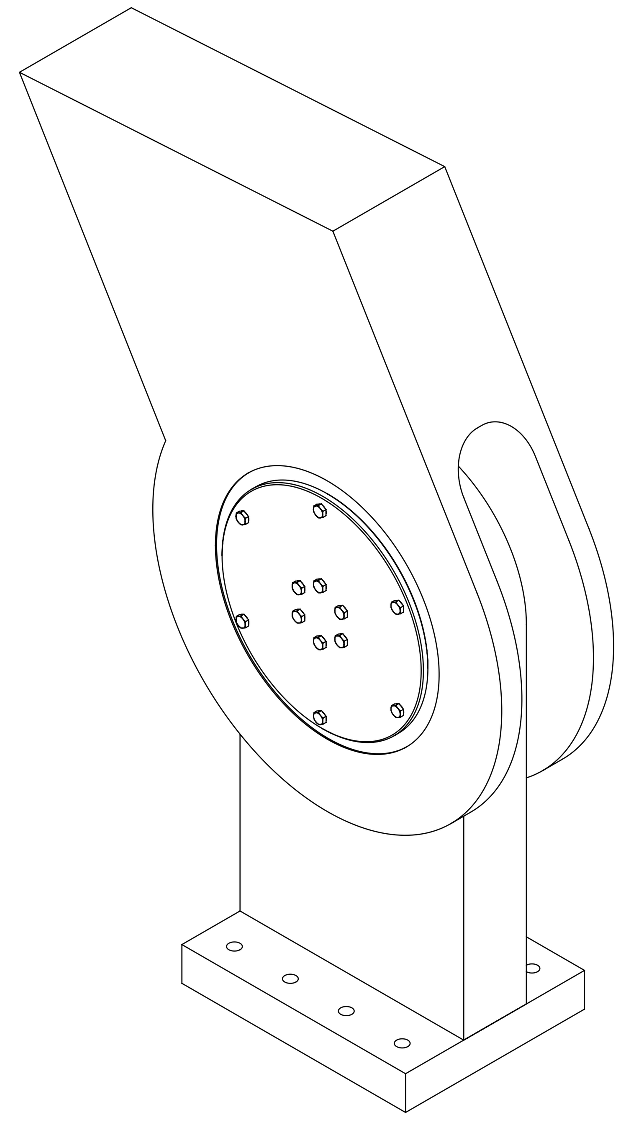
Drawn By	Status	Revision
M. Thorogood	S4	1

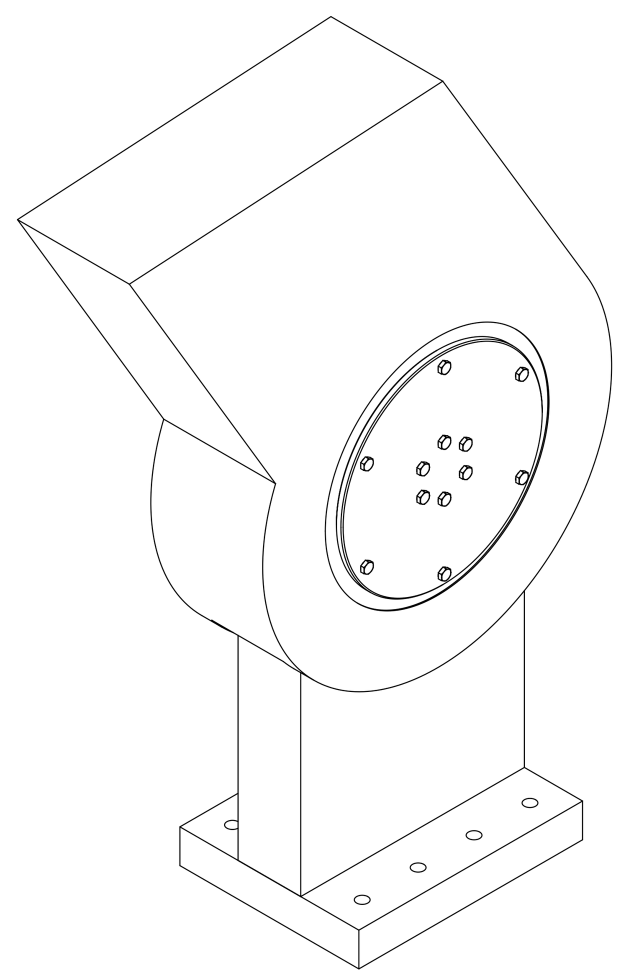
Checked By	Approved By	Date
C. Fleming	O. Stross	14/07/2023





SECTION A-A





NOTES

1. OUTLINE DESIGN FOR PLANNING. FURTHER DESIGN DEVELOPMENT REQUIRED.

2. DIMENSIONS ARE INDICATIVE AND REQUIRE FURTHER VERIFICATION.

3. NOT FOR MANUFACTURE.

rev	amendments	check	date

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Client

COMHLACHT CHALAFORT ÁTHA CLIATH
DUBLIN PORT COMPANY

Project

3FMProject Bringing Dublin Port To 2040

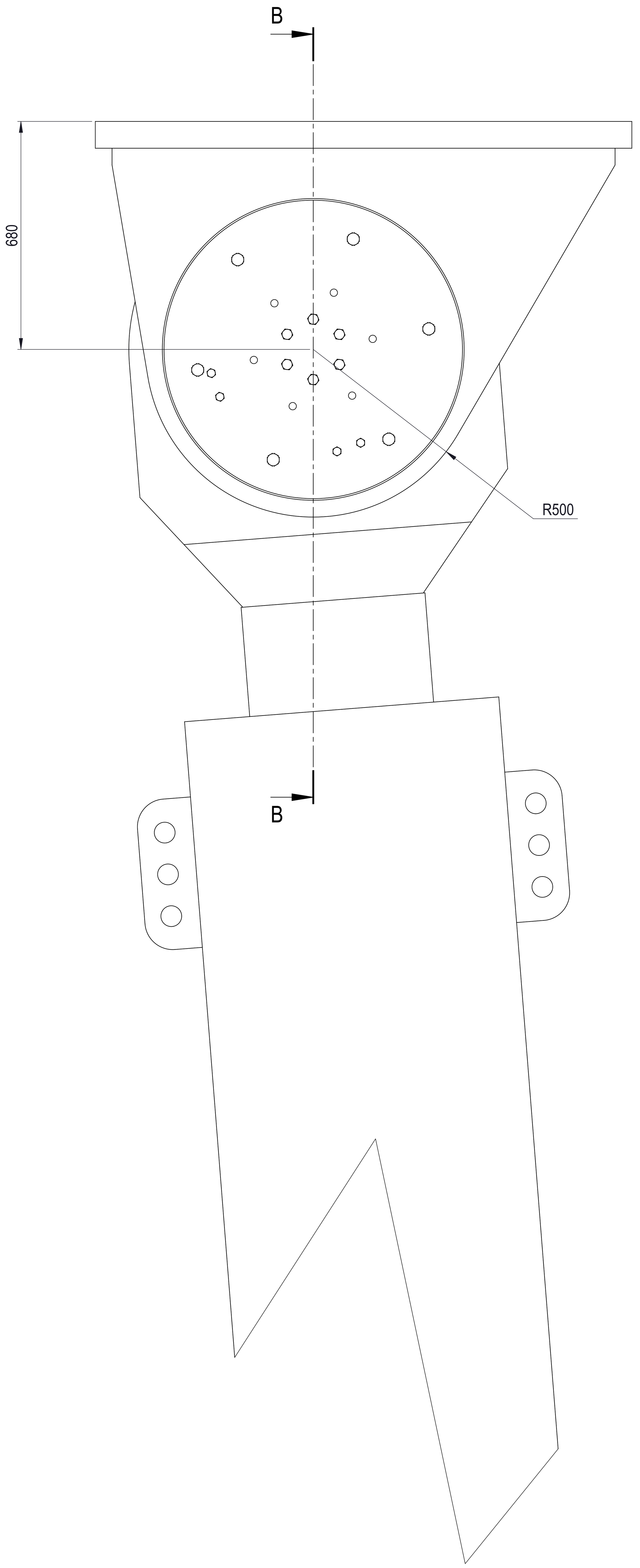
Title
SPAR Bridge
Counterweight Pivots

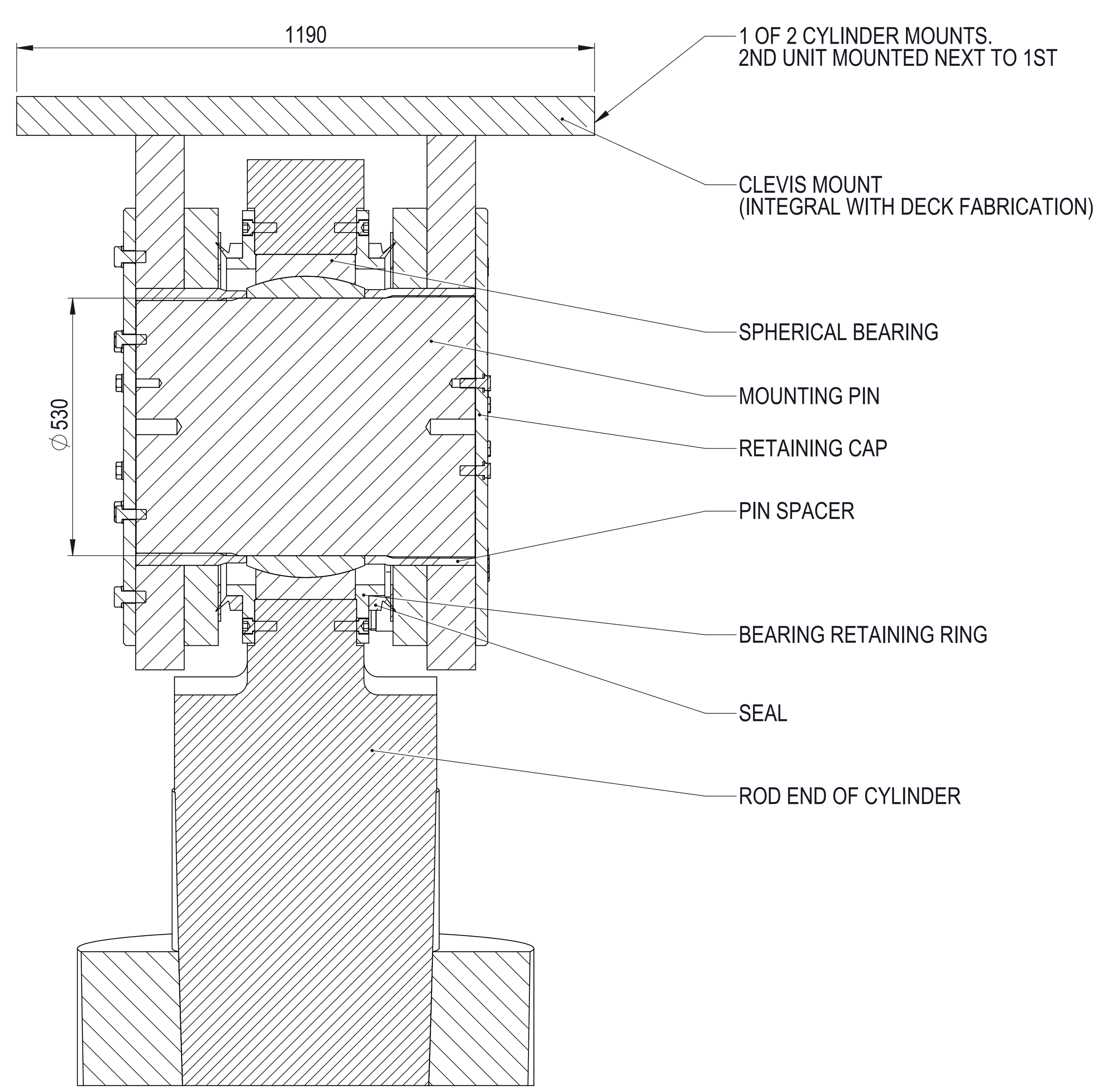
Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	1:500

Drawing Number
EADON-SBR-SP-DR-M-100-00051

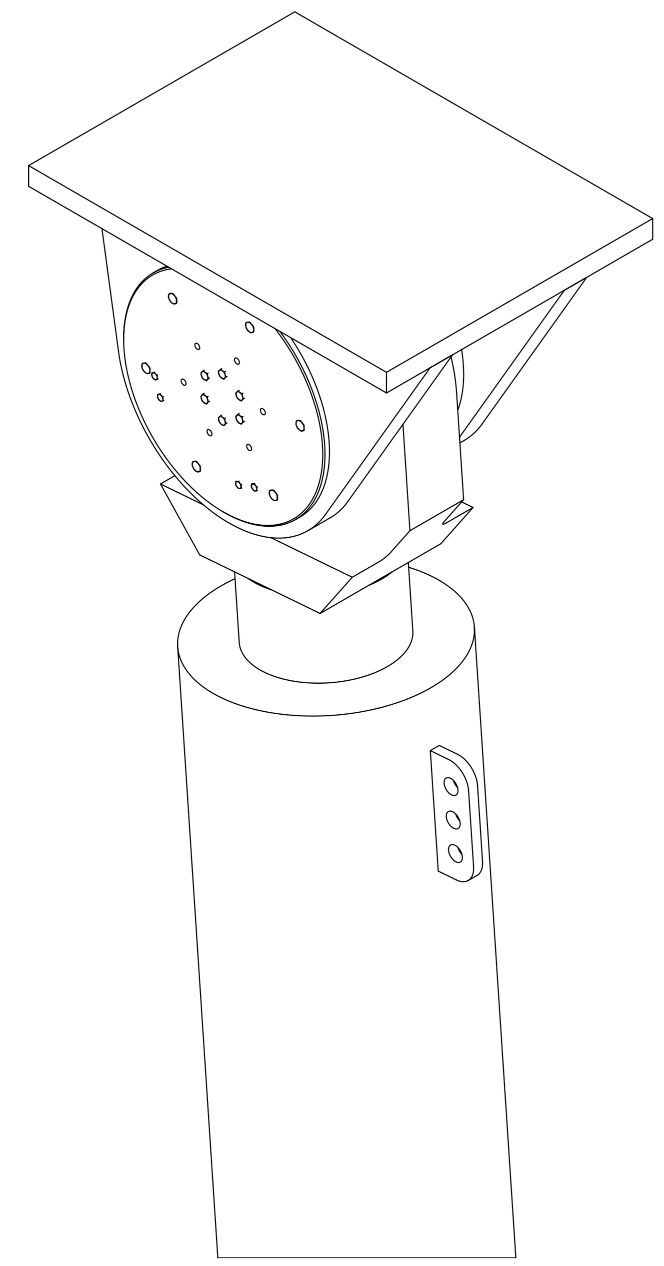
Drawn By	Status	Revision
M. Thorogood	S4	1

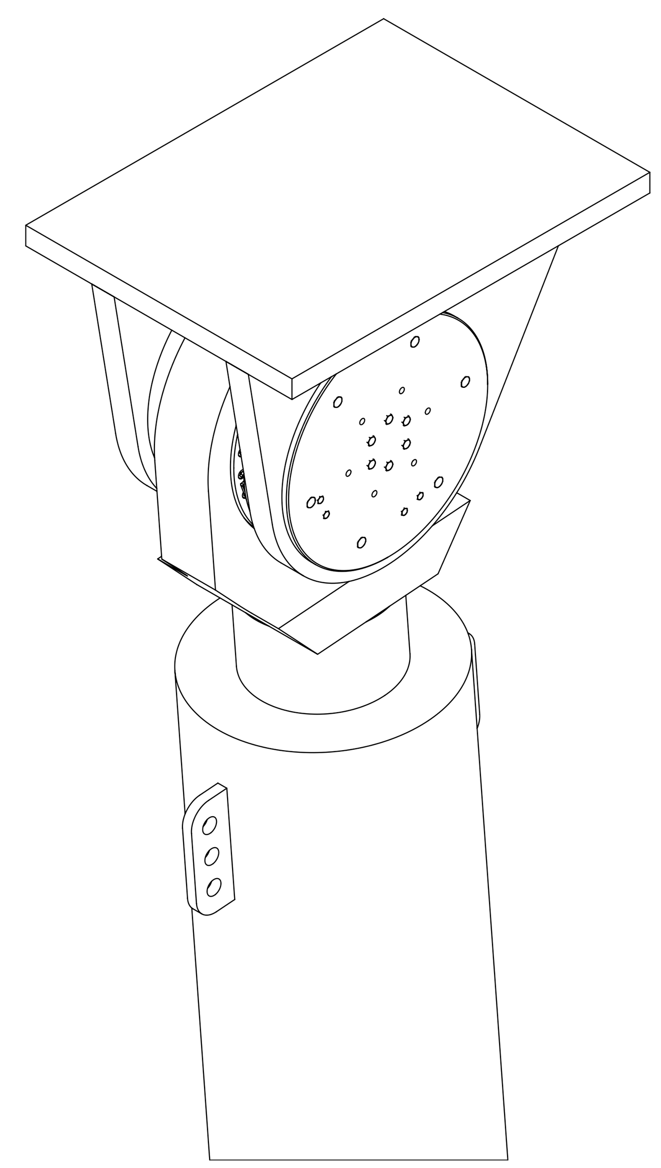
Checked By	Approved By	Date
C. Fleming	O. Stross	14/07/2023





SECTION B-B





NOTES

1. OUTLINE DESIGN FOR PLANNING. FURTHER DESIGN DEVELOPMENT REQUIRED.

2. DIMENSIONS ARE INDICATIVE AND REQUIRE FURTHER VERIFICATION.

3. NOT FOR MANUFACTURE.

rev	amendments	check	date

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Client
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DUBLIN PORT COMPANY

Project
3FMProject Bringing Dublin Port To 2040

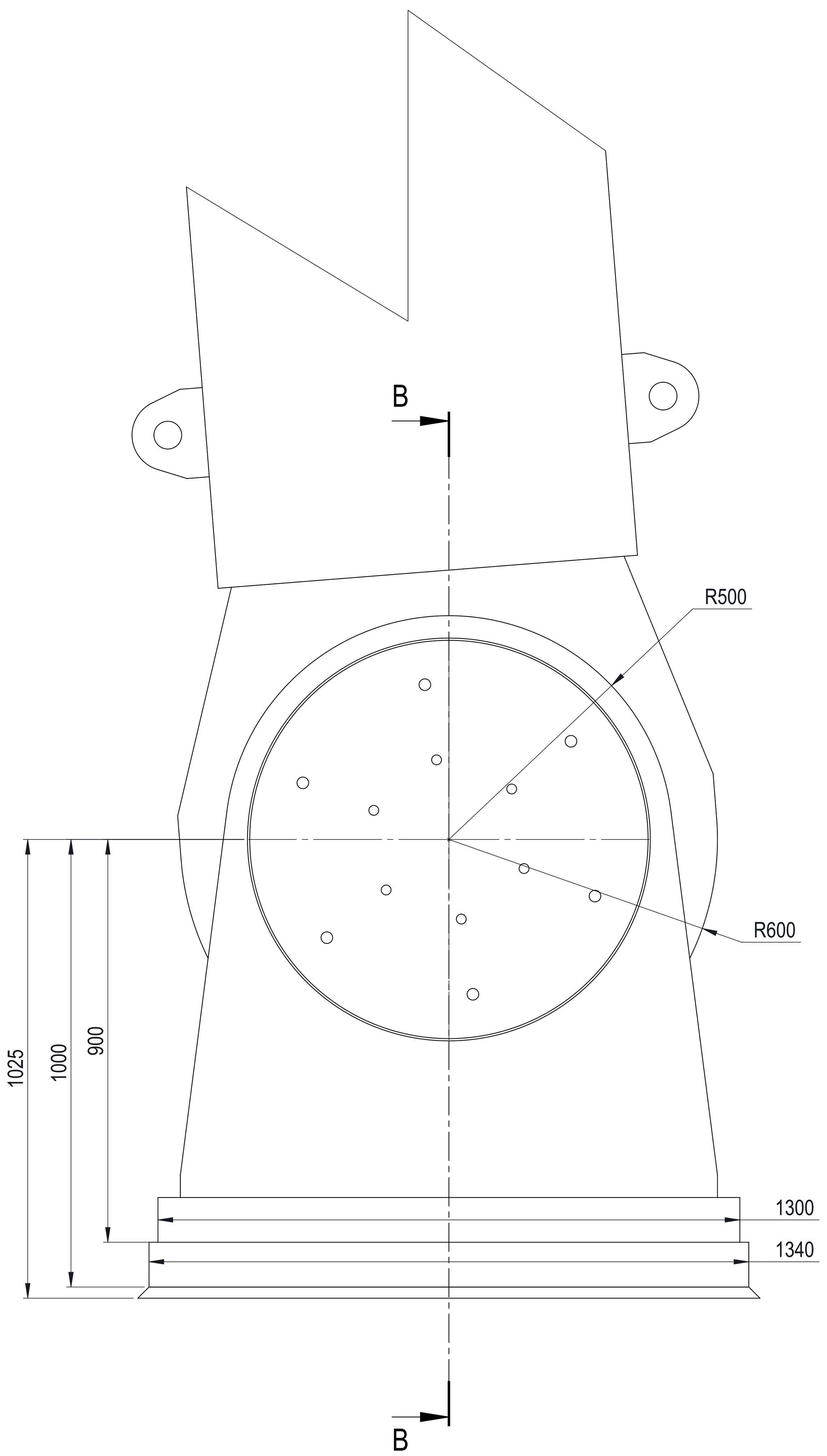
Title
SPAR Bridge
Upper Cylinder Mount

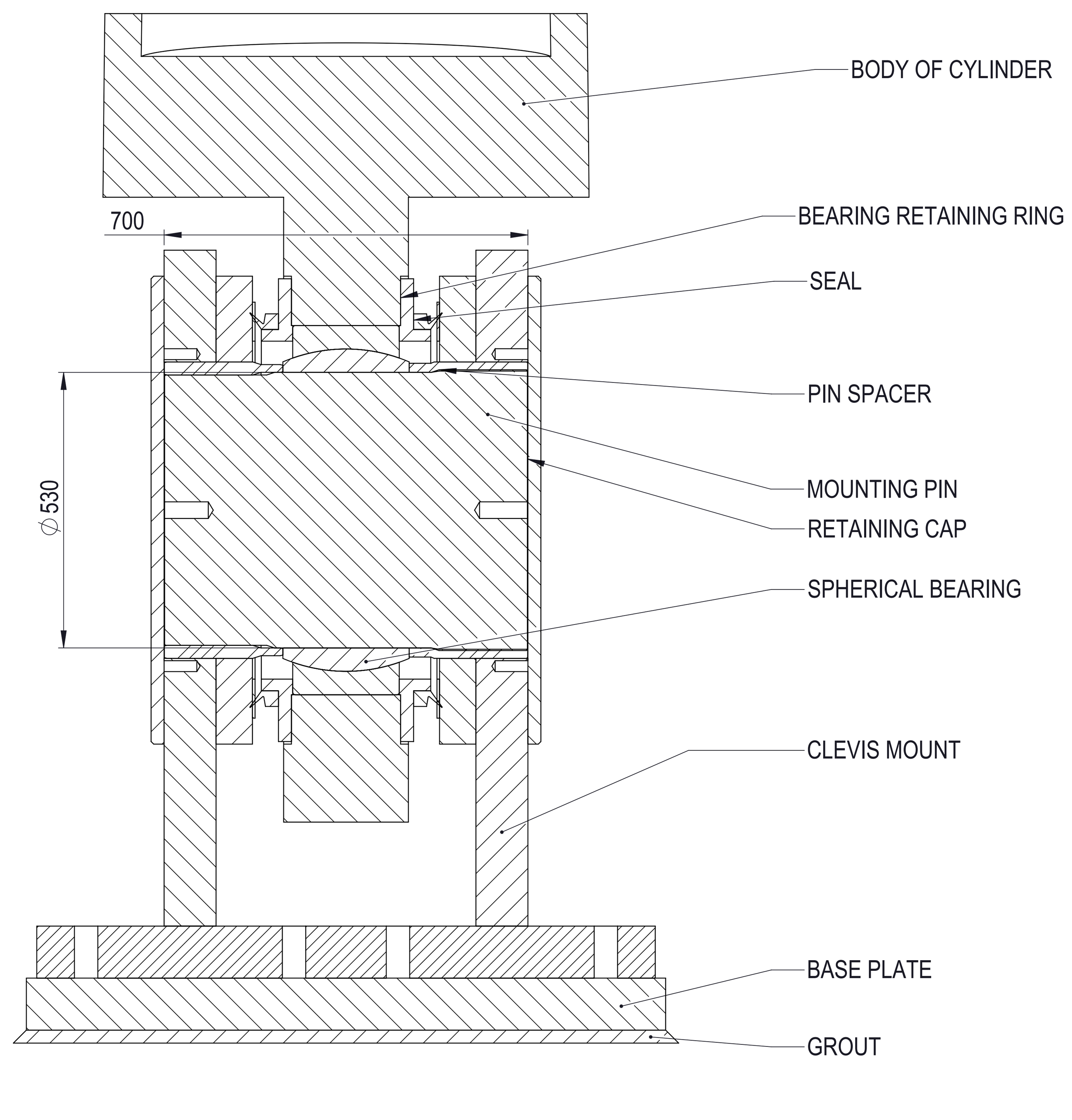
Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	1:20

Drawing Number
EADON-SBR-SP-DR-M-100-00052

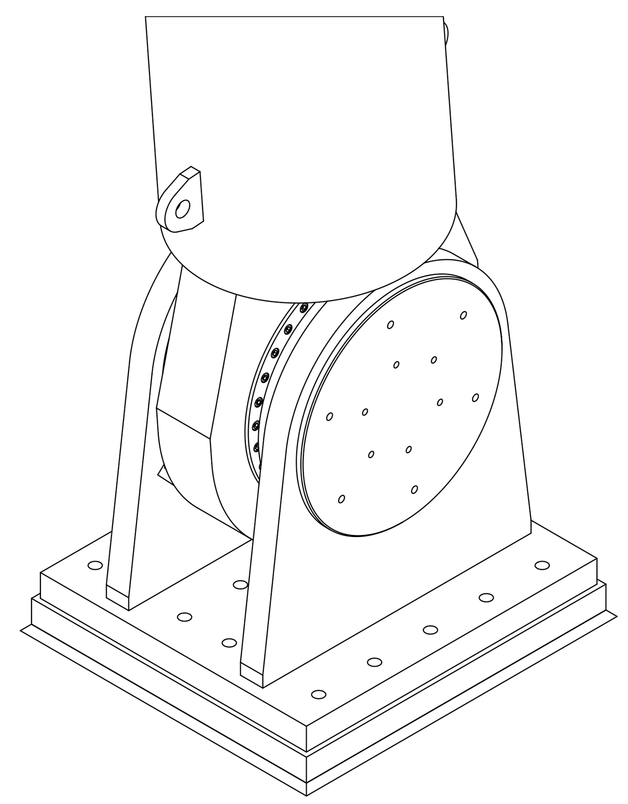
Drawn By	Status	Revision
M. Thorogood	S4	1

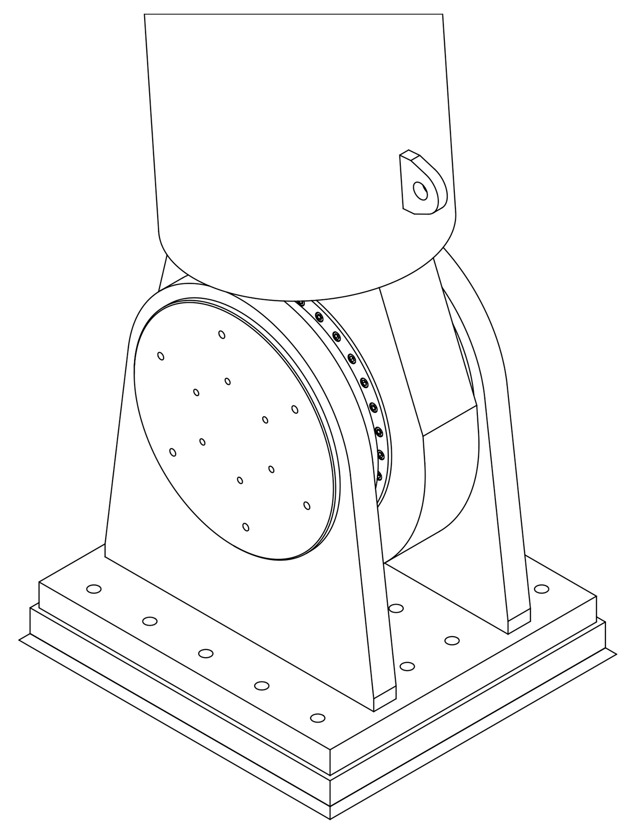
Checked By	Approved By	Date
C. Fleming	O. Stross	25/05/2023





SECTION B-B





NOTES

1. OUTLINE DESIGN FOR PLANNING. FURTHER DESIGN DEVELOPMENT REQUIRED.

2. DIMENSIONS ARE INDICATIVE AND REQUIRE FURTHER VERIFICATION.

3. NOT FOR MANUFACTURE.

rev	amendments	check	date

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Client

COMHLACHT CHALAFORT ÁTHA CLIATH
DUBLIN PORT COMPANY

Project

3FMProject Bringing Dublin Port To 2040

Title

SPAR Bridge
Lower Cylinder Mount

Project Number	Sheet Size	Drawing Scale
CP1901_3FM	A1	1:20

Drawing Number
EADON-SBR-SP-DR-M-100-00053

Drawn By	Status	Revision
M. Thorogood	S4	1

Checked By	Approved By	Date
C. Fleming	O. Stross	14/07/2023

Appendix B Geotechnical Asset Summary Sheet

SUBJECT
SPAR Bridge

DOCUMENT NO.

ASSET SUMMARY SHEET

SECTION 1 - ASSET INFORMATION

1:1 Bridge Type
6 span bridge, articulated at each pier and fixed at one abutment end.

1:2 Location
Dublin Port, east of Tom Clark Bridge

1:3: Local GI Plan
Refer to Figure 1 for Ground Investigation Plan.

1.4:Relevant borehole information
The following boreholes were considered to determine the stratigraphy and properties of the ground at this asset.

Borehole ID	Maximum Depth of Borehole (mbgl)	Distance from Asset (m)
BH-B01	28.60	0
BH-B02	29.20	0

Geotechnical Interpretive Report, Dec 2019 by IGSL ltd consulted to derive the proposed ground model and geotechnical parameters at the bridge location.

The GI information provided in this report is based on the GI data available until 16th of March 2023. Additional GI data will be required to proceed with the detailed design in order to validate the assumption made at this stage. COWI has endeavoured to assess all information provided to them during this assessment but makes no guarantees or warranties as to the accuracy or completeness of this information.

1.5: Published Geology
Refer to Figure 2.1 to 2.4 for local annotated geology and geological cross section.

SECTION 2: GROUND MODEL

2.1: Design Ground Model - Machinery Pier (BH-B01)

A summary of the local ground conditions is presented in the table below.

Geological Unit	Design Level - Top of Stratum (mAOD)	Design Thickness (m)
Very soft back sandy silty **CLAY** (ESTUARINE DEPOSITS)	-2.06	5.20
Stiff to very stiffdark grey sandy gravelly **CLAY** (ESTUARINE DEPOSITS)	-7.26	5.70
Stiff grey sandy gravelly **CLAY** (PORT CLAY)	-12.96	0.80
Very dense dark grey sandy clayey **GRAVEL** (GLACIAL DEPOSITS)	-13.76	3.15
Medium Strong to Strong black **LIMESTONE**	-16.91	13.75 (not proven)

Notes:
Most of the Estuarine Deposits consists of sandy silty or gravelly CLAYs.
A small layers (less than 1.0m) of dense sandy gravelly GRAVEL found interbedded within the clay of the Estuarine Deposits
Very dense sandy Clayey GRAVEL (GLACIAL DEPOSITS) immediately above the LIMESTONE

2.2: Design Ground Model - Typical Approach Pier South (BH-B02)

A summary of the local ground conditions is presented in the table below.

Geological Unit	Design Level - Top of Stratum (mAOD)	Design Thickness (m)	
Very soft back sandy silty **CLAY** (ESTUARINE DEPOSITS)	0.11	1.00	
Very soft back sandy clayey **SILT** (ESTUARINE DEPOSITS)	-0.89	3.50	
Very soft back sandy silty **CLAY** (ESTUARINE DEPOSITS)	-4.39	2.40	
Stiff to very stiff grey sandy gravelly **CLAY** (ESTUARINE DEPOSITS	-6.79	2.60	
Stiff grey sandy gravelly **CLAY** (PORT CLAY)	-9.39	0.50	
Very dense dark grey sandy clayey **GRAVEL** (GLACIAL DEPOSITS)	-9.89	7.22	Approx. 1.5m of Glacial Clay interbedded. Approx 1.22m of core loss, probably sand from the Glacia
Medium Strong to Strong black **LIMESTONE**	-17.11	11.98 (not proven)	

Notes:
Most of the Estuarine Deposits consists of sandy silty or gravelly CLAYs.
A small layer (less than 1.0m) of dense sandy gravelly GRAVEL found interbedded within the clay of the Estuarine Deposits
Glacial Deposits were mainly GRAVELs. However, they were interbedded layers of very stiff sandy gravelly CLAY.
Very dense sandy Clayey GRAVEL (GLACIAL DEPOSITS) immediately above the LIMESTONE

2.2: Static Geotechnical Parameters

Laboratory test results are not available for BH-B01 and -B02. Hence, geotechnical soil parameters have been taken from the Geotechnical Interpretative Report for Dodder Public Transportation Opening Bridge (Dec 2019)

SPT plots are from BH-B01 and -B02

These parameters are unfactored.

Geological Unit	γ		φ'		c'	c_u	E'	Eu	E_h/E_v	Cv	UCS	v_u	v	PI	SPT N
	Above Water Level	Below Water Level	ϕ'_p	ϕ'_{cv}											
	kN/m^3	kN/m^3	°	°	kPa	kPa	MPa	MPa	-	m^2/yr	Mpa	-	-	%	-
Very soft CLAY (ESTUARINE DEPOSITS)	-	16 (1)	24 (4)	24 (4)	-	10 (7)	1.5 (8)	2.5 (8)		-	-	0.49	0.3	30 (assumed)	2
Stiff CLAY (ESTUARINE DEPOSITS)	-	16 (1)	24 (4)	24 (4)	-	10+71.6 Max 225kPa (7)	26.1 (8)	43.5 (8)		-	-	0.49	0.3	30 (assumed)	2+14z (max 44)
Stiff CLAY (PORT CLAY)	-	20 (2)	28 (5)	27 (5)	-	200 (7)	30 (8)	50 (8)		-	-	0.49	0.3	15	40
Very dense GRAVEL (GLACIAL DEPOSITS)	-	21 (3)	37 (6)	34 (6)	-	-	75 (9)	-		-	-	-	0.25	-	50
Medium Strong to Strong black LIMESTONE	-	26	36 (assumed)	36	5 (assumed)	-	1125 (11)	-	1	-	37.5 (10)	0.49	0.3	-	N/A

Notes:

1. Characteristic unit weight below groundwater table for low to medium Clay is based on BS 8002:2015 - Figure 2.
2. Characteristic unit weight below groundwater table for high Clay is based on BS 8002:2015 - Figure 2.
3. Characteristic unit weight below groundwater table for dense Sand and Gravels is based on BS 8002:2015 - Figure 2.
4. Assumed based on maximum assumed plasticity of 30%.
5. Section 4.3.1.4.8 of BS 8004:2015 gives ϕ'cv=27°, for PI=15. Section 4.3.1.4.10 of BS 8004:2015 gives ϕ'pk=28° (It is assumed OCR = 1, therefore ϕ'dil=1° is adopted). ϕ'pk=28° has been adopted as design value.
6. Section 4.3.1.3.11 of BS 8004:2015 gives ϕ'cv=34°, for ϕ'ang=4° gravel is sub-rounded to angular. Assuming Id = 50%, ϕ'dil=3°Section and this gives ϕ'pk=37° . ϕ'pk=37° has been adopted as design value.
7. Cu = SPT N * f2. F2 takes as 5 for PI of 15% and PI of 30%
8. Eu is based on relationship between Eu and Cu (after Jamiolkowski et al.). For PI=15-30, Eu/Cu=250. E'd is based on 0.6Eu. **Note that this correlation is based on the high strain level with that of spread foundations.**

9. E'd is based on 1.5N. **Note that this correlation is based on the high strain level with that of spread foundations.**
10. Based on the strength description from the borehole logs (CIRIA R181 - Piled foundations in weak rock - Figure 2.2), and assuming an medium strong rock, the Geological Society Classification (1970) suggests 15MPa<σc<50MPa. UCS tests for this material show values ranging 25MPa<σc<50MPa (Medium Strong BS ENB ISO 14689). A design value of UCS=37.5MPa has been adopted.
11. E'=j*Mr*σc, where j is a mass factor related to discontinuity spacing in the rock, Mr is the modulus ratio between the deformation modulus and unconfined compression strength of the intact rock and σc is the unconfined compression strength of the intact rock (CIRIA R181 - 6.1.3.c). For poor RQD=25-50, the a value j=0.2 has been adopted, (See CIRIA R181 - Piled foundations in weak rock - Table 2.5). A modulus ratio of 150 has been adopted forvery marly limestones (BS 8004 Table 4 - group 3 rock).

2.3: GROUNDWATER

The groundwater is assumed to be hydrostatic at max high tie level.

2.4: GEOHAZARDS AND OTHER RISKS

No desk study was available to the design team at this time. However, the following Geohazards and Risks have been identified for this asset:

Obstructions: The presence of boulder or obstruction in the estuarine deposits and glacial tills. Risk to pilling during construction.

Soft ground at shallow depth: Soft ground typically has low strength and high compressibility. Specific problems related with soft ground include excessive total and differential settlement between piers and negative skin friction in piled foundations. Where soft ground (cu < 40 kPa) is encountered, it should be assessed for negative skin friction on proposed piles.

Chemically aggressive ground: sulphates naturally occur in clay materials and glacial tills and other sediments as well as groundwater. There is a significant potential for chemical attack on concrete which is in contact with the ground. there is a high risk of sulphates/ sulphides present within the estuarine deposits and natural strata such as the glacial tills. Need for specific types of concrete and concrete mix suitable for the local ground conditions.

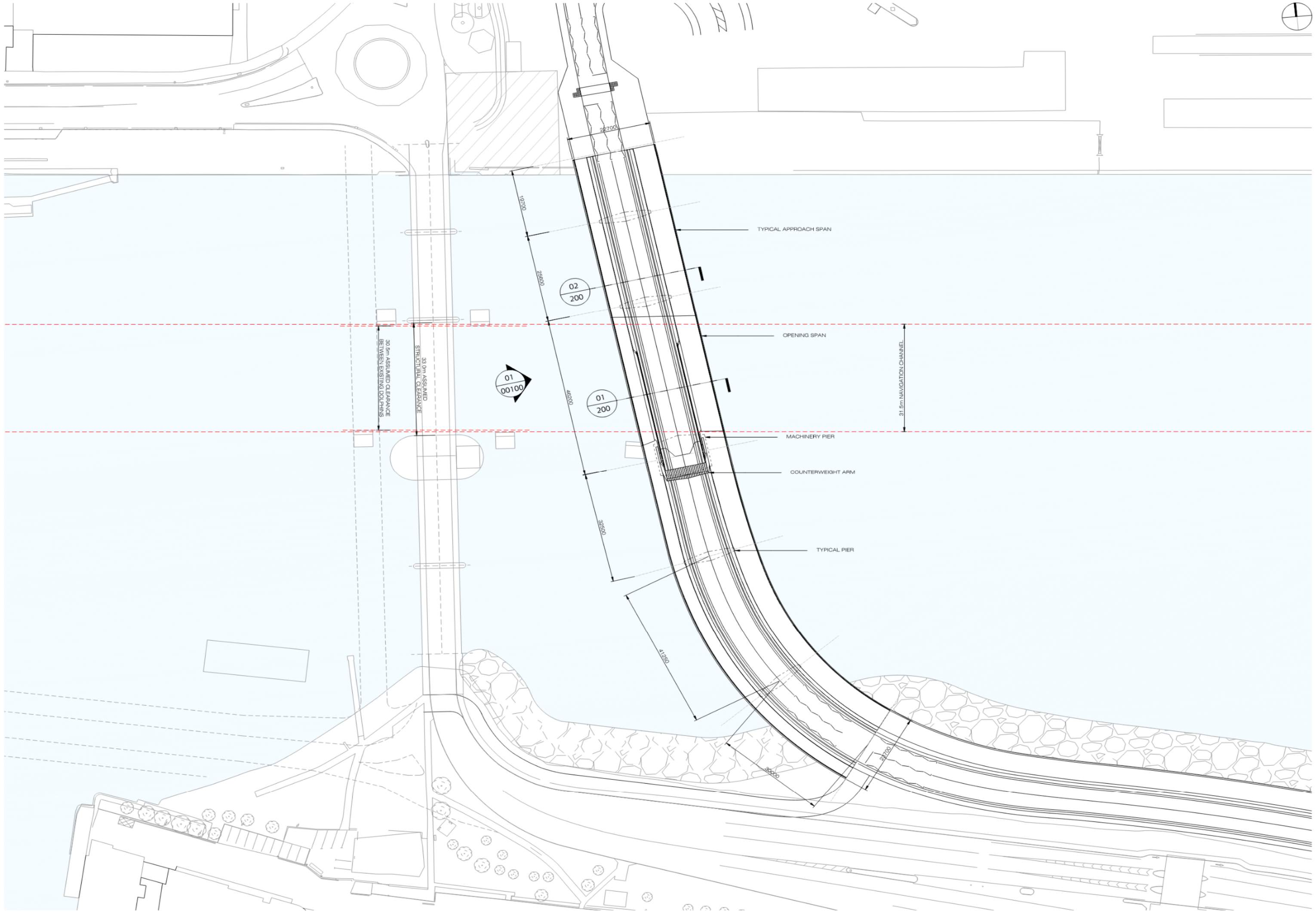
Obstructions (had stratum): The presence of medum strong LIMESTONE may provide problems during piling, unable to achieve the

2.5: ADDITIONAL GI

2No. Rotary core boreholes have been drilled at the location of the bridge to a depth of up to 30m. However, this GI data is incomplete and not all lab testing was provided to the design team at the time of writing this summary. Furthermore, addional GI shall be carried out at detailed design to develop the design. Once all GI data is available, the ground model and geotechnical soil parameters will be updated/reviewed and reported in the Geotechnical Design Report for the bridge.

COWI

Project	SPAR		
Asset No. & Name	SPAR Bridge		
Figure Title & No.	Figure 1 - Existing GI Location Map		
Section		Revision	1

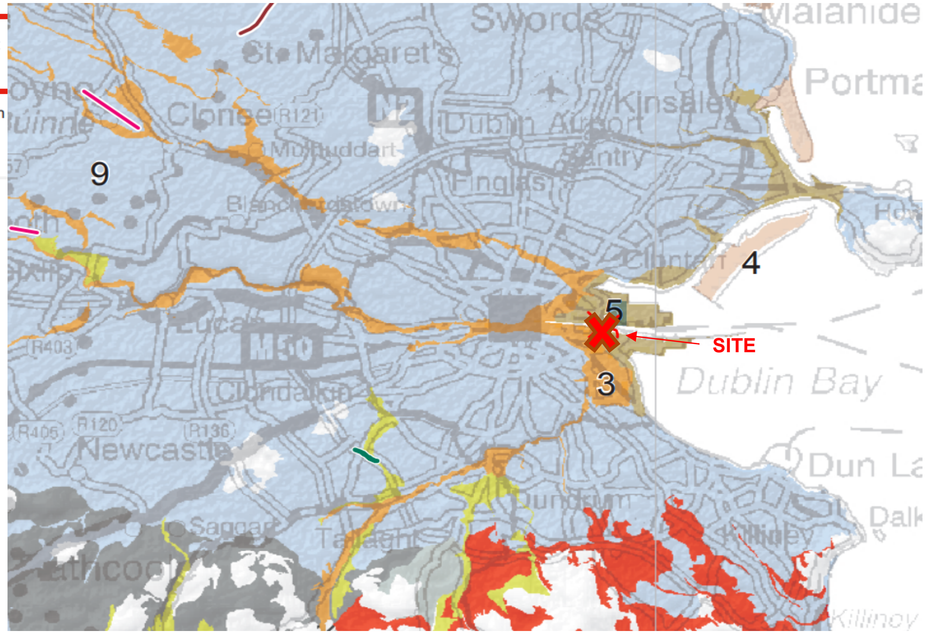


01 Bridge Plan
00005 SCALE 1:500@ A1

COWI

Project	**HS2 MWCC Phase One C2/C3**		
Asset No. & Name	SPAR Bridge		
Figure Title & No.	Figure 2.1- General Arrangement		
Section		Revision	1

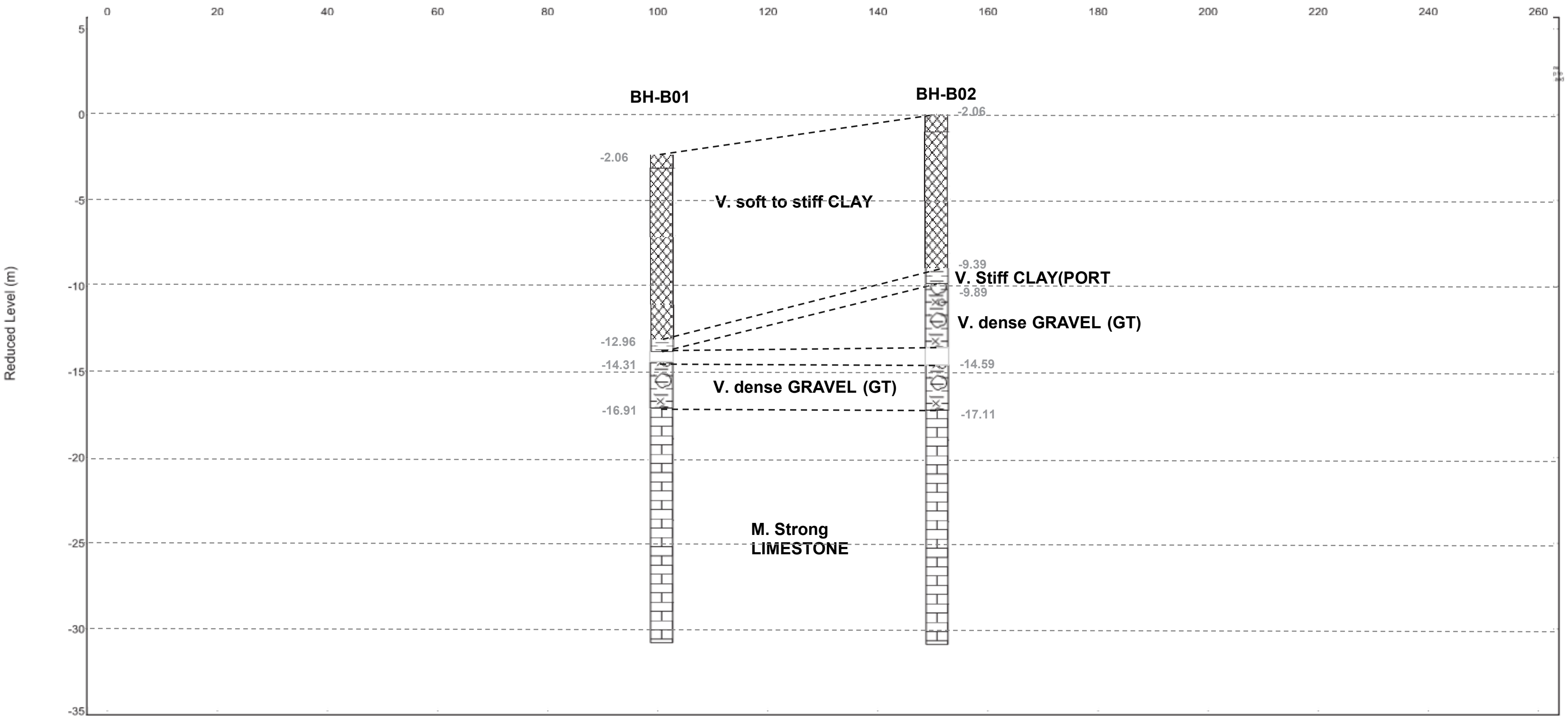
3	Alluvium	Alluvium is a post-glacial deposit along river valleys consisting of generally bedded gravel, sand, silt or clay in a variety of combinations, often with a high percentage of organic carbon (10 – 30%). Alluvium is mapped on modern day river floodplains or Holocene river terraces.
4	Wind blown sand	Wind-blown sand is deposited following ice sheet retreat. These deposits are composed of well sorted medium to fine sands and are found along coastal areas in the form of sand dunes or sand sheets.
5	Marine and estuarine deposits	Marine and estuarine deposits comprise sand and gravel beach sediments, raised beaches, tidal marsh deposits and estuarine silt and clay. These have been deposited as the ice sheet retreated from the continental shelf and sea levels rose.
6	Slope deposits	Slope deposits consist of an assemblage of rock fragments, blocks and sediment at the base of steep slopes and cliffs in the form of sheets or cones. These are created by large scale slope movements, continuous rock fall, peat slides, debris flows or periglacial processes. Very large slope failures took place immediately following the retreat of the last ice sheet, as the Earth's crust rebounded. Smaller scale slope deposits are still being formed today.
7	Glaciofluvial and glaciolacustrine sand and gravel	Glaciofluvial and glaciolacustrine sand and gravel are indirect glacial deposits transported to their final position by melt-water during the ice sheet meltdown and sorted in this process. Glaciofluvial deposits are generally represented by stratified 'sands and gravels', the clasts are usually (sub)rounded and loosely packed. Glaciolacustrine sediments often include bottomset facies composed of fine sand and silts overlain by coarser sediments ascribable to foreset and topset facies.
8	Glaciomarine sediments	Glaciomarine sediments are indirect glacial sediments recorded in marine depositional environments including glaciodeltaic sediments, subaqueous fans and submarine avalanche deposits.
9	Till derived from limestones	Tills are tightly packed, unsorted, unbedded, glacial deposits possessing many different particle sizes with commonly sharp, angular to sub-angular clasts. Till forms beneath a glacier as it erodes the bedrock or pre-existing sediment that it is flowing over. Glacial ice is the principal depositional agent, but gravity and, in some cases, water, also plays a part. In Ireland, till lithology can often be related to the type of bedrock directly beneath it (e.g. Dempster et al., 2013). Tills presented in this map are categorised according to their dominant lithology. Till lithology is important, as it greatly influences the physical properties of the till, e.g. shear strength, porosity and cohesion. The transport and
10	Till derived from sandstones and shales	
11	Till derived from	



COWI

Project	HS2 MWCC Phase One C2/C3		
Asset No. & Name	SPAR Bridge		
Figure Title & No.	Figure 2.2- General Geological - Quaternary 500K		
Section	C2 S2	Revision	1

Project	HS2 MWCC Phase One C2/C3		
Asset No. & Name	SPAR Bridge		
Figure Title & No.	Figure 2.3 - General Geology		
Section	C2 S2	Revision	1



COWI

Project	HS2 MWCC Phase One C2/C3		
Asset No. & Name	SPAR Bridge		
Figure Title & No.	Figure 2.4 Geological Cross Section		
Section	C2 S2	Revision	1

SUBJECT

SPAR Bridge

TITLE

Figure 3.1. Summary of Test Results from Geotechnical Interpretive Report, Dec 2019 by IGSL ltd

ASSET SUMMARY SHEET

Extract from Geotechnical Interpretive Report, Dec 2019 by IGSL ltd

Table 21 – Derived Geotechnical Parameters

Parameter	Alluvial Soils	Coarse Grained Glacial Soils	Fine Grained Glacial Till	Mudstone / Shale Interbeds	Limestone
Moisture Content (%)	31 to 124 (note extremely variable)	4.2 to 11	2.3 to 13%, typically 6 to 8%		
Plasticity Index (%)	Non-Plastic	Non-Plastic	9 - 14		
Bulk Unit Weight (kN/m³)	15	20	24	24	26
Angle of Shearing Resistance (∅)	27°	34°	36° (Stiff / Very Stiff Till)	26°	38°
SPT N-Value	5 (Land) 2 (Marine)	14-Refusal (>50)	30+, commonly with refusal (>50) (Stiff / Very Stiff Till)		
Undrained Shear Strength (Soils)	11-22 kN/m² (Land) 0-11 kN/m² (Marine – Vane Testing)		>150 kN/m² (Stiff / Very Stiff Till)		
Compressive Strength (Rock)				0.3 MPa a in distinctly weathered & extremely weak Mudstone. 0.6 MPa in partially weathered very weak or weak Mudstone	80 MPa in strong to medium strong muddy Limestone
Young's Modulus / Stiffness (E)			100 MPa (Very stiff Glacial Till)	80 MPa in distinctly weathered weak Mudstone 150 MPa in partially weathered Mudstone	4 GPa in medium strong Limestone 11 GPa in strong to very strong Limestone
Consolidation **Mv** **Cv**	0.1-4.3 m²/MN 1.5-22 m²/Year		0.10* – 0.20 m²/MN 7-32 m²/Year		

* Typical value (0.10 m²/MN) for low compressibility Boulder Clay as suggested in Tomlinson (2001)

SUBJECT

SPAR Bridge

TITLE

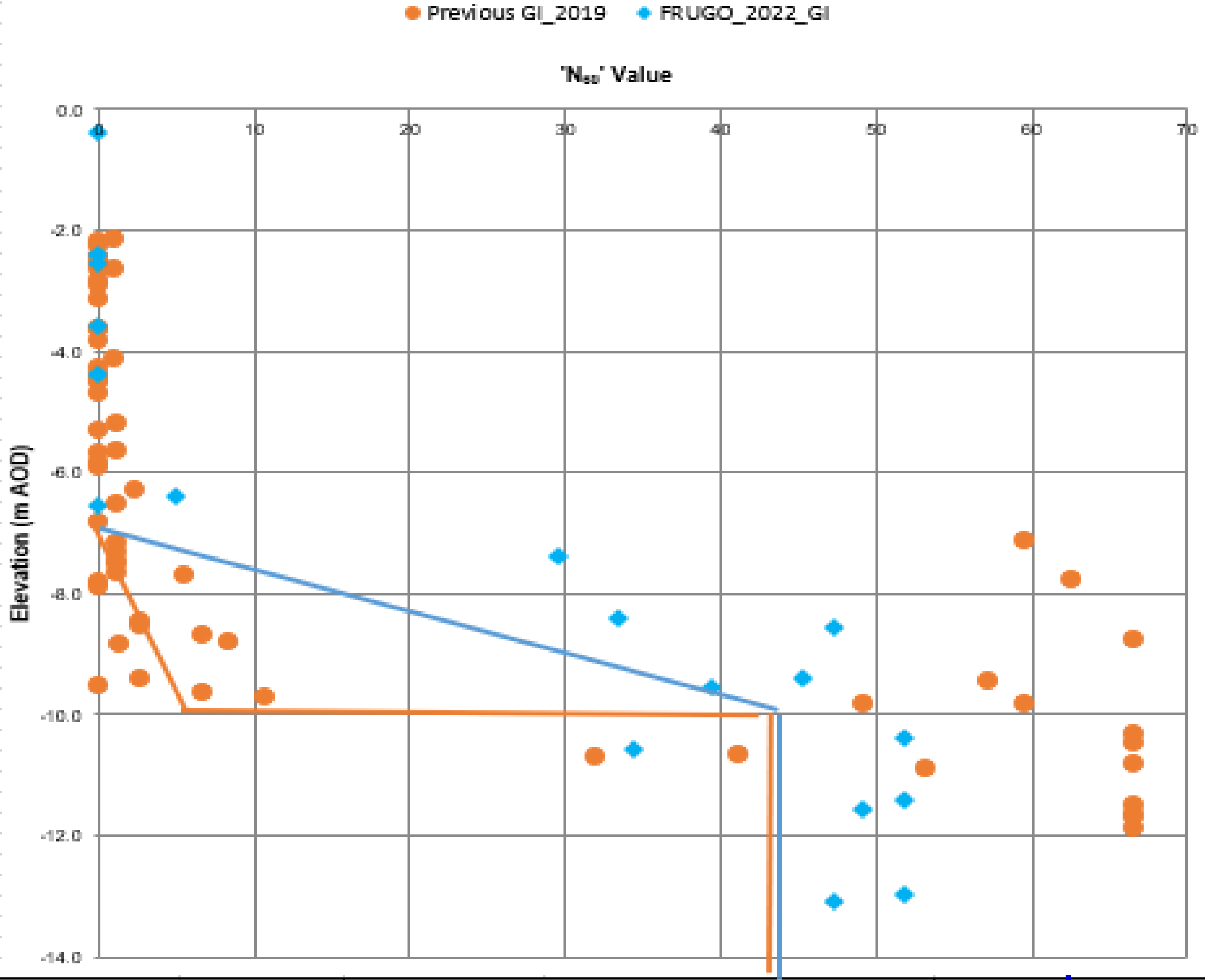
Figure 3.2. SPT 'N' vs Elevation

ASSET SUMMARY SHEET

SPT-N60 vs. Elevations (m AOD)

(For SPT tests up to 50 Blows)

Project ID:	A235995	Project Title:	SPAR - STAGE 2 - Dublin Port Opening Bridge	Location:	RIVER BED
Client:	N/A	Geology :	SILTS AND CLAYS	Figure:	



	N Value
Number of Tests	92
Minimum	-
Maximum	70

Notes

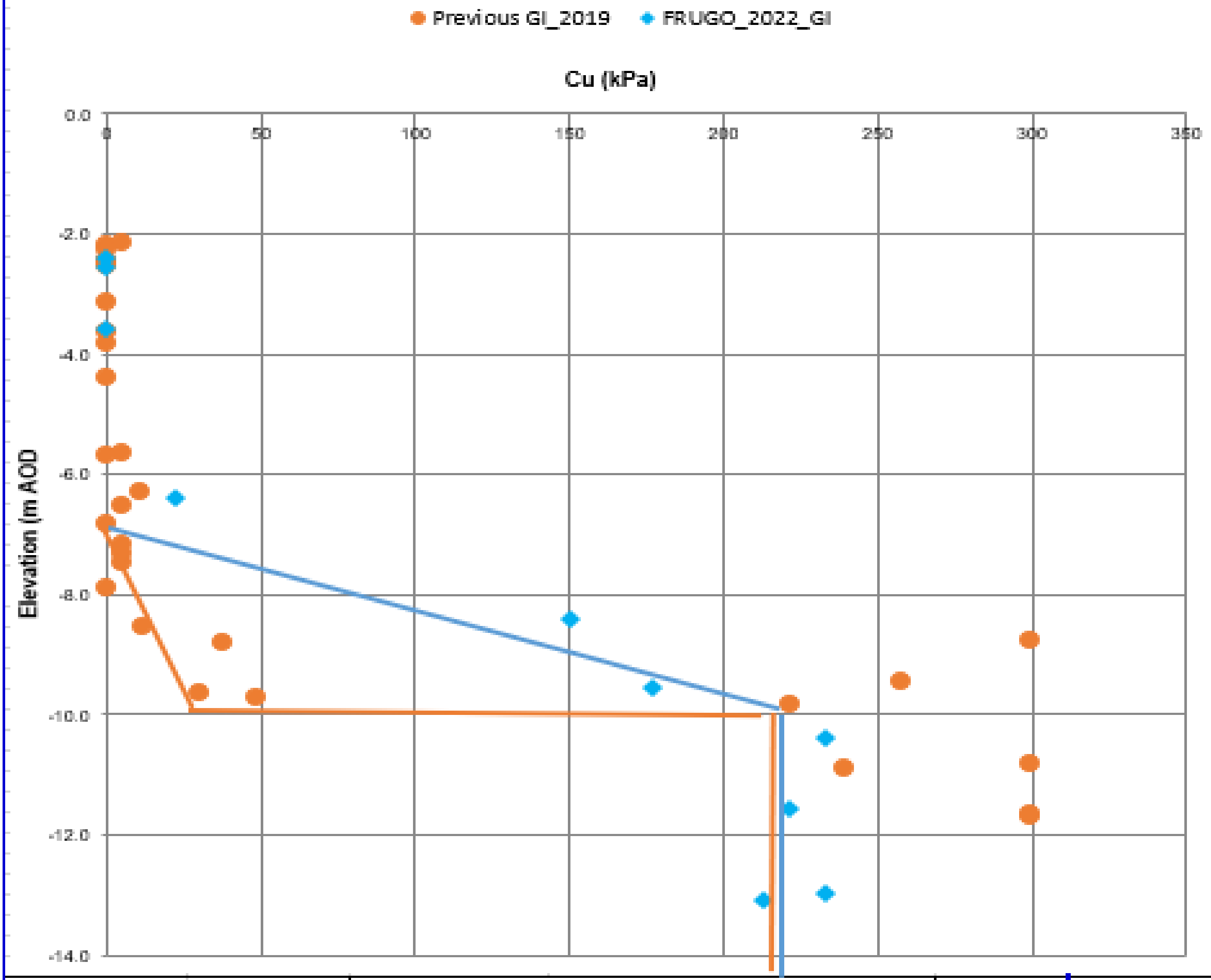
Plot Date: 27/03/2023

SUBJECT	TITLE
SPAR Bridge	Figure 3.3. Cu vs Depth

ASSET SUMMARY SHEET

Cu (kPa) vs. Elevation (m AOD)
(SPT tests up to 50 Blows)

Project ID:	**A235995**	Project Title:	**SPAR - STAGE 2 - Dublin Port Opening Bridge**	Location:	**RIVER BED**
Client:	**N/A**	Geology :	**SILTS AND CLAYS**	Figure:	



	N Value	Notes	Plot Date:	27/03/2023
Number of Tests	92			
Minimum	-			
Maximum	70			

SUBJECT: SPAR Bridge

TITLE: Figure 3.4. SPT vs Elevation

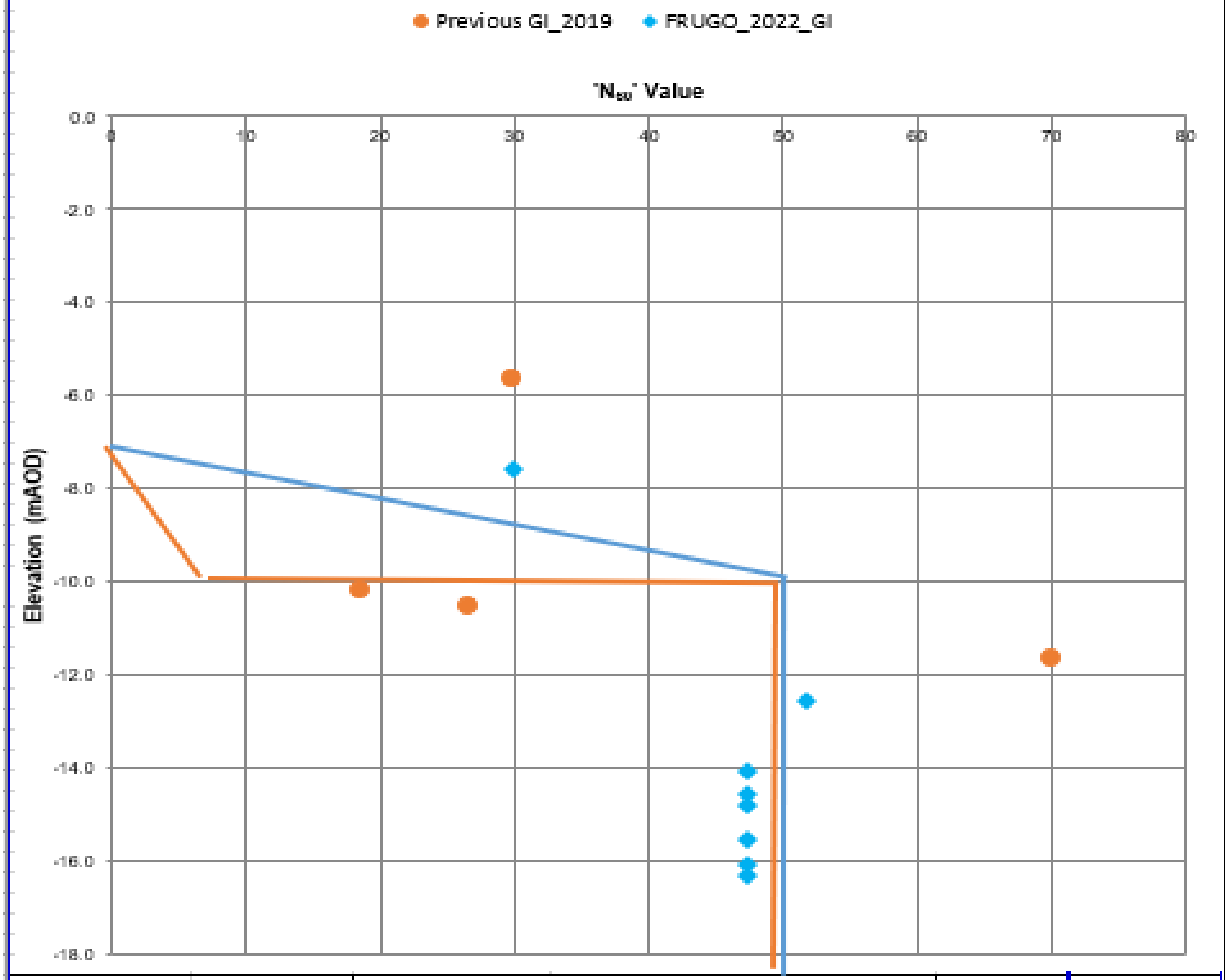
ASSET SUMMARY SHEET

COWI

SPT-N_{60} vs. Elevation (m AOD)

(For SPT tests up to 50 Blows)

Project ID:	A235995	Project Title:	SPAR - STAGE 2 - Dublin Port Opening Bridge	Location:	RIVER BED
Client:	N/A	Geology :	SAND AND GRAVELS	Figure:	



	N Value
Number of Tests	92
Minimum	-
Maximum	70

Notes

Background C3 scheme wide parameters shown are based on holebase database geology codes dated 12/01/2022.

Plot Date: 27/03/2023

SUBJECT

SPAR Bridge

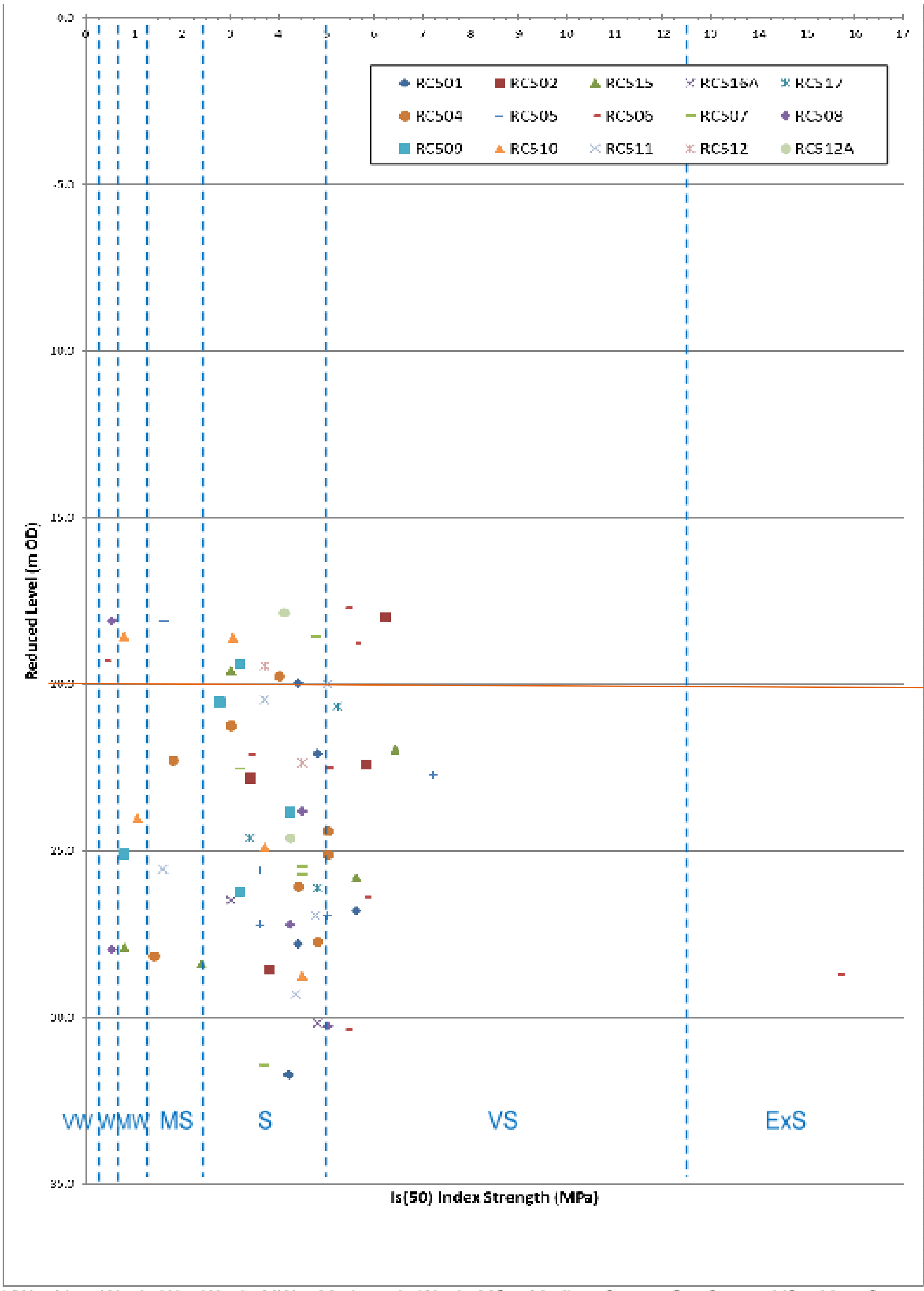
TITLE

Figure 3.5 Point Load Test vs Elevation from Geotechnical Interpretive Report, Dec 2019 by IGSL ltd

ASSET SUMMARY SHEET

Extract from Geotechnical Interpretive Report, Dec 2019 by IGSL ltd

Figure 33 – $I_s(50)$ strengths obtained from diametrial Point Load Strength Index testing. Reduced levels used in plot to allow for comparison of overwater and land rock cores



VW = Very Weak, W = Weak, MW = Moderately Weak, MS = Medium Strong, S = Strong, VS = Very Strong, ExS = Extremely Strong
(ISO 14689:2017 (E))

SUBJECT: **SPAR Bridge**

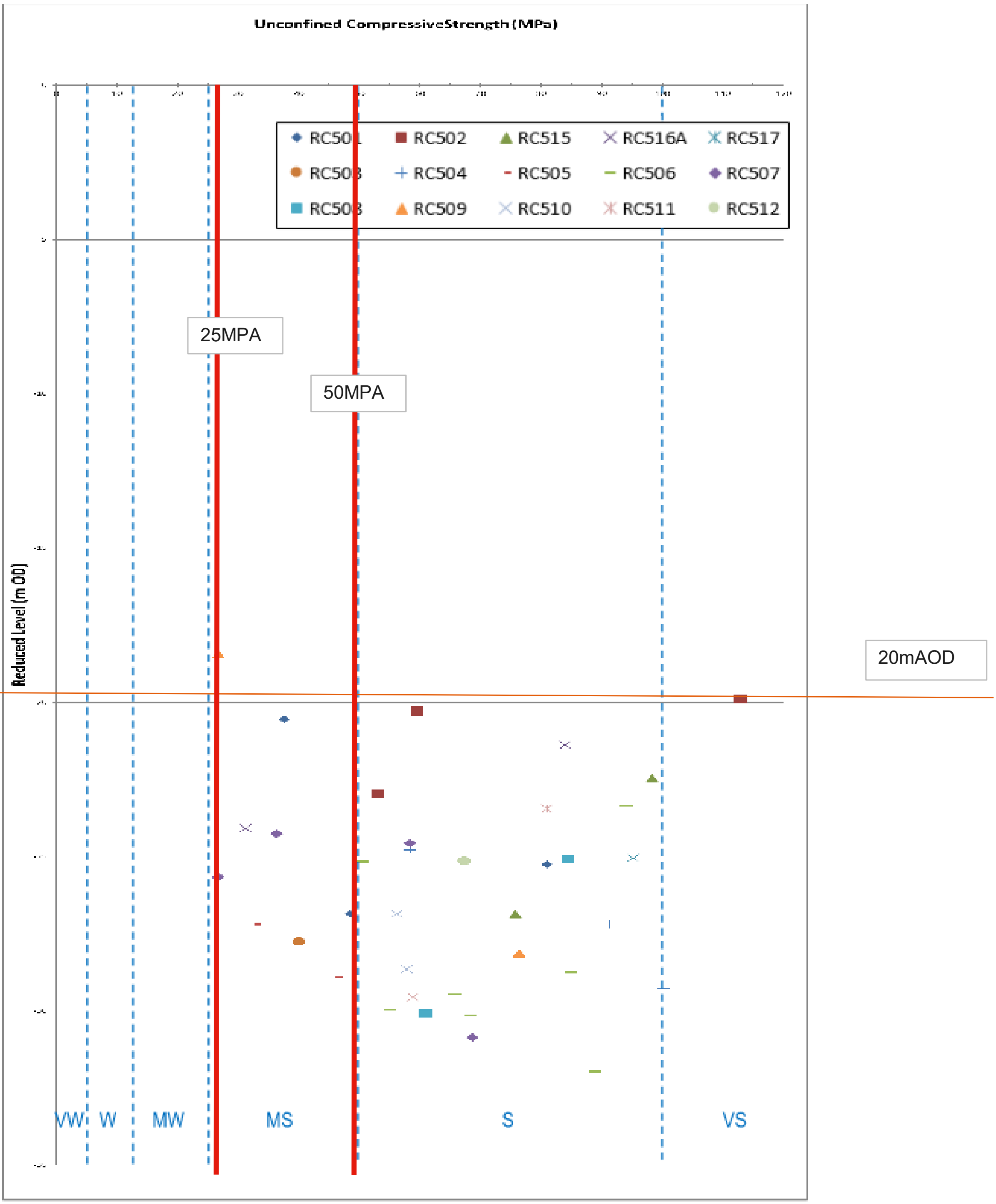
TITLE: **Figure 3.6. UCS vs Elevation from Geotechnical Interpretive Report, Dec 2019 by IGSL ltd**

ASSET SUMMARY SHEET

Extract from Geotechnical Interpretive Report, Dec 2019 by IGSL ltd

Figure 34 – UCS strengths (MPa) obtained from core testing

Reduced levels used in plot to allow for comparison of overwater and land rock cores



VW = Very Weak, W = Weak, MW = Moderately Weak, MS = Medium Strong, S = Strong, VS = Very Strong (ISO 14689:2017 (E))

SUBJECT
SPAR Bridge

DOCUMENT NO.
Figure 3.7 Plasticity and PSDs from Geotechnical Interpretive Report, Dec 2019 by IGSL ltd

ASSET SUMMARY SHEET

Extract from Geotechnical Interpretive Report, Dec 2019 by IGSL ltd

Figure 27 – Atterberg Limit Plot (Glacial Deposits)

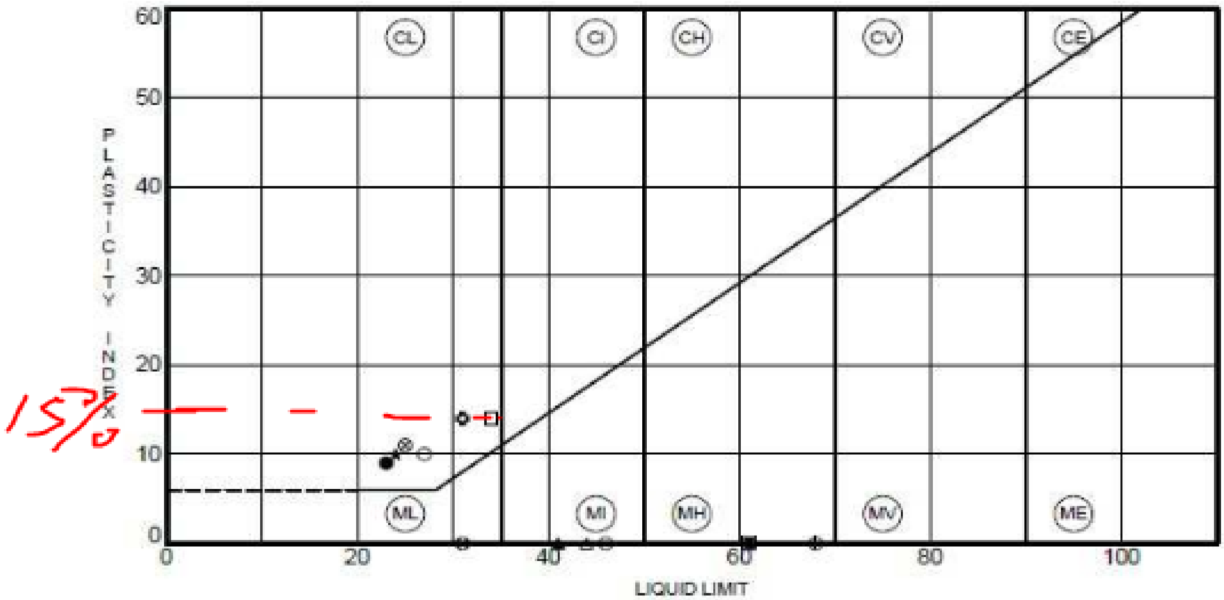
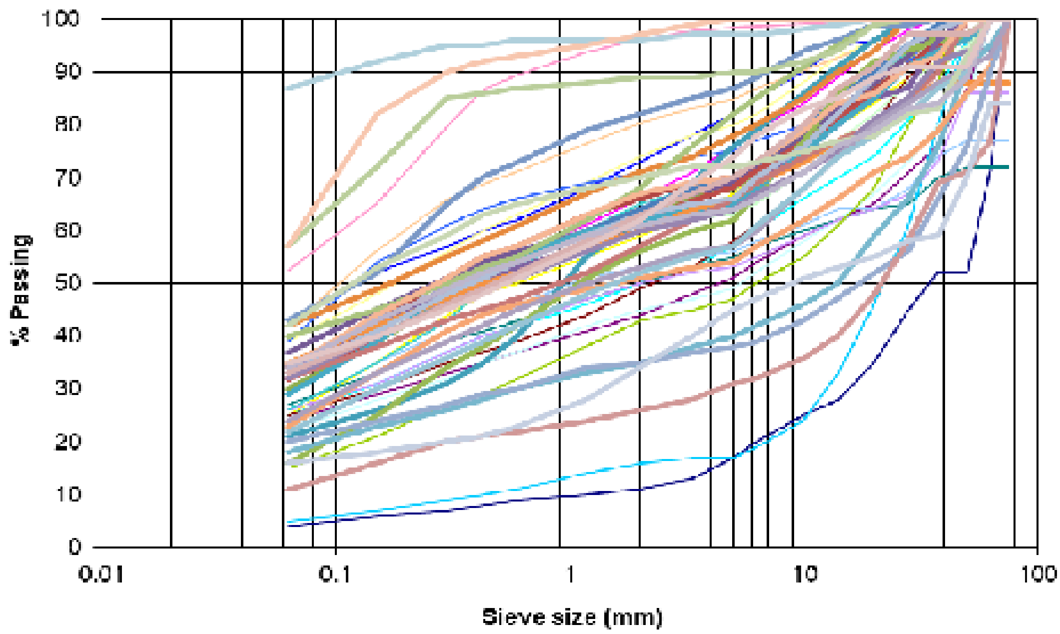


Figure 28 – Grading Envelope (Glacial CLAY / Till)



Appendix C Architectural Images

SPAR BRIDGE

Image Appendix
12th June 2024

View of SPAR Bridge in closed position, from the Samuel Beckett Bridge

View of SPAR Bridge in a half open position, from the Samuel Beckett Bridge

View of SPAR Bridge in closed position, from the Samuel Beckett Bridge at night

View of SPAR Bridge in a half open position, from the Samuel Beckett Bridge at night

View along the navigation channel from the port side towards the city with the SPAR Bridge closed

View along the navigation channel from the port side towards the city with the SPAR Bridge open

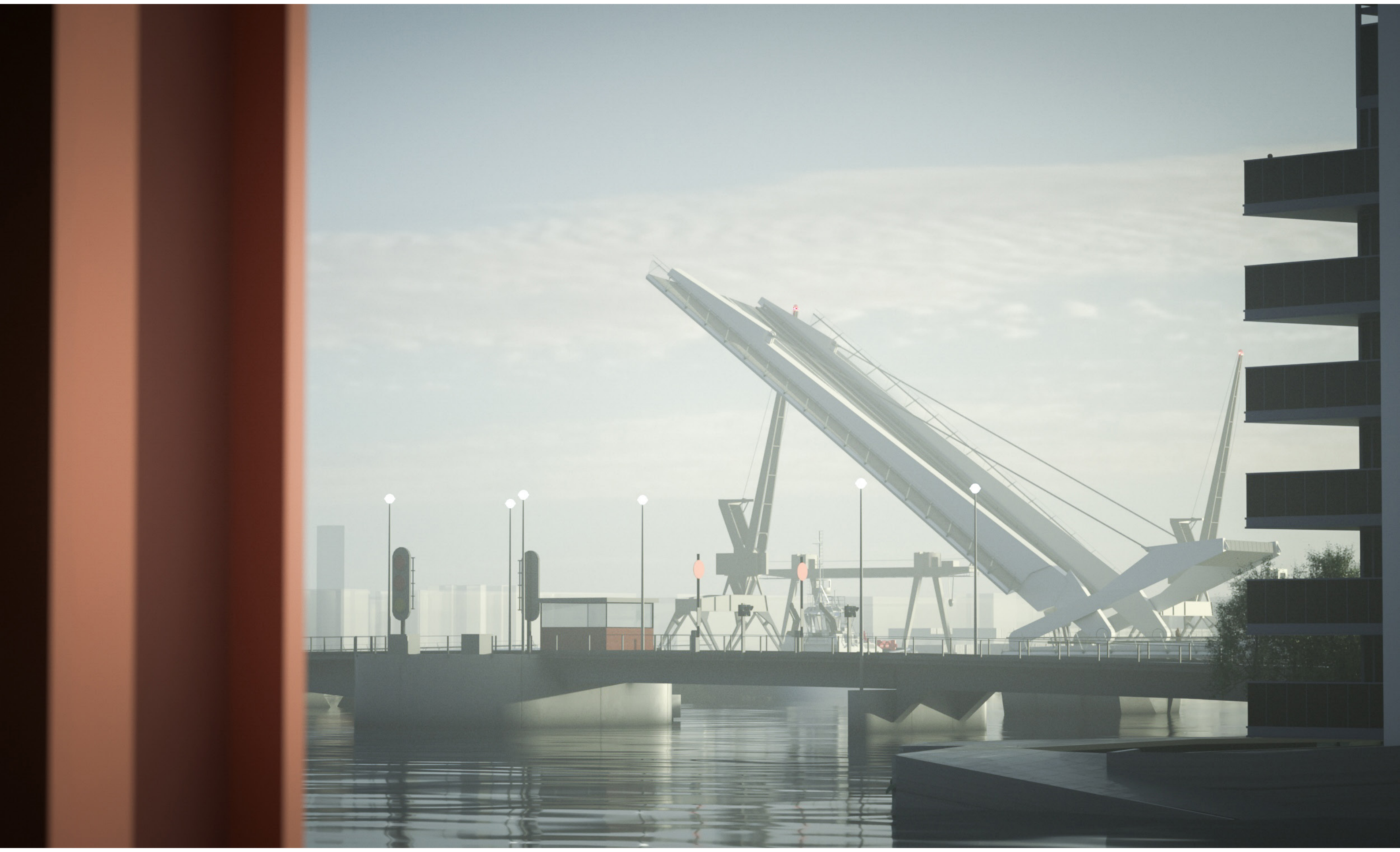
Approaching the SPAR bridge along the navigation channel

The counterweight gives a distinct identity to the bridge and clearly denotes the opening span

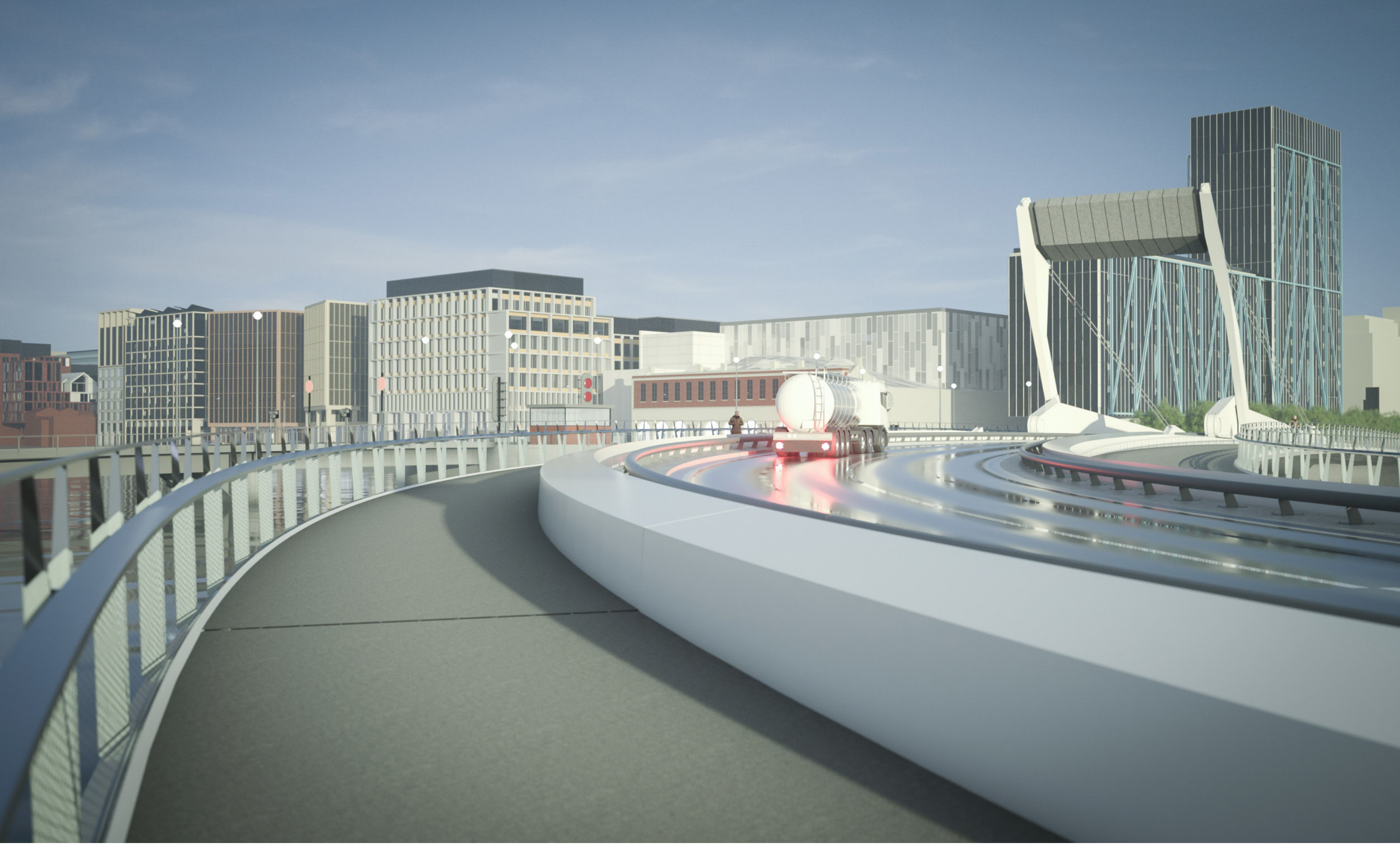
SPAR Bridge counterweight silhouetted behind the Tom Clarke Bridge

SPAR Bridge during opening sequence

View of SPAR Bridge in closed position from aross the River Dodder



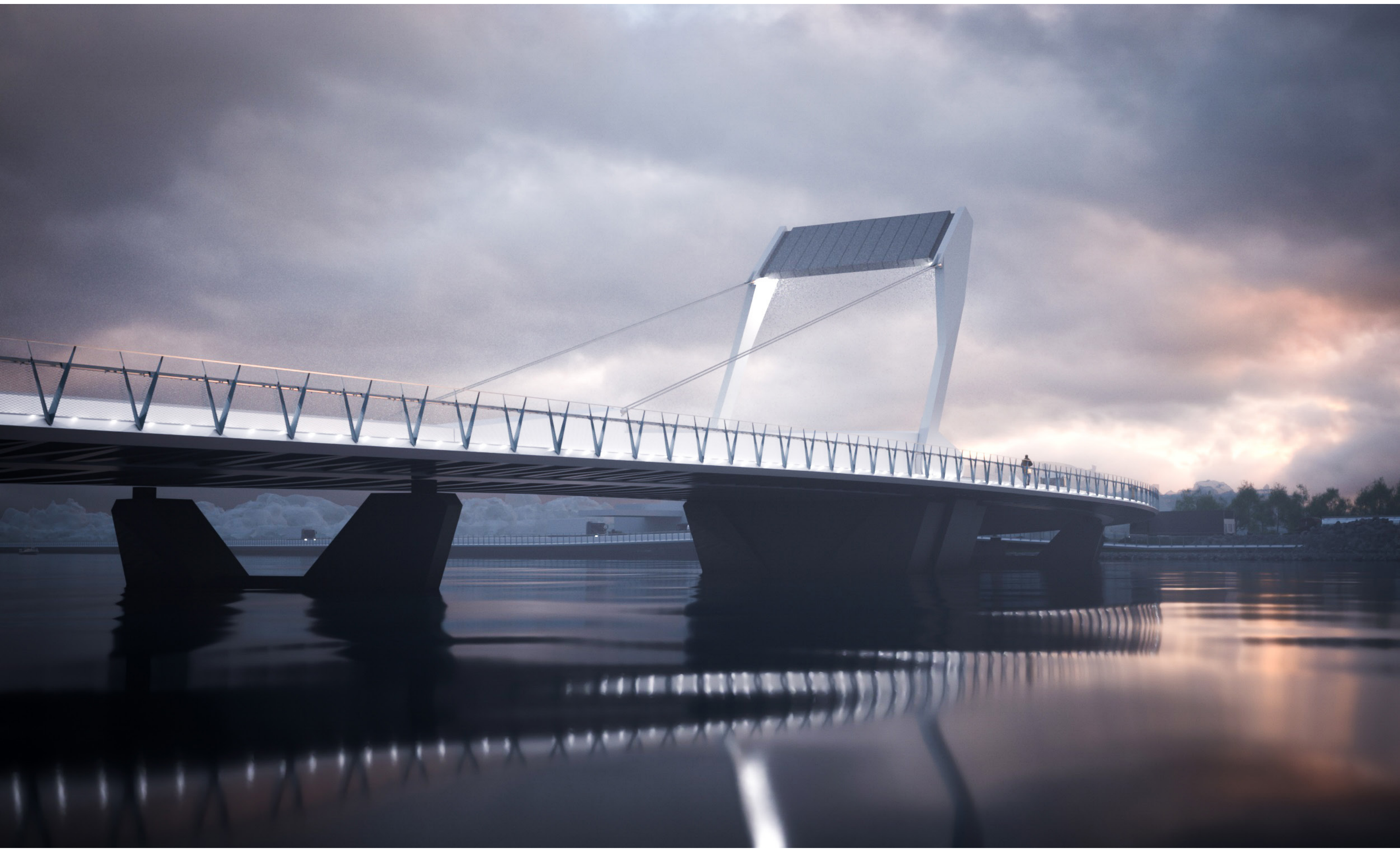
View of SPAR Bridge during opening sequence from aross the River Dodder



Secondary walkway separated from the carriageway by spine beam

The SPAR piers are aligned with the piers of the Tom Clarke Bridge beyond

The low level lighting picks out the bridge deck as a ribbon of light

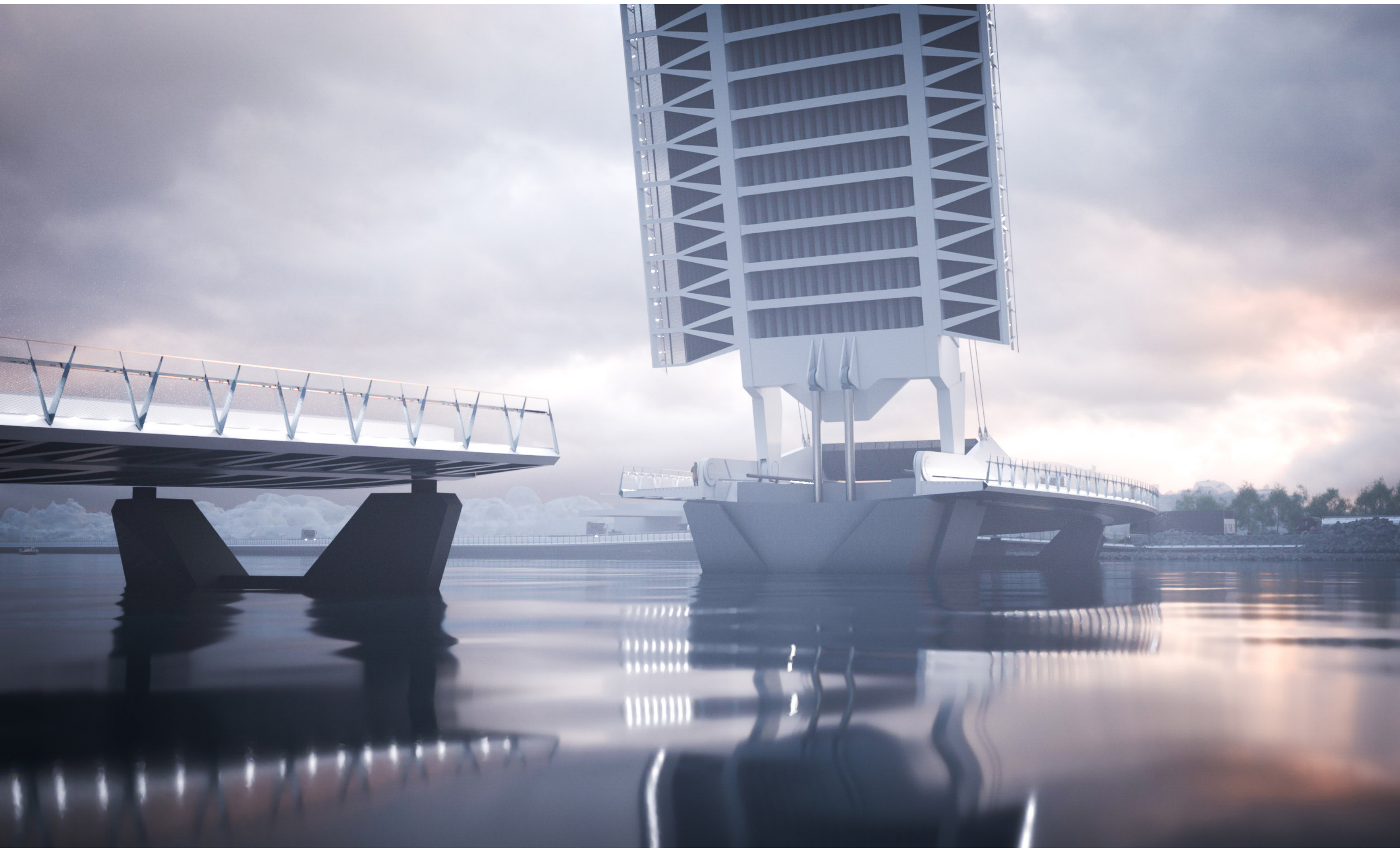


The low level lighting stays contained within the bridge deck

The soffit grid structure is revealed as the opening span is lifted

The counterweight provides a distinctive gateway element when the bridge is closed

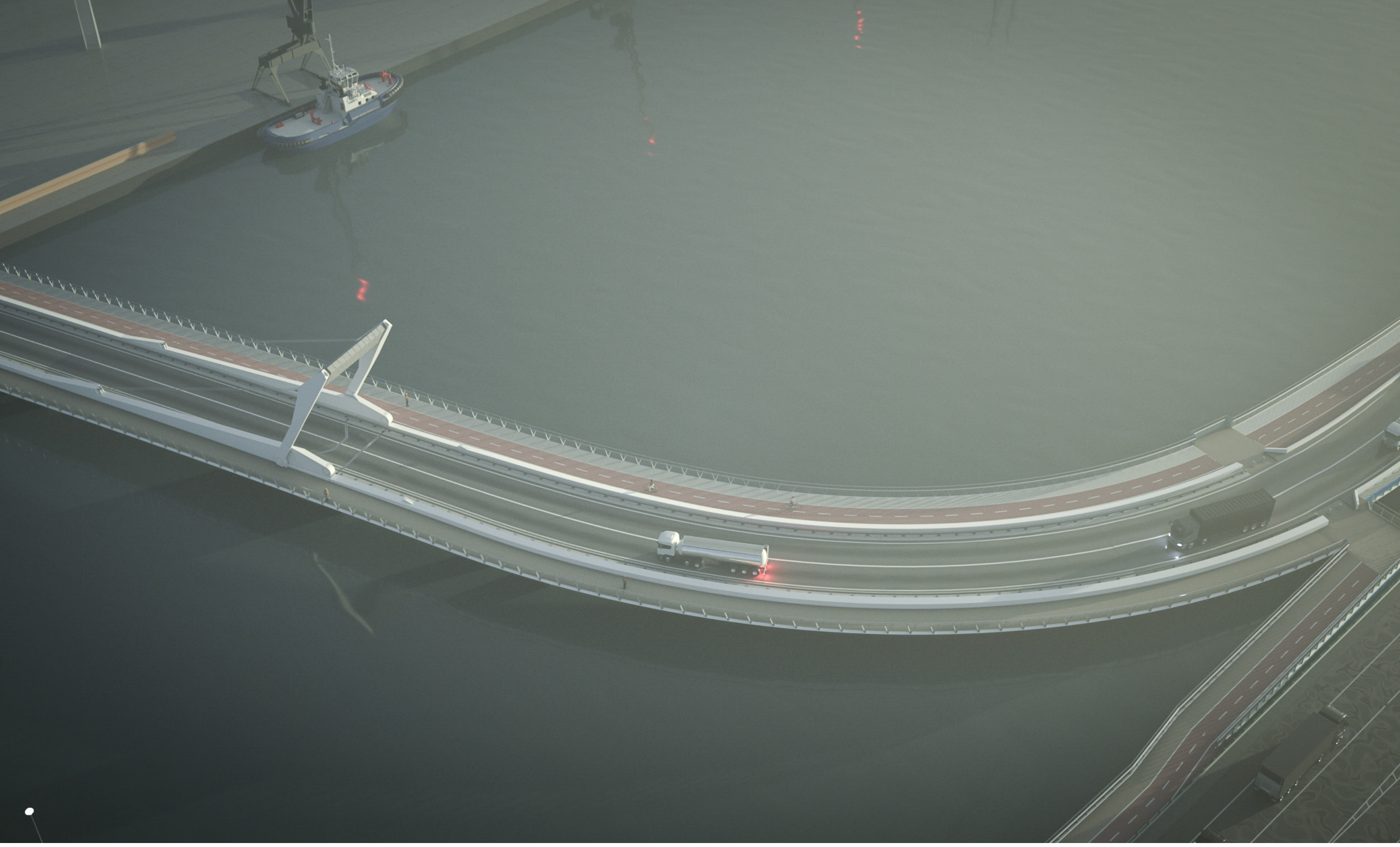
The counterweight aligns with the approach beams when the bridge is open



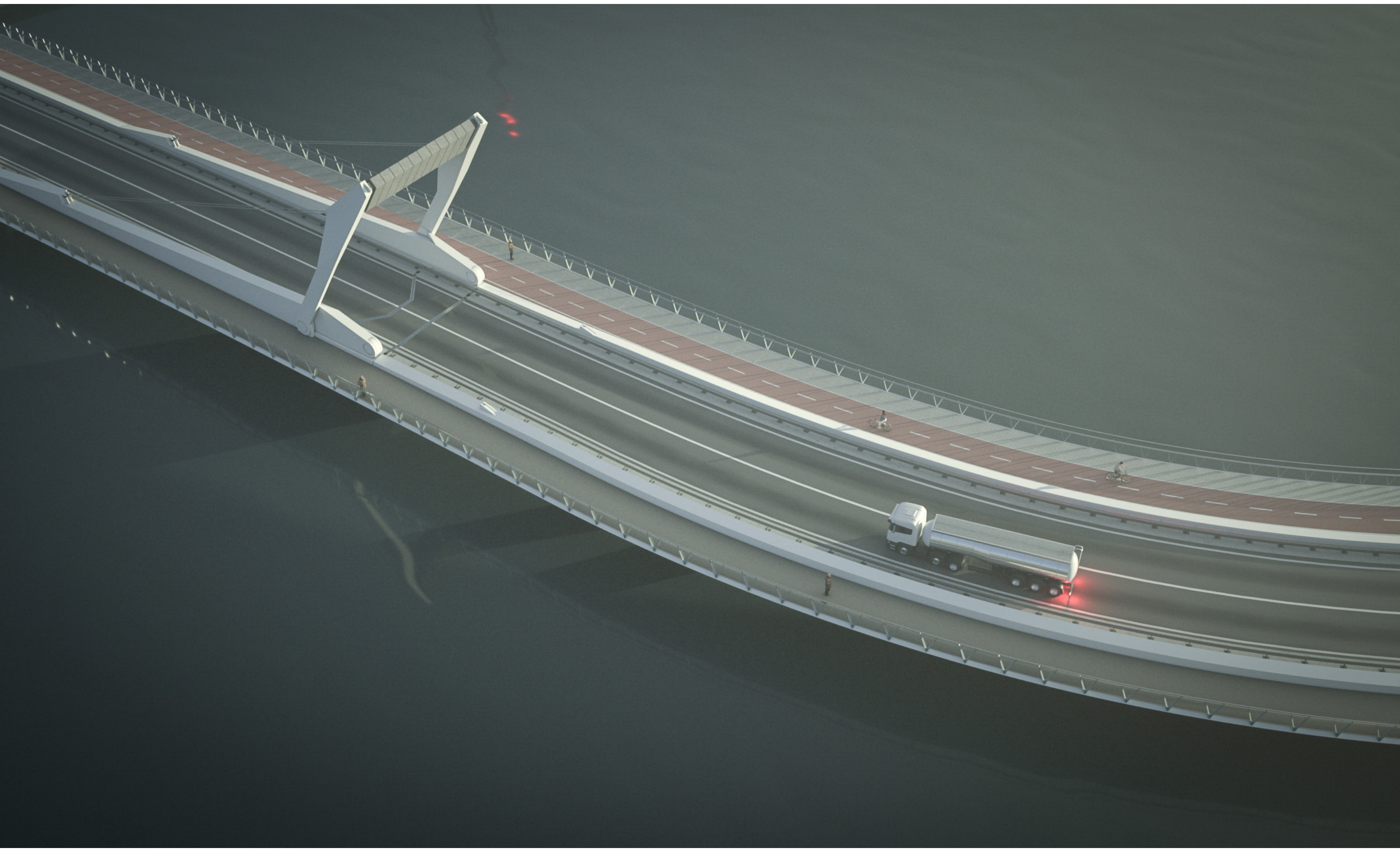
The machinery pier contains the rams and supports the counterweight and opening span

The counterweight aligns with the approach beams when the bridge is open

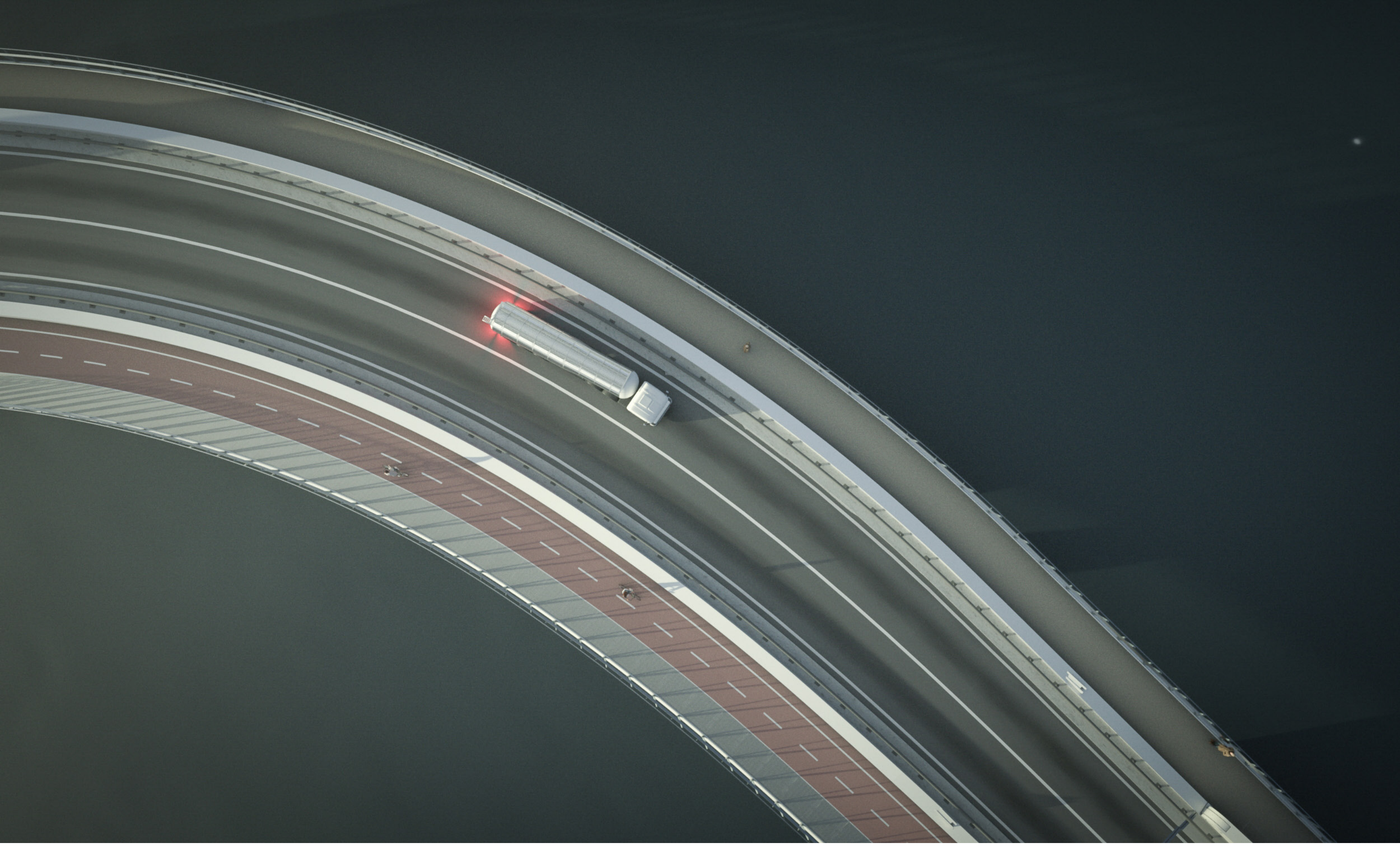
The counterweight provides a gateway element across the road to the port when the bridge is closed



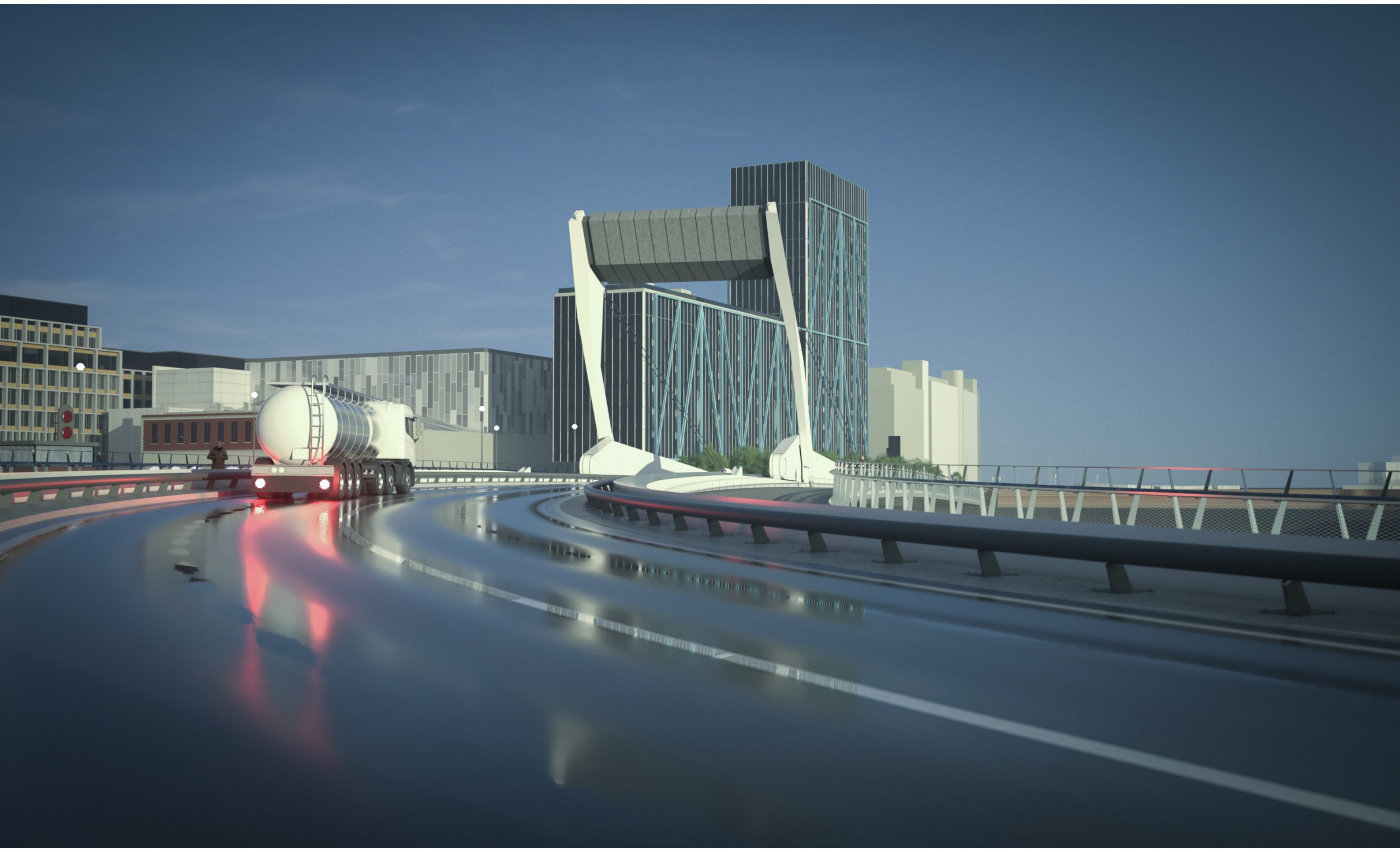
Overview showing smooth transition onto the SPAR viaduct



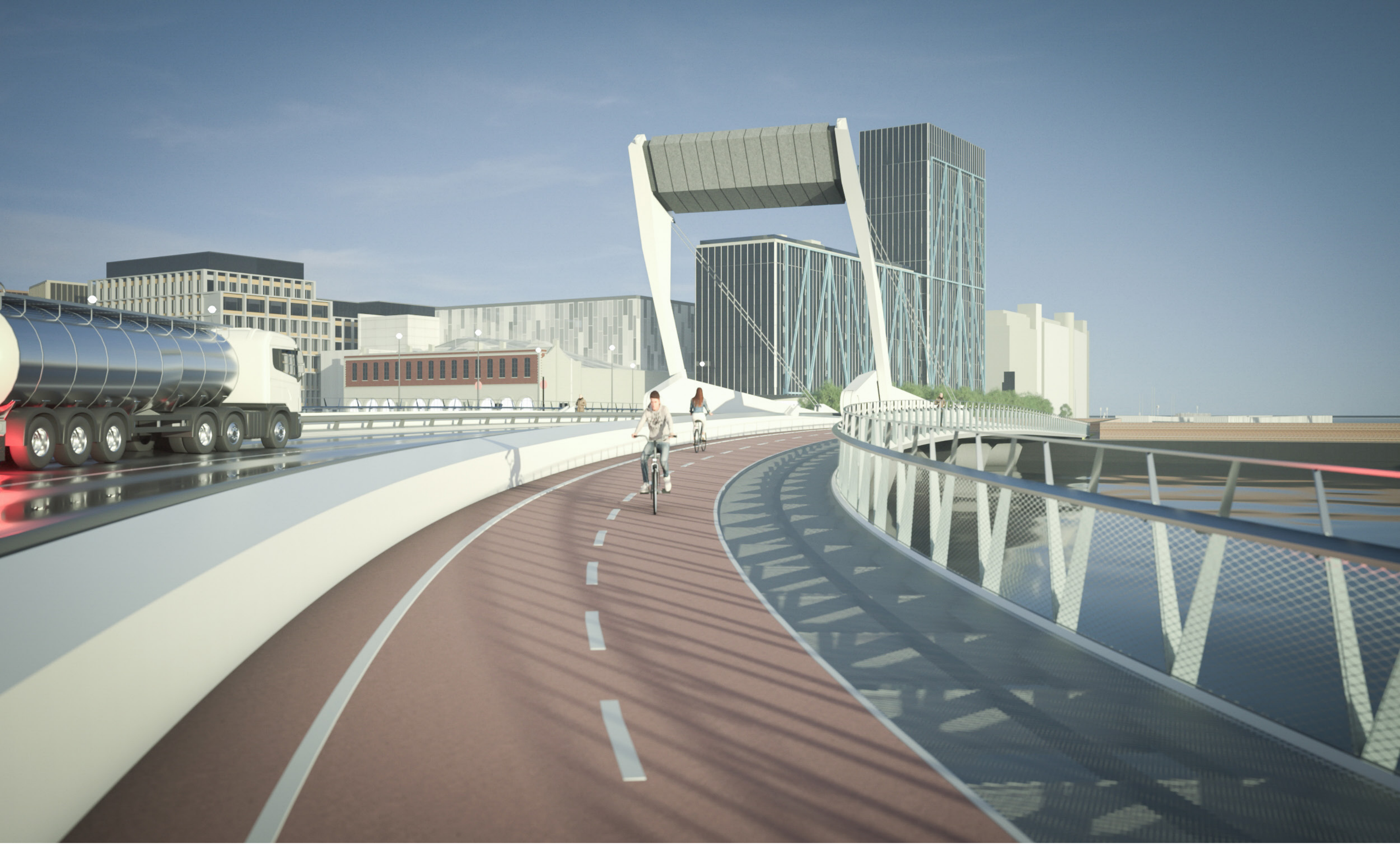
Overview of SPAR bridge opening span



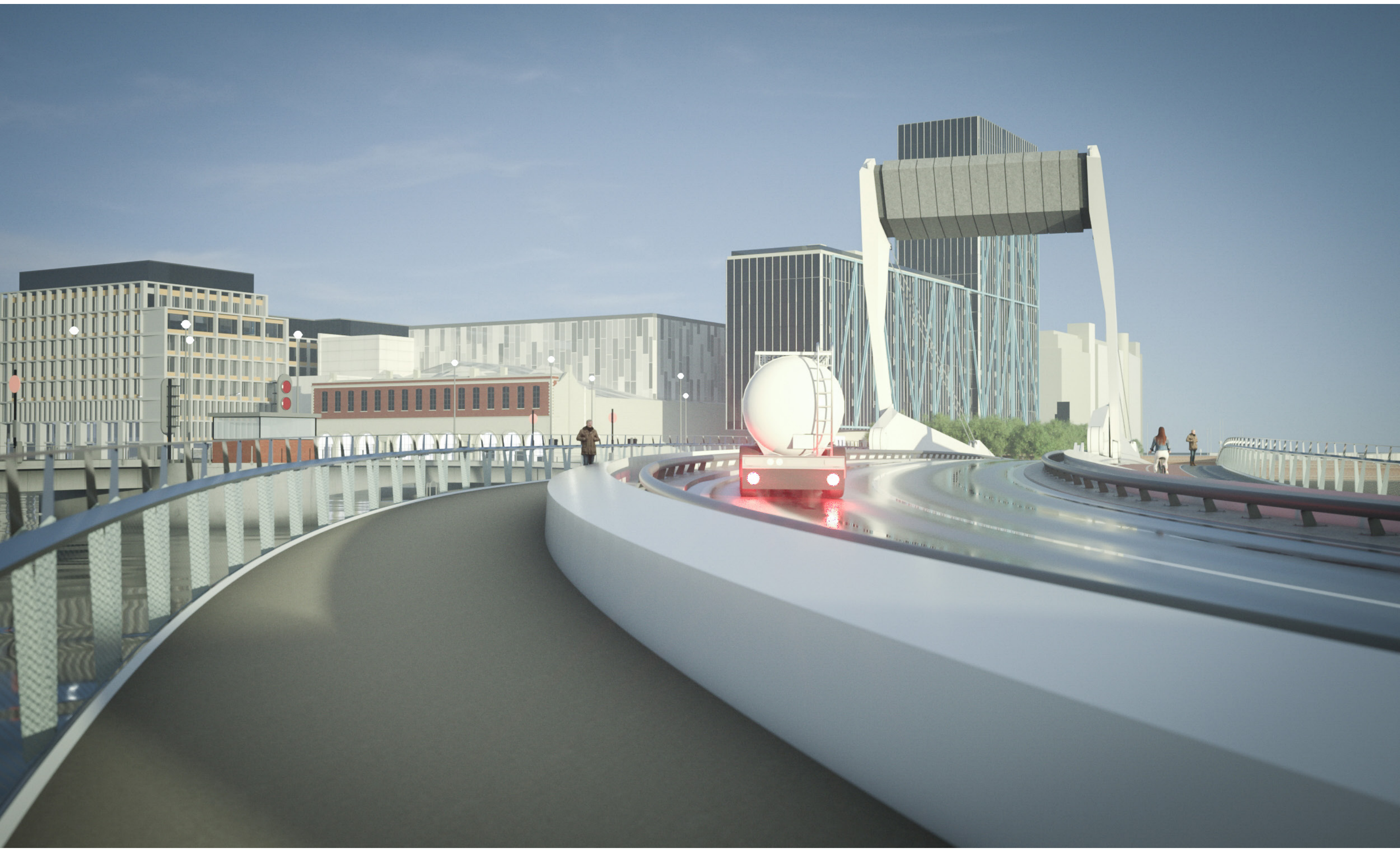
Overview of SPAR bridge transition



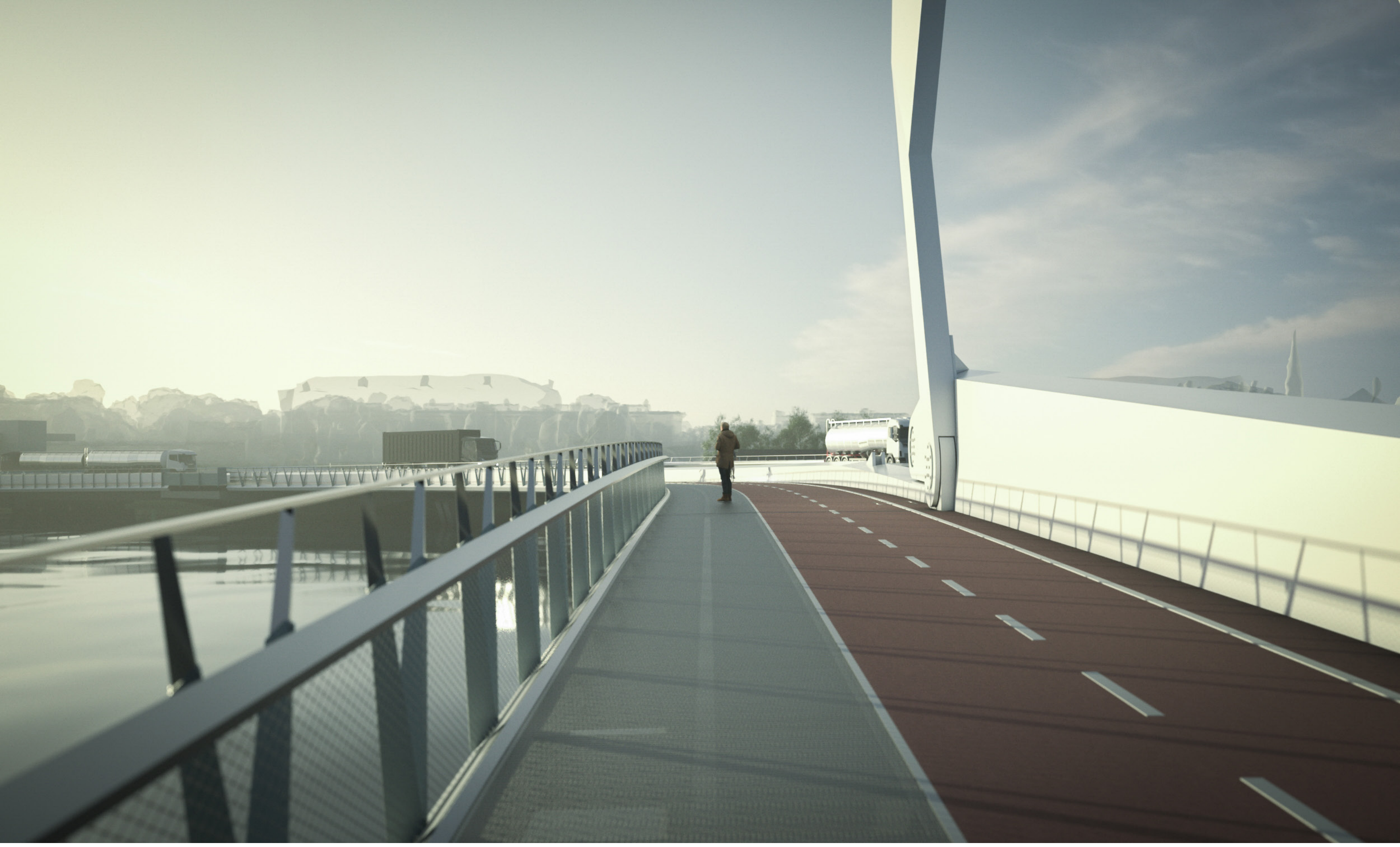
Counterweight forms gateway over carriageway



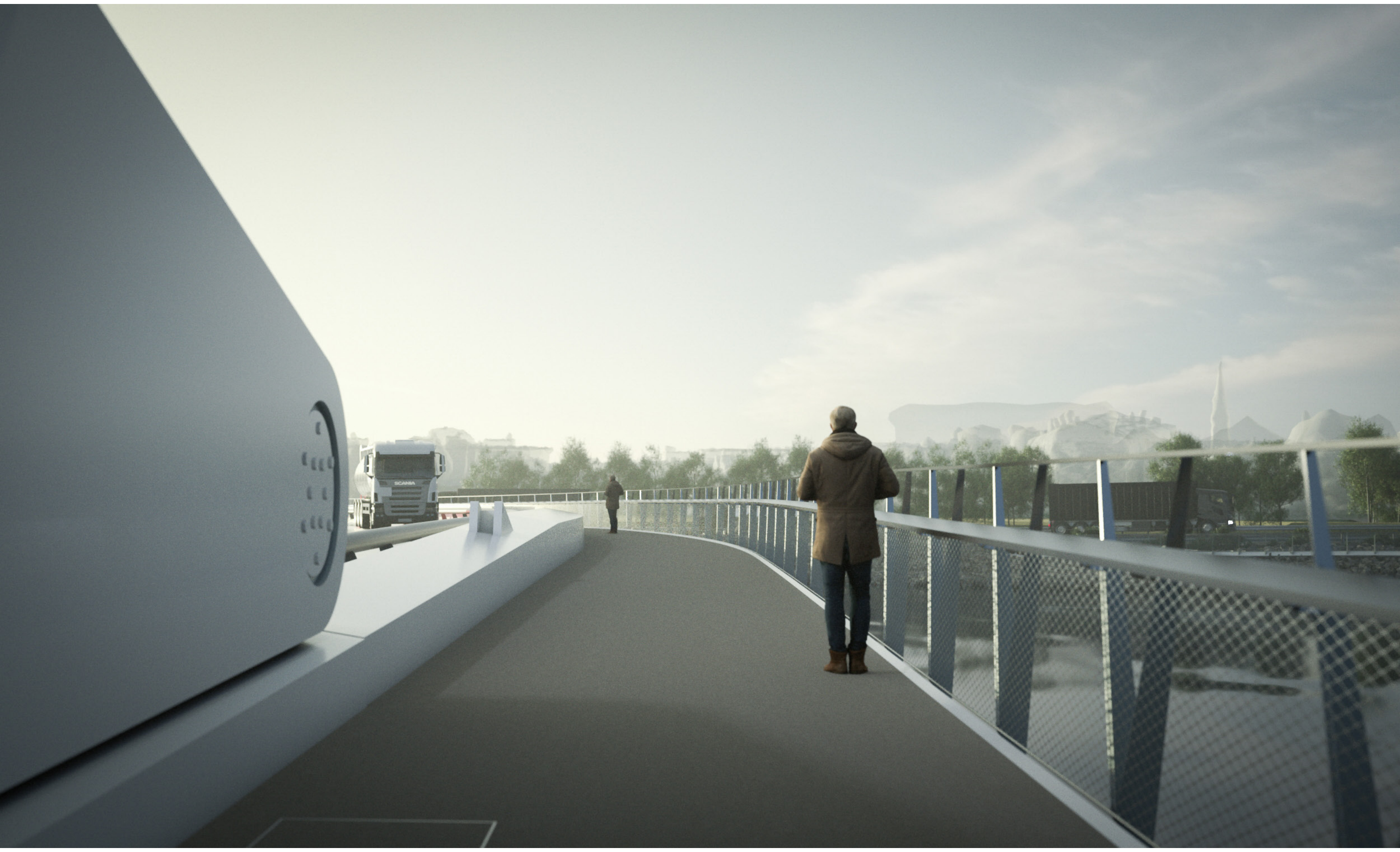
Active travel route separated from the carriageway by spine beam



Secondary walkway separated from the carriageway by spine beam



Separating the active travel walkway from the carriageway allows a lightweight parapet



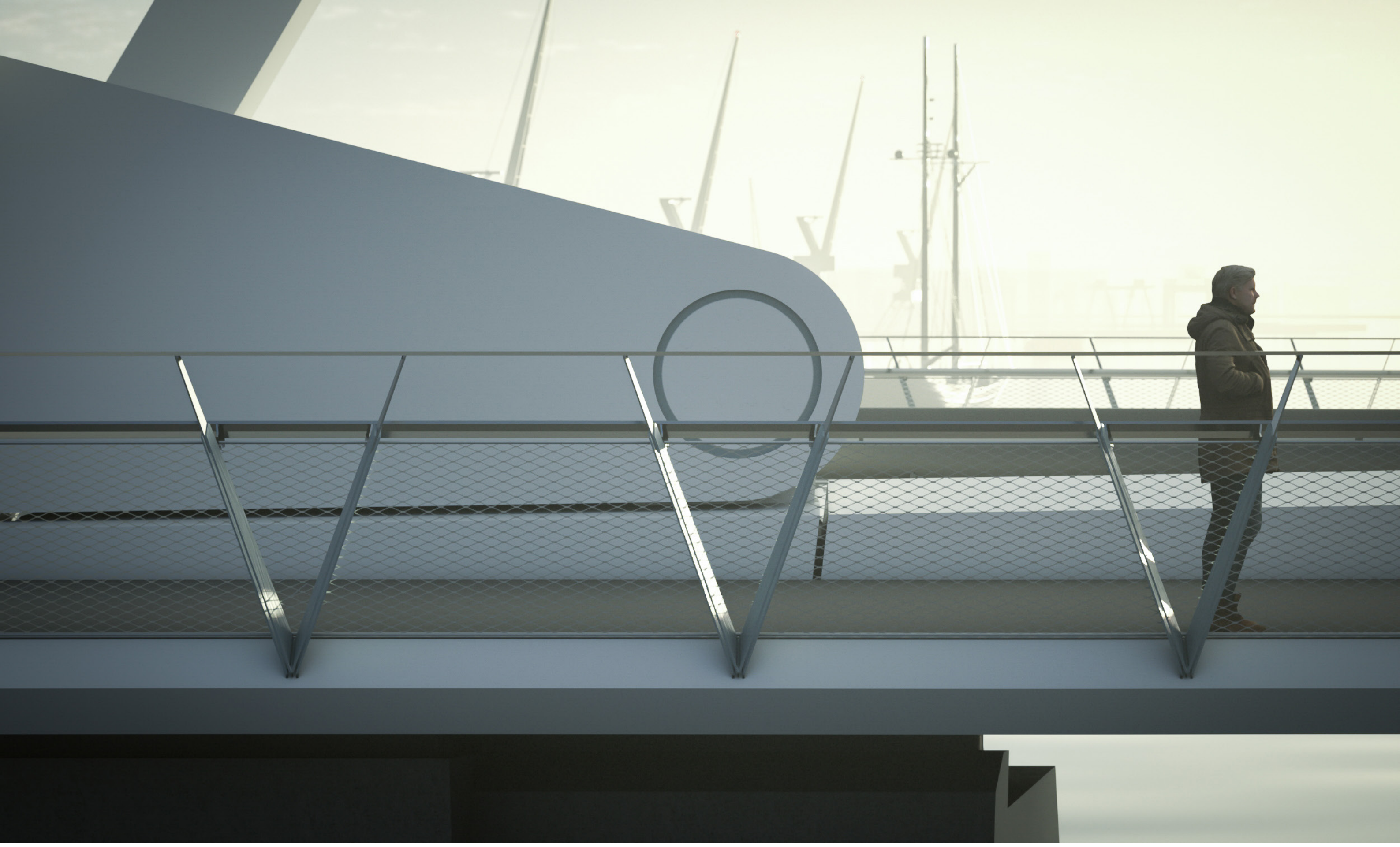
Separating the secondary walkway from the carriageway allows a lightweight parapet

Counterweight forms gateway over carriageway

View from water level showing SPAR bridge smoothly transitioning onto SPAR viaduct

The geometry of the typical piers and machinery piers allow light to catch the faces differently to break up the visual mass

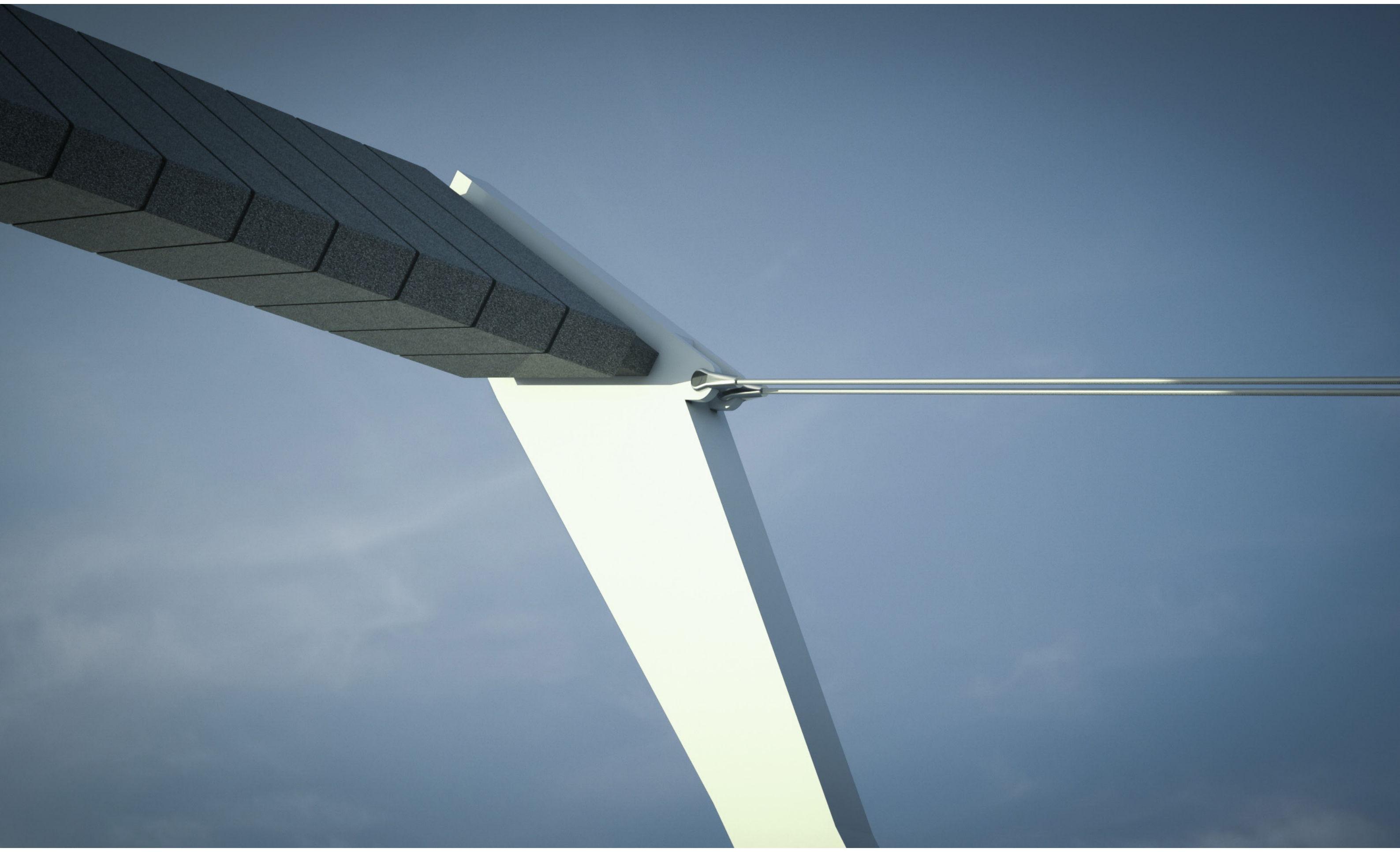
Spine beams at lifting span separate carriageway from active travel walkway



Pivot points on opening span integrated into opening elements and aligned to parapet grid

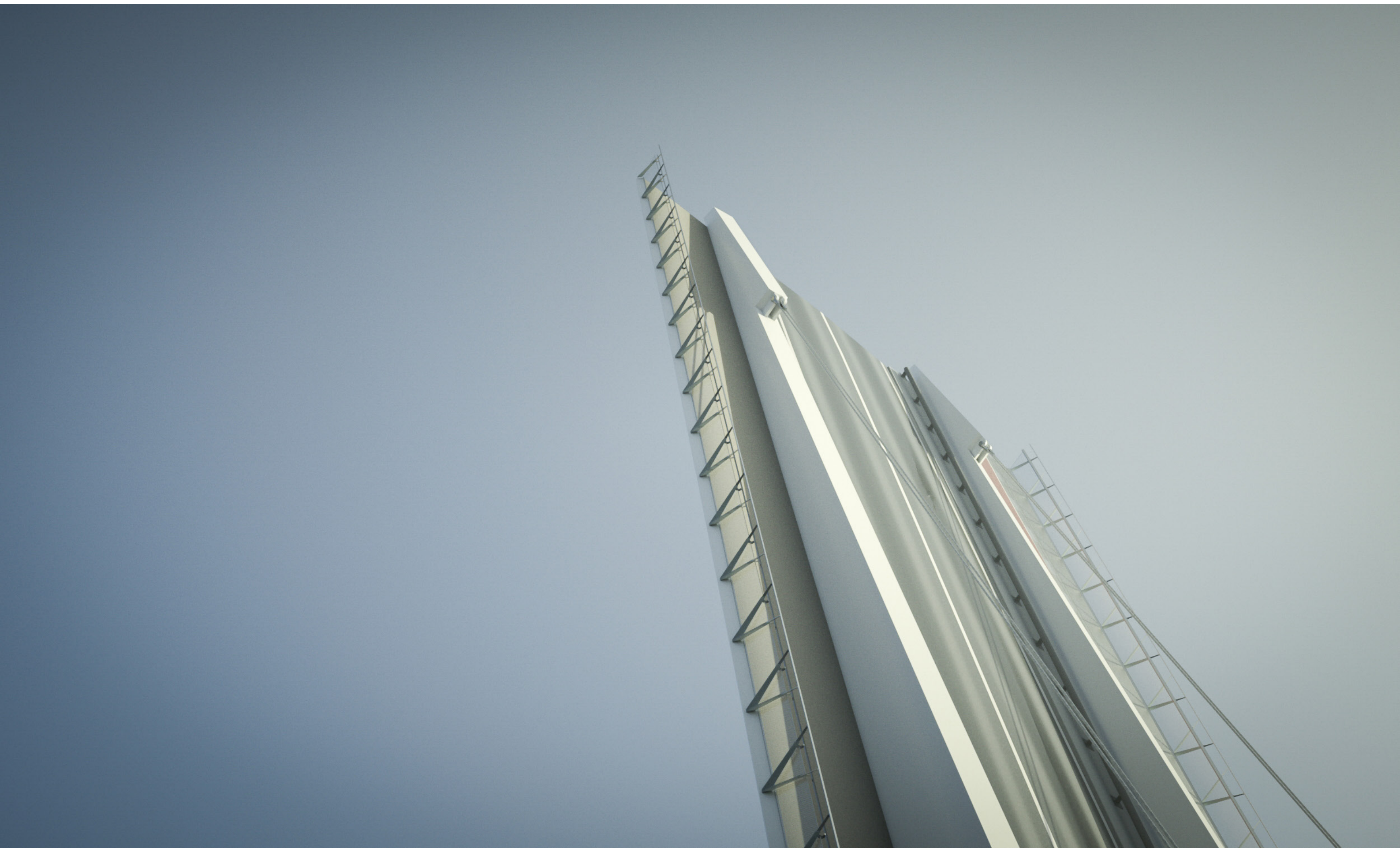
Spine beams separate pedestrians from HGV traffic on carriageway

Detail showing lifting span soffit grid and relationship to parapet



Twin plates integrated into geometry of counterweight arm provide cable connections

Tip of spine beams shaped to accept cable connections



Tip of spine beams shaped to accept cable connections