

SYDNEY HARBOUR BRIDGE CYCLEWAY NORTHERN ACCESS PROJECT

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INITIAL DESIGN PHASE

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1 Connecting to Country

1.1 Acknowledgment of Country

We acknowledge Country, the Cultural Landscape that we are working upon, We acknowledge the custodianship of its people and the privilege and responsibility to Connect and Design with Country.

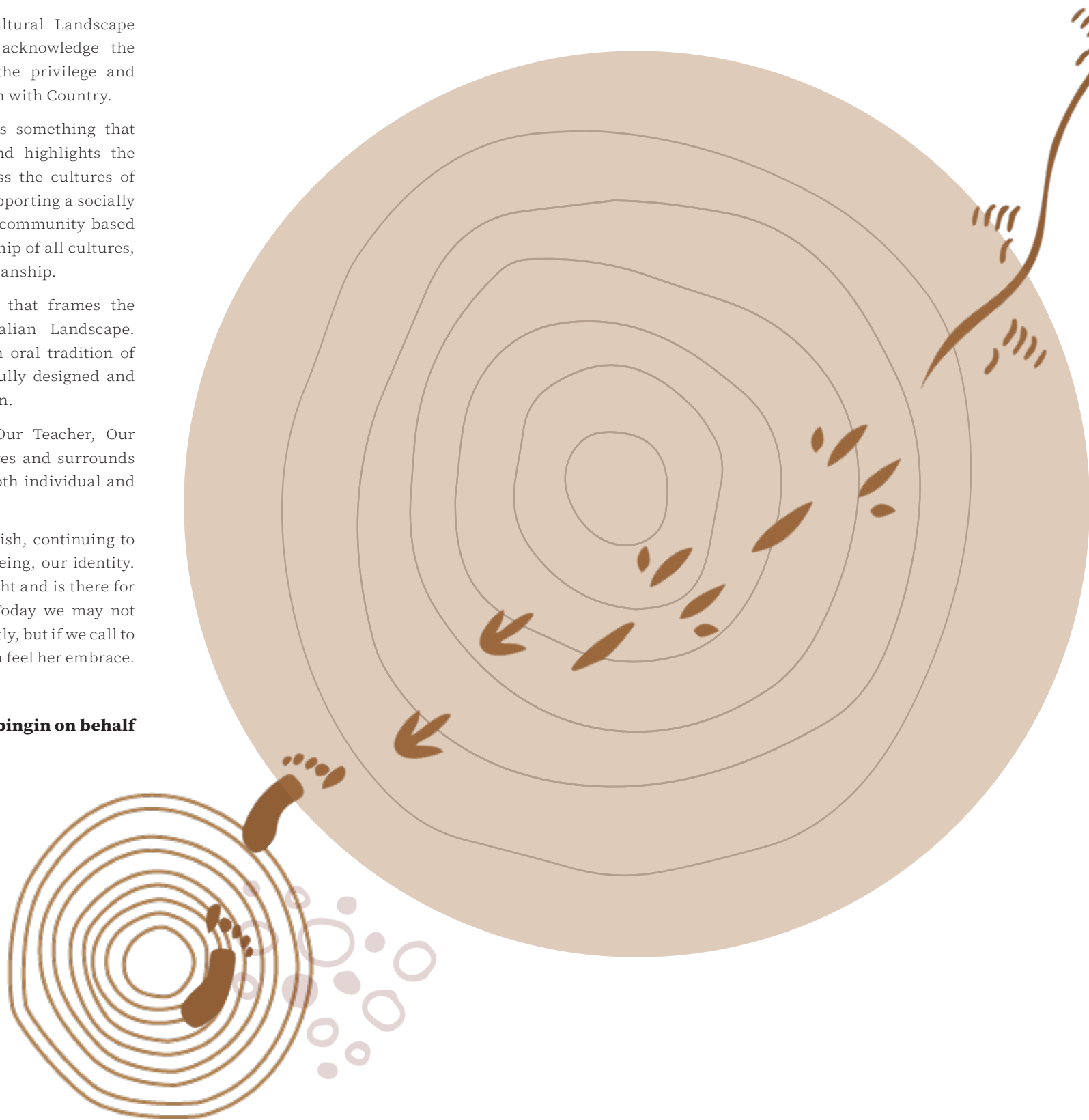
Sensing and caring for Country is something that transcends cultural differences and highlights the many values that are similar across the cultures of our contemporary communities. Supporting a socially inclusive, resilient, and innovative community based on, honouring the wisdom and kinship of all cultures, captured through the lens of custodianship.

Country is a cultural topography that frames the ancient knowledge of the Australian Landscape. Collected and nurtured through an oral tradition of dance, stories, song, and art carefully designed and maintained, gifted to each generation.

For us Country is Our Mother, Our Teacher, Our Library, Our Kin it sustains, inspires and surrounds us. The experience of Country is both individual and collective, both new and familiar.

From her we learn, share and flourish, continuing to care for country is central to our being, our identity. Country is a responsibility, not a right and is there for all who respect and cherish her. Today we may not always be able to see Country instantly, but if we call to it, we can always sense her and again feel her embrace.

- Christian Hampson CEO Yerrabingin on behalf of our design team.



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Project lead



COLLINS + TURNER
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Heritage



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Engineers



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Movement + Cycling



ELECTROLIGHT
Lighting

1.2 Country to Country

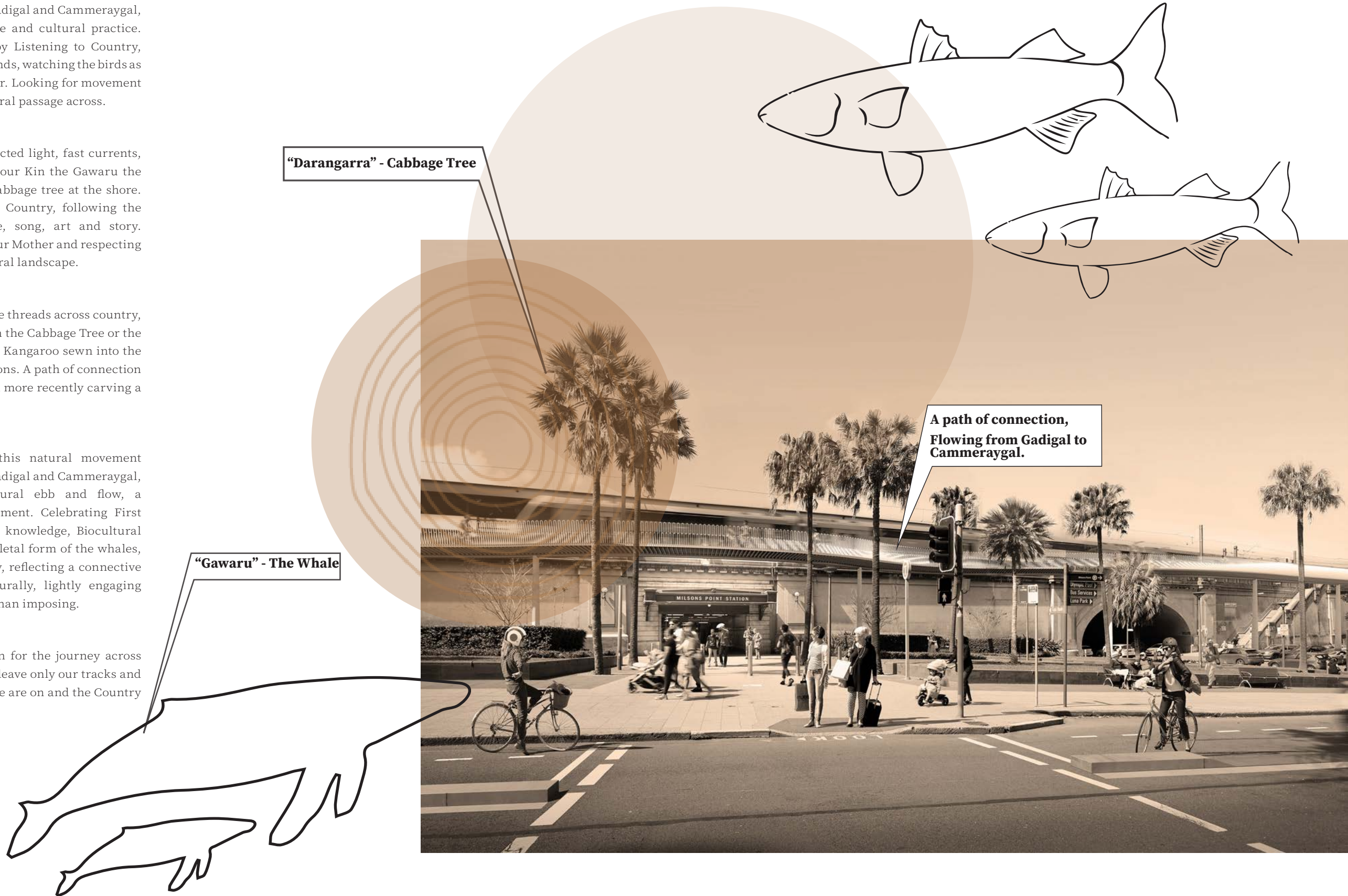
The Sydney Harbour Bridge is the alignment of the movement traversed by the Gadigal and Cammeraygal, to share resources, knowledge and cultural practice. This design journey begins by Listening to Country, Ngara Bamal the prevailing winds, watching the birds as they feed and span the harbour. Looking for movement in the water, the tides the natural passage across.

A Journey of filtered and reflected light, fast currents, and eddies, being greeted by our Kin the Gawaru the Whale and Darangara the Cabbage tree at the shore. We respect and acknowledge Country, following the paths shared through dance, song, art and story. Ensuring we tread lightly on our Mother and respecting the custodians and their cultural landscape.

These stories and paths are like threads across country, like the fishing line made from the Cabbage Tree or the Kurrajong, or the sinew of the Kangaroo sewn into the cloaks worn in the colder seasons. A path of connection and a confluence of clans, and more recently carving a path to reconciliation.

Our design connects with this natural movement across the confluence of the Gadigal and Cammeraygal, a threshold guided by natural ebb and flow, a transition of light and movement. Celebrating First Nations traditional ecological knowledge, Biocultural connection to ecology, the skeletal form of the whales, fish and shells of this Country, reflecting a connective thread, a sinew flowing naturally, lightly engaging Country upon arrival, rather than imposing.

Country is again a companion for the journey across the deep water, and where we leave only our tracks and Acknowledging the Country we are on and the Country we come from.



2 Site

2.1 Site Appreciation

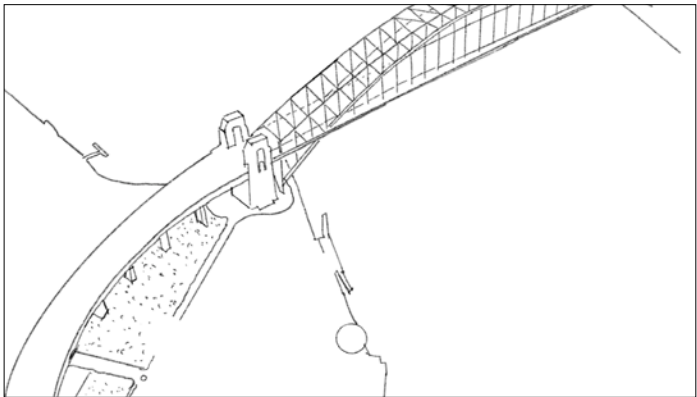
Country

Country encompasses every aspect of this place – the earth, the sky, the water and all living entities. It is the essence of this place and underpins all elements within and how this place has evolved.



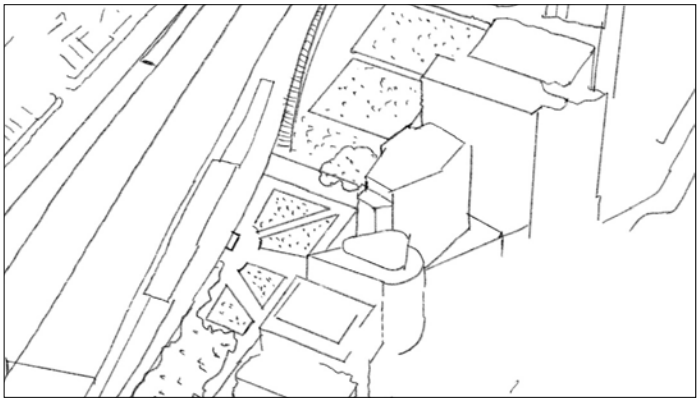
Bridge

The sweep of the approach and the arch of the span are imprinted as expressions and experiences of the city. Experiencing them is intrinsic to journeys between Cammeraygal Country and Gadigal Country and for people within this area.



Park

Bradfield Park is a key open space that is treasured by the local community and with heritage status in its own right and in parallel to the bridge and station. An element of the place that has sustained life with essential green infrastructure, habitat for local fauna and social interactions of the community.



Movement

Throughout millennia the movement of people and the importance of arrival has been fundamental attribute of this place. The confluence of people moving to and from public transport and around this area as pedestrians, the local vehicle traffic movements and the evolving role of cycling connections to support its growth sit against the backdrop of essential road and rail flows over the bridge.



2.2 Site Analysis

A complex network of heritage structures, serious infrastructure, amazing views with places for the every day.

Bradfield Park North

Bradfield Park North is bounded by the northern SHB abutment along the east and open to along the west to Milsons Point commercial and residential zone. The Park is characterised by lawns, a dense but pleasant tree canopy of mature trees, paths, and artworks. The Park contains remnant of kerbs marking the western end of the former Willoughby Street prior to the bridge’s construction and interpretation of former structures. The Park straddles the crest of the Milsons Point ridge which offers a natural survey point looking south toward the Harbour bridge.

Milsons Point Station Entrance

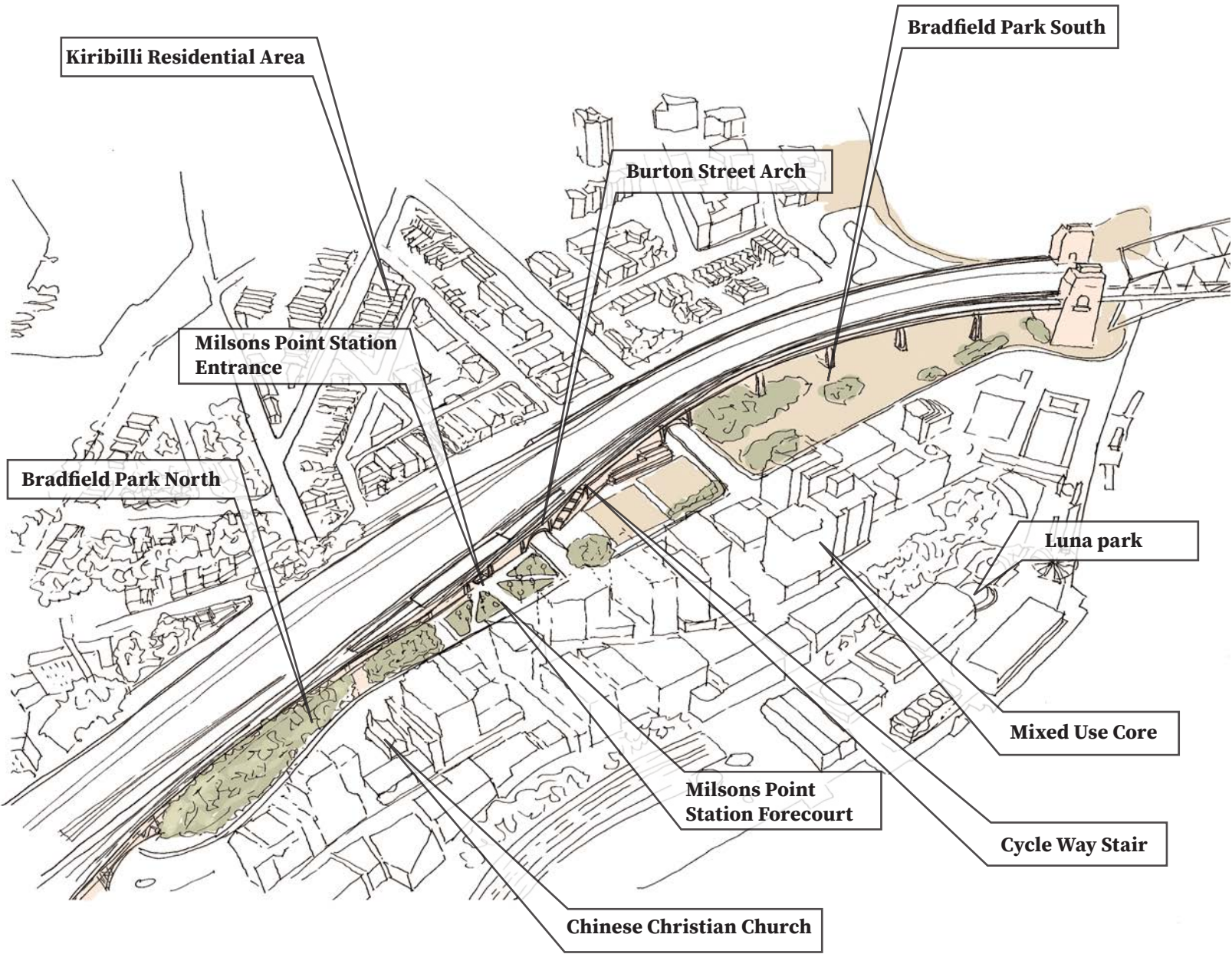
The station entrance is an integral part of the SHB and a focal point of the radial paths and trees that make up Bradfield Park Central. The entrance features the original decorative awning as well as symmetrical light fittings and twin pilasters supporting a classical cornice and parapet. The parapet features a central crest inscribed with the date of the SHB opening in 1932.

Burton Street Arch

The Burton Street arch sits adjacent to the existing cycleway stair. It is an integral element to the SHB and an essential part, both historically and aesthetically, of the northern approach to the Sydney Harbour Bridge. The underpass is used as an important pedestrian connector to the smaller scale village environment of Kirribilli and offers opportunity for the Kirribilli markets (since the mid-1970s). The CMP acknowledges the visual prominence and landmark value of the arch and for its setting to be retained and respected.

Kirribilli Residential Area

Kirribilli Village centre is a low to moderate scale residential suburb with a number of shops, cafes and schools. Residents are of low single houses including terrace houses and medium density walk-up houses.



Chinese Christian Church

The Chinese Christian Church dates from 1888 and is located on the ridge line of Milsons Point and is a natural survey and orientation point along Argyle Street.

Luna Park

Luna Park is a state heritage listed amusement park located on the Sydney Harbour Foreshore. The place is an attractor for tourists and visitors to Milsons Point and the station park.

Mixed Use Core.

The mixed use core is a high density mixed use area with buildings generally 20+ stories. The area attracts a range of visitors and locals that will frequent the Milsons Point area.

Cycleway stair

The stair is integral to the construction of the bridge and abutments. While it may be maligned by some, the stair’s architectural detailing including concrete pilasters, lamp and ornamental parapets that peel off the bridge remain. The stairs are significant as highly intact, original elements of the SHB and must be retained.

Milsons Point Station forecourt

The station forecourt is a prominent piece of open space and significant to both the Milsons Point Station and the curtilage for the SHB and its concrete abutments. The space is heavily frequented by pedestrians due to its proximity the train station and offers excellent unobstructed key views toward the SHB including the curving sweep of the approach spans, pylons and the arch. The space is also characterised by formal plaza layout further defined by raised planters, mature palm trees lining the radial approaches to the station. The sky, open space and views are exceptionally important spaces to retain, respect and protect.

Bradfield Park South

Bradfiel Park South lies outsided the area of influence of the cycleway bit is an important open space park dominated by the approach spans of the SHB and its granite pylons. The park comprises sloping open lawns with pockets of mature tress and views to Sydney Harbour. This space is listed on the World Heritage List and includes the Work Heritage Buffer Zone of the Sydney Opera House.

3 Design Statement



3.1 Setting the Scene

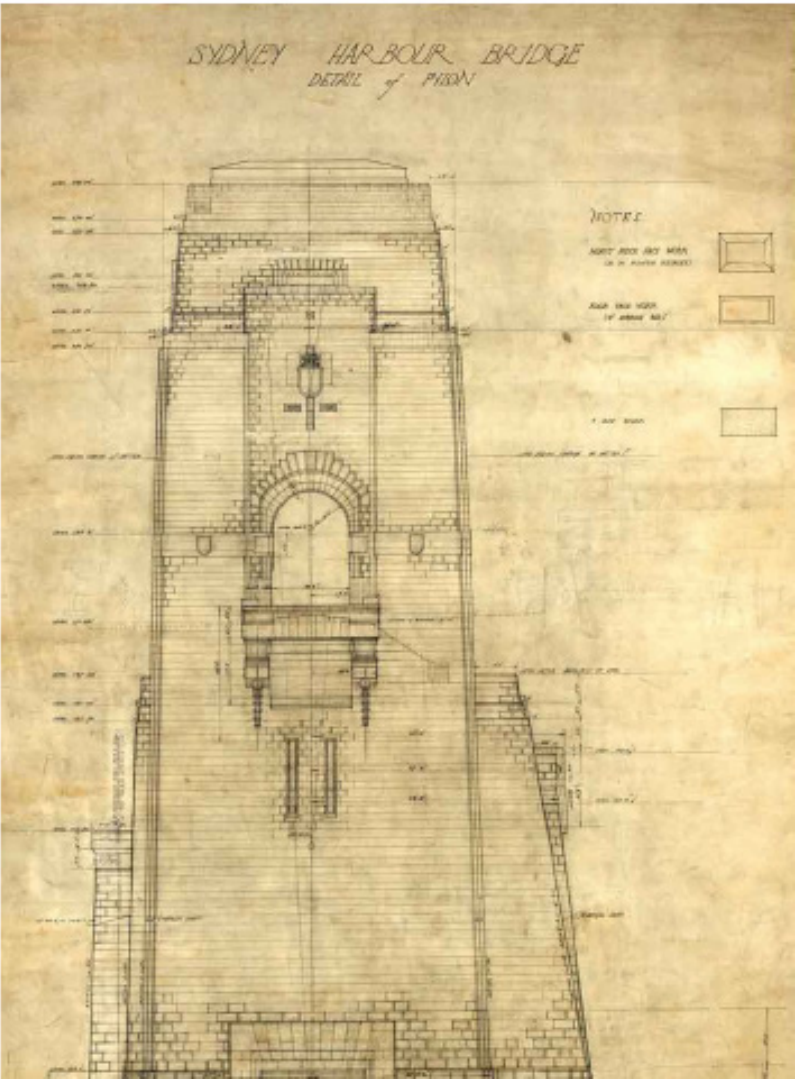
Our approach is drawn entirely from its setting. This much needed piece of civic infrastructure balances local impact with citywide opportunity.

Balance is the key word for this project. We believe that ‘threading the path’ between intervention and preservation, subtlety and identity, lightness and integrity should be the basis for evaluating success .

To our minds, success lies in delivering on the primary design challenge which is to achieve functionality and preserve what is unique and powerful about the setting and valued by the community; that being - Country, the bridge and Bradfield Park

This can be described in three scales:

- embedding ‘meta narratives’ of designing with respect for this Cammeraygal Country.
- the preservation of significant scenic and place defining cultural fabric - Bradfield Park and the Sydney Harbour Bridge,
- and the design of structure which is elegant, enduring, and a delight to use for all cyclists.



3.2 Alignment

Our design seeks to maximise the retention of the existing relationship between Bradfield Park and the Bridge itself - an act of allowing Country to breathe.

Our aim in developing the design presented here is the minimal intrusion on views to the Bridge for most park users, residents, commuters and visitors.

In seeking a unique design outcome we have strived for the lightest touch- brushing the sky, earth and existing structure, with a form that dissolves into air whilst leaving the much loved park largely untouched.

We honour the sweep of the Bridge at the macro scale with a formal language that complements the sweeping curves of the approach viaduct and the arch beyond, maximising the legibility of state heritage registered structures including the Milsons Point Station entry and Burton Street arch.

With this in mind we have matched the cycleway’s alignment to that of the of the viaduct, such that infrastructure and movement are combined in a more simple, complementary and intuitive manner leaving the park open and uncluttered.

The cycleway geometry adjusts with deference to the heritage of Milsons Point Station entry. The extent of the curve carefully traces the powerful park geometry on the ground plane. In doing so, the cycleway frames the address to Milsons Point Station and it’s forecourt, and subtly slows cyclists as they descend towards Bradfield Park. The cycleway flattens out over the heritage awning to create an address which when viewed from Alfred Street respects the established datums of the approach viaduct.

Our design premise is that we let the site’s topography and significant existing values guide our moves to deliver the 21st-century public infrastructure which is distinctly of its place.



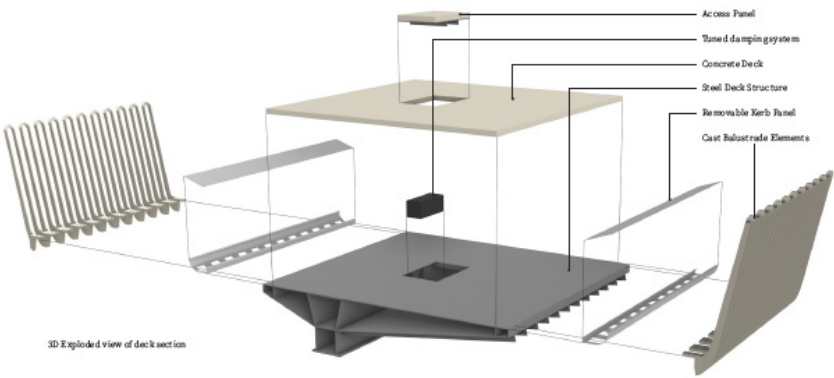
3.3 Form + Detail

The serpentine form, an assembly of complimentary curves, is minimal in its solution and organic in its geometry.

Lightness, fluidity and transparency have been given equal weighting to robustness, build-ability, sustainability and long-term maintenance in our matrix of considerations.

We have looked for inspiration from a wide range of sources in the natural and modern worlds to arrive at a design solution that ties this project to its place. By utilising leading sustainable technologies and simple construction we maximise efficiency and minimise waste.

We have considered the structural detail as a kit of parts - an assembly of modular components fabricated offsite which are assembled to create a continuous, elegant and seamless fluid form. These elements combine to create a piece of civic infrastructure, an enduring and timeless composition appropriate for a 100 year lifespan.



3.4 Gradient + Park Integration

Gradient

A key benefit of our concept is that the cycleway achieves an average gradient of 2% percent along its length, and relaxed gradients of less than 5% in all areas. The cycleway responds to key moments such as over the entrance to Milsons Point Station where it levels out to respect the heritage fabric. The long linear alignment which closely mirrors the sweep of the bridge and approach viaduct creates a more gentle and safe gradient than that of the reference scheme.

Park Integration

By placing the cycleway at the very edge of the park, we preserve the existing experiential qualities of Bradfield Park and the scale and significance of the viaduct wall.

We land the cycleway on the existing eastern most path and therefore minimise the requirement for additional hard surfaces and preserve all existing trees.

The removal of pedestrian circulation on the eastern side is rationalised by giving clear separation to the forecast 2000 cyclists utilising the new pathway each day. We have prioritised separating of movement to limit conflict between pedestrians and cyclists. The Alfred Street footpath which is generous in width is reduced from 5m down to 4m along its length, providing adequate opportunity to enter and use Bradfield Park without diminishing user amenity.

The cycleway lands on ground just to the south of the existing rotunda and we bring the cyclist to the highpoint of Alfred Street, which intersects on axis with the Chinese Christian Church and the former alignment of Willoughby Road.

There are significant safety benefits of arriving at this point on the highest ground at the north of Bradfield Park in that cyclists and pedestrians have excellent prospect and vision to ensure that any conflict is mitigated.

We have taken into account that only 20% of Cyclists are anticipated to travel on to the Burton Street underpass and 80% will travel north along the Pacific Highway or towards North Sydney. The 20% returning down Alfred Street have the benefit of the down hill run on the proposed bi-directional cycleway on Alfred Street adding only 20 seconds to their journey.

We understand that any intervention into an existing public space is a process of stakeholder negotiation and we commit to a collaborative co-design with TfNSW and North Sydney Council to ensure the community receives not just like for like, but a better outcome with excellent amenity.



3.5 Summary and Evaluation of Benefits

At it's completion in 1932 the Sydney Harbour Bridge was one of the most advanced pieces of structural engineering ever constructed - and the largest single span bridge in the world.

More than the technical prowess of the teams that conceived, designed and fabricated it, and the toil and skill of the labourers who built it, the completion of the arch symbolised in steel, concrete and stone an act of nation building. With a land connection between Sydney's northern and southern suburbs finally enabled - Bradfield's vision was complete, and the city transformed.

90 years later, the Harbour Bridge Northern access project similarly represents the opportunity to affect the lives of millions, with the construction of the missing link in the cities active transport network.



Whilst this linear alignment is a departure from the reference scheme we base our proposition on an evaluation of impacts which span usability, heritage, and design with Country.























Through the careful organisation of alignment, form and detail, our design concept preserves as much as possible the existing relationship between Bradfield Park and the views toward the sweeping intersecting arcs of the Bradfield Highway and the towering steelwork beyond, whilst maintaining as much as possible of the park.

In seeking a vocabulary for the new structure's design, our team has collaborated closely to evaluate a series of alternative strategies against a matrix of core criteria. Our team have framed this evaluation in consideration of the primary place & project drivers that have been identified - Country, the Bridge (including Milsons Point Station), the Park and Cycleway Performance. This matrix and our design proposition builds upon the foundational work that TfNSW have done.

Our scheme capitalises on opportunities for meaningful impact on the various users of this place, and considers a variety of personas who have a significant stake in this project. These include locals, tourists and visitors, station users and other train passengers passing through, cyclists from 8 to 80, heritage enthusiasts and first nations people.

The table adjacent indicates the results achieved with our design proposition. In all cases we have sought balance across the place & project factors and how the design proposal will impact on people's appreciation and use of this area.

-  Positive refinements
-  Retention of existing positive attributes

Country	
Visual Impacts on views to Country including sky, earth and water	
Impacts on appreciation of native flora and fauna	
Integration of Country Narratives beyond cycleway	
Bridge	
Visual Impacts on views of SHB (refer Heritage section for further information)	
Fabric Impacts on SHB	
Improves accessibility to iconic struncture of SHB	
Provision of a refined and elegant structure to harmonise with visual power of SHB	
Circulation Impacts on movements to and from Milsons Point Station	
Construction Impacts	
Park	
Visual Impacts on views of Bradfield Park (refer Heritage section for further information)	
Fabric/Landscape/Archaeology Impacts on Bradfield Park	
Amenity Impacts on Bradfield Park	
Circulation Impacts on movements to and through Bradfield Park	
Construction Impacts	
Cycleway Performance	
Widths	
Grades	
Curvatures at change of direction	
Safety & Security considerations	
Cycling & Pedestrian Conflict	
Integration with broader network	
Travel Time	
Provision of rest/gathering/amentiy points	



4 Heritage

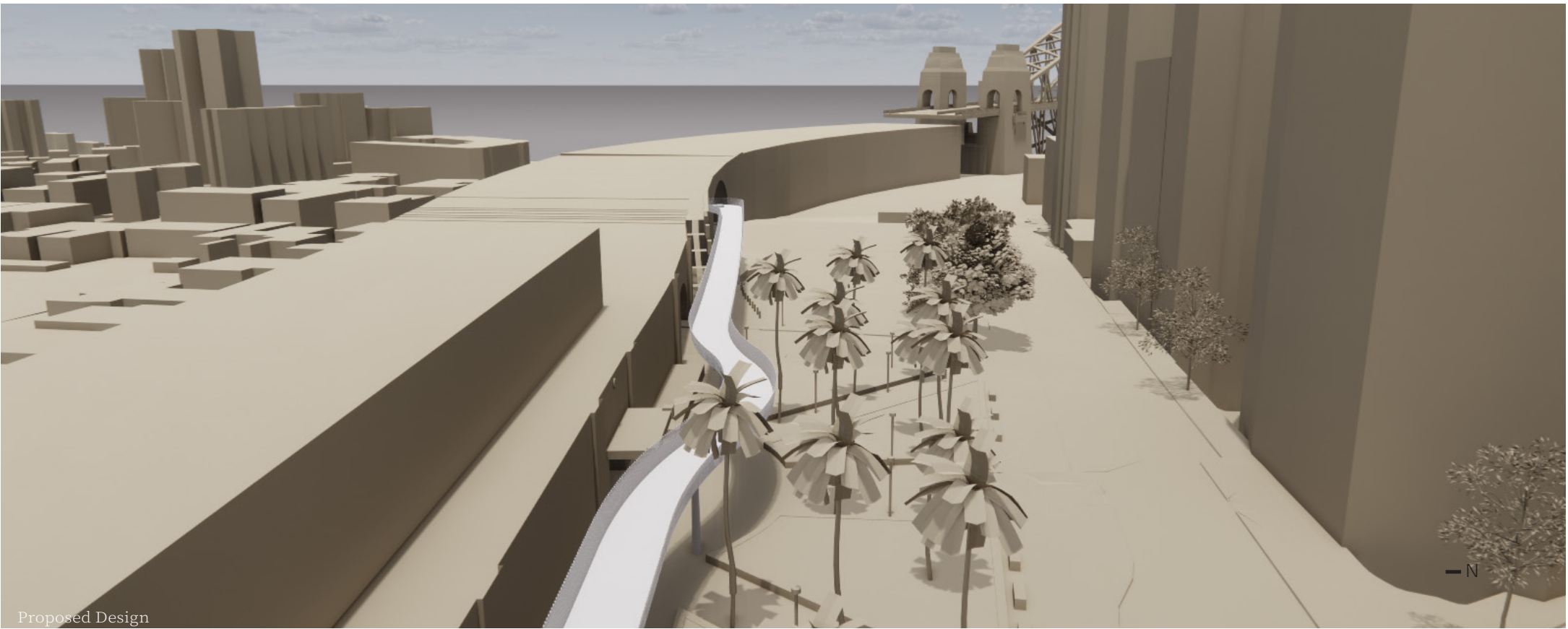
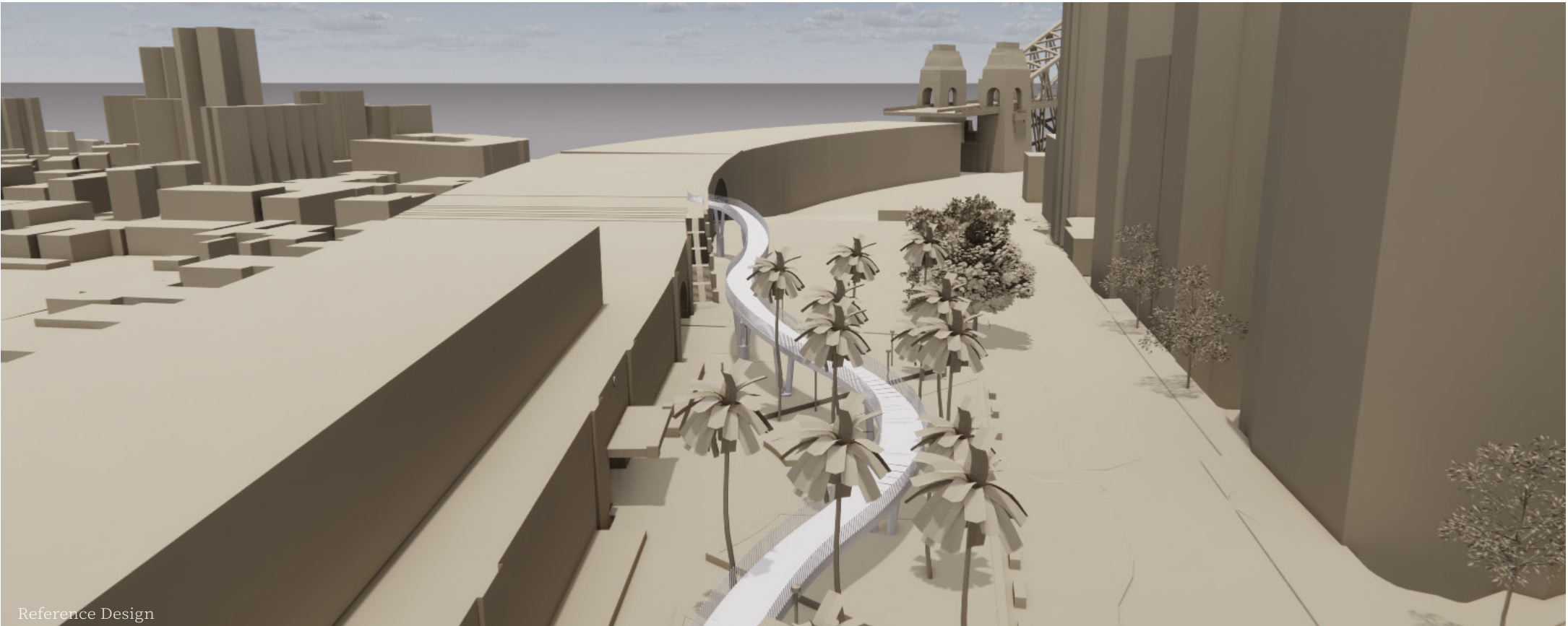
4.1 Heritage Assessment

Close consideration of the heritage values of the Sydney Harbour Bridge, Milsons Point Railway Station Group and Bradfield Park have guided the evolution of the cycleway design proposal. Key reference documents including their listings, conservation management plan and other relevant heritage management documents have been referenced and evaluation undertaken throughout the process.

The evolution of the alignment of the design proposal has considered the cycleway as an object that is seen in the round from many locations. The visual analysis of impacts on the views to the heritage elements has been fundamental to the decision making about the design proposal.

Summary of the heritage aseessment of the design propoals indicates that the proposed design:

- retains and respects the key views towards the SHB and its northern approaches;
- strengthens active transport links between the CBD and the north side of the Harbour;
- improves accessibility for cyclists to this iconic structure and the experience of making this crossing;
- does not connect with or affect the fabric of SHB except at southern arrival point;
- aligns itself and relates closely to the curvature of the bridge approach and does not detract from or intrude on the visual power of this engineering masterpiece;
- enhances the accessibility of active transport to and across the bridge and strengthen its social value;
- combines functionality with simple, refined and elegant structure consistent with the original design intent for the bridge;
- is a simple, direct and elegant response to the project brief;
- retains and respects the landscape and configuration of Bradfield Park with its uninterrupted views of the sky and the curved approach to SHB;
- respects the Bradfield Park archaeological site with minimal minimal impact;
- the cycleway ramp touches down lightly with a natural sense of belonging on the alignment of the former Willoughby Street



4.2 Visual Impact Analysis

The various key views towards and from the SHB and Milsons Point station entry, demonstrate clearly that the proposed alignment and design of the cycleway ramp will result in considerably reduced visual impacts on these views, and retention of the visually open character and public space of Bradfield Park, thereby respecting the recent works and planting carried out by North Sydney Council.

The proposed design acknowledges and respects the symmetry of the station entry design and its role in providing shelter and framing views to the park and SHB. The subtle curving out of the ramp at this location is an acknowledgement of the importance and design integrity of this entry.



VIEW SOUTH ALONG ALFRED STREET NEAR SCULPTURE: Reference Design



VIEW SOUTH ALONG ALFRED STREET NEAR SCULPTURE: Proposed Design



VIEW SOUTH FROM BRADFIELD PARK NORTH: Reference Design

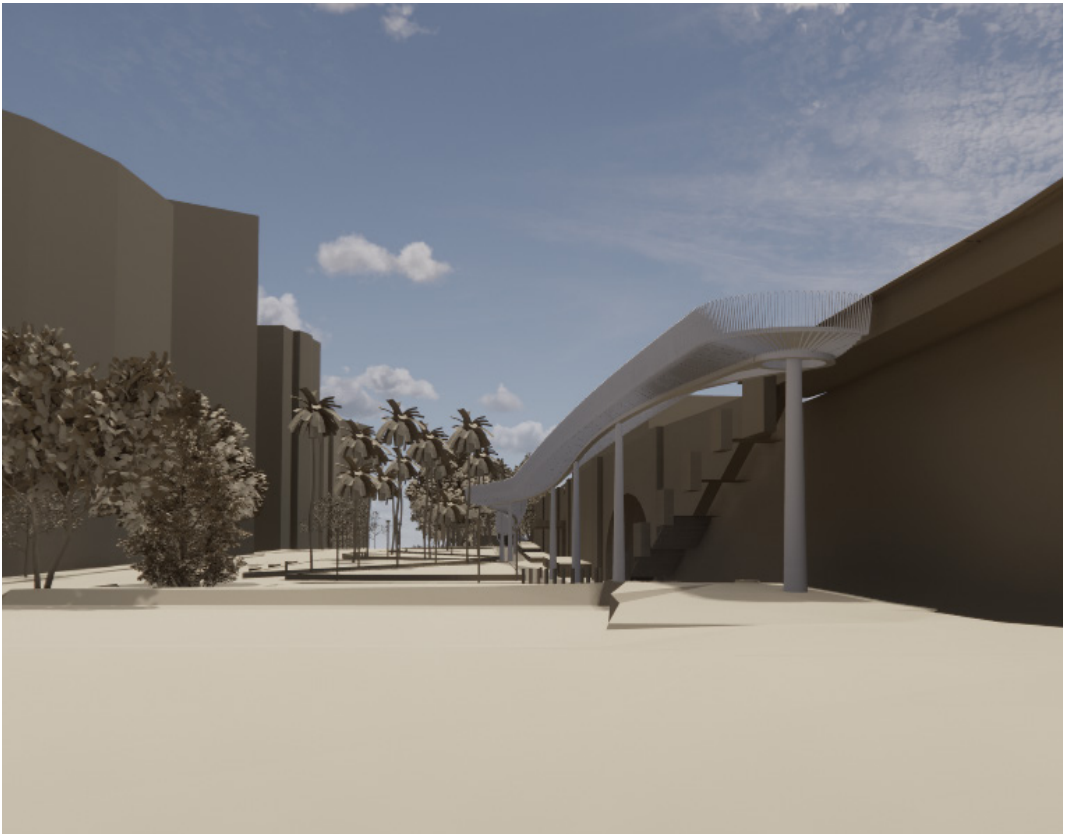


VIEW SOUTH FROM BRADFIELD PARK NORTH: Proposed Design

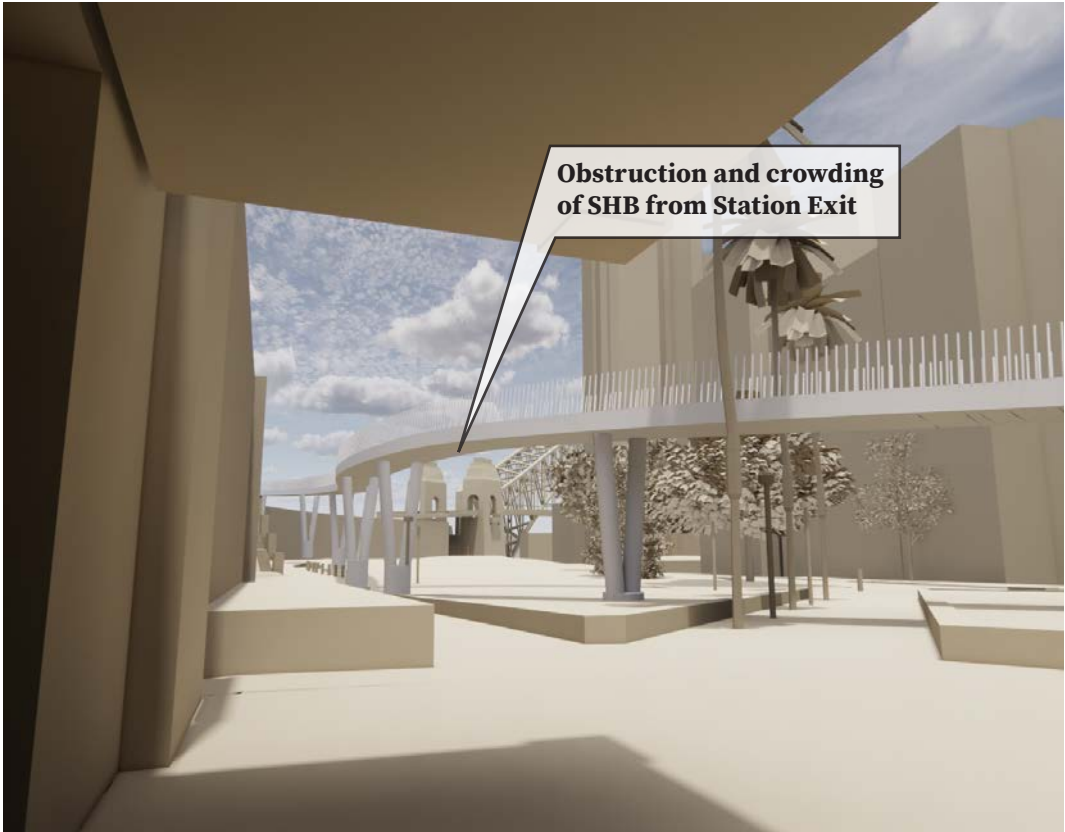
4.2 Visual Impact Analysis



VIEW NORTH FROM BRADFIELD BOWLING CLUB: Reference Design



VIEW NORTH FROM BRADFIELD BOWLING CLUB: Proposed Design

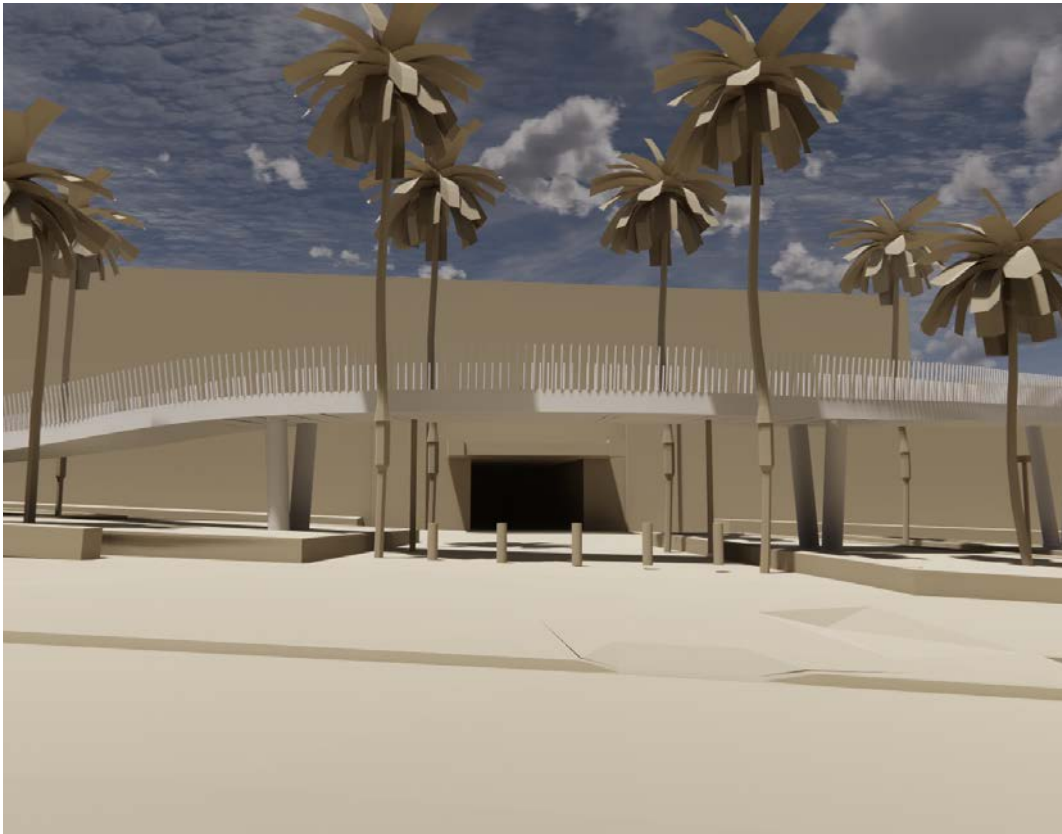


VIEW SOUTH FROM STATION EXIT: Reference Design

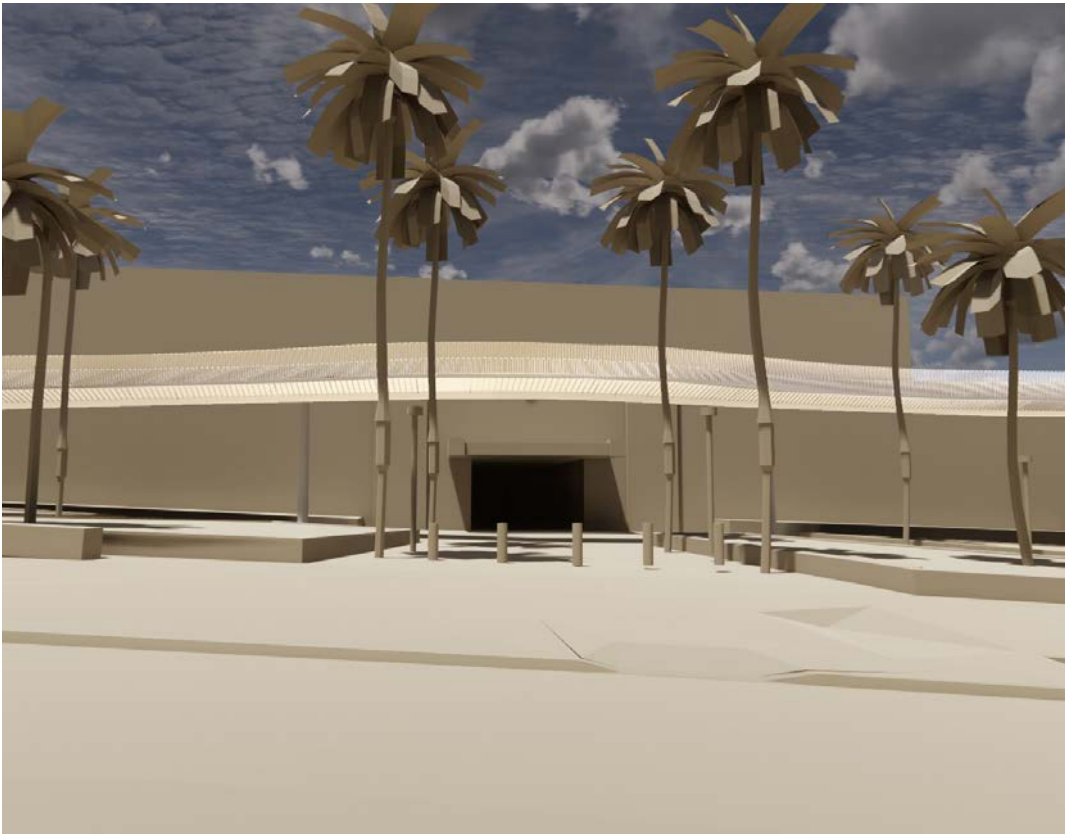


VIEW SOUTH FROM STATION EXIT: Proposed Design

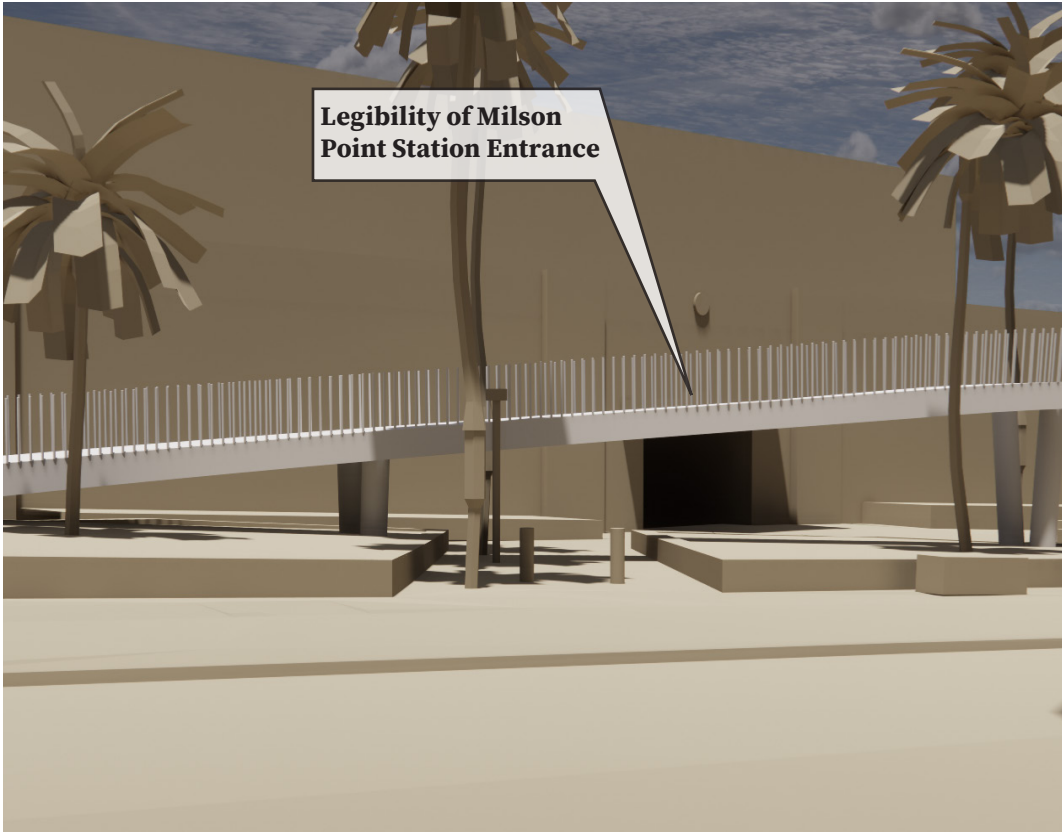
4.2 Visual Impact Analysis



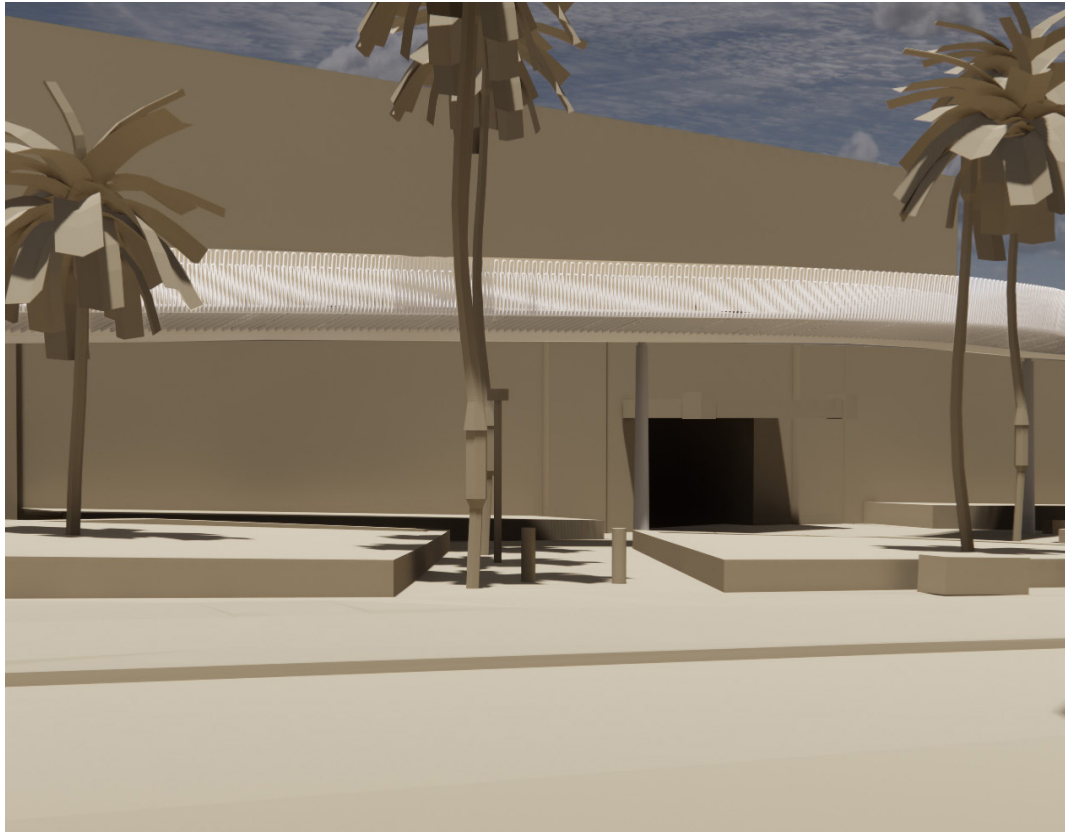
VIEW TOWARDS STATION ENTRANCE ON AXIS: Reference Design



VIEW TOWARDS STATION ENTRANCE ON AXIS: Proposed Design



VIEW ALONGNG N-W DIAGONAL PATH TO STATION: Reference Design



VIEW ALONGNG N-W DIAGONAL PATH TO STATION: Proposed Design

5 Transport

5.1 Transport & Movement

The Sydney Harbour Bridge is one of the busiest cycleway corridors in Sydney, with approximately 2,000 cyclists per day using this link. The 55 steps at the northern end act as a significant impediment to the movement of cyclists and limit future growth in cycling numbers due to capacity constraints. The stairs also limit the ability for cyclists using larger bikes such as E-Bikes or Cargo Bikes from using the existing cycleway. It is critical that the cycleway provides for an inclusive design solution that meets the needs of all users – meeting the ‘8 to 80’ objective of enabling access for users of all ages and abilities and this has been a key driver for this design.

Our design solution meets the needs of cyclists by providing a high-quality connection between Bradfield Park North and the existing bridge structure. A 3m wide cycleway (between kerbs) is provided along the full length of the structure which exceeds the 2.4m width provided in the reference design. This increased width will provide for a more comfortable ride for cyclists of all abilities and capacity of projected future transport.

The average gradient of the cycleway is 2% which is a 4m elevation change over a distance of just under 200m. This gradient is fully compliant with the project brief and relevant AUSTROADS design guidelines which recommends average gradients of no more than 3% for cycleways longer than 100m. The design provides for a flat and slightly curved section of ramp adjacent to Milsons Point station which will facilitate both an easier journey for cyclists riding up the ramp as well as reducing speeds of cyclists travelling in the northbound direction. The shallow gradient adopted will assist in meeting the objective of providing a cycleway that is inclusive for riders of all ages and abilities. The maximum gradient of 4.5% also falls below that recommended in the project brief of 5%. The minimum radius of 21m is also compliant with the design brief.

The adopted cycleway design provides for an extended bridge structure that lands in Bradfield Park North approximately 50m north of that contemplated under the TfNSW reference scheme -close to the existing rotunda structure. This landing point has been selected to provide benefits to the movement of cyclists and pedestrians in the area, including:

- Allowing for a reduced average gradient when compared to the reference scheme – providing for a more comfortable riding experience.
- Reducing conflicts between pedestrians on Alfred Street and cyclists using the new ramp given the separation provided between these user groups, especially where public transport across is the driver of movement.
- Providing for improved sight lines for cyclists given the cycleway lands at the ‘high point’ on Alfred Street.
- Facilitating an easier and safer transition onto the future Alfred Street separated cycleway given the flat gradient at which the cycleway lands in Bradfield Park North.

It is important to recognise that it is common for cyclists to utilise the northern end of the existing cycleway at Milsons Point as a place to gather and discuss their next movements. This may be stopping at Kirribilli for a coffee, continuing on through to North Sydney or simply discussing aspects of their outing. In this context it is important that a generous amount of space is provided at the base of the ramp to allow this to take place without conflicting with other users of Bradfield Park North or Alfred Street. Our design provides this objective by landing the cycleway close to the existing viaduct and well away from Alfred Street. A new park amenity-Cammeraygal Place, has been proposed to provide additional seating and bike hoops. This will provide cyclists with time and space to make a decision whether to stop and gather or continue on their journey north or south along Alfred Street.



The cycleway landing in the adopted design lands in Bradfield Park North approximately 50m north of that contemplated under the TfNSW reference scheme. This additional distance, travelling at a comfortable cycling speed of 10km/h, would result in a very minor increase in travel time of approximately 20 seconds for the 20% of cyclists traveling back south towards Burton Street.

In addition to the needs of cyclists, pedestrian connectivity and safety has been prioritised as part of the adopted design. This includes:

- The retention of key pedestrian pathways in Bradfield Park North, including the majority of the existing north-south footpath that runs adjacent to the existing viaduct.
- Strategic placement of columns outside of Milsons Point station to be clear of the key pedestrian desire lines

towards Alfred Street. The column locations will not impact pedestrian movements between the station entry point and the three primary east-west pathways connecting through to Alfred Street.

- Good level of separation between the cycleway landing point and the Alfred Street footpath which will reduce the instances of conflicts between these user groups.
- Retention of the 55 stairs for use by pedestrians for exercise or as an elevated look out.

The design will result in a minor relocation of an infrequently used east-west pathway near the existing rotunda. Existing east-west pathways further south on Alfred Street would be retained and facilitate pedestrian connectivity through to the pathway adjacent to the viaduct.

6 Structure

6.1 Structural Design

The following describes the structural strategy for the elevated cycleway :

Foundations

Foundations will be bored reinforced concrete piles, a single 600 or 900mm diameter pile with a reinforced concrete pile cap thickening located below paving level. Alternatively, smaller diameter piles could be used in order to limit the need for a large pile rig and the associated disruption to trees and existing landscaped elements. For the smaller piles a larger pile cap would be required but due to the location of the columns in the paved areas these pile caps can be relatively shallow and do not risk damage planted areas.

Columns

The column locations have been specifically chosen to provide minimum disruption to the existing sight lines, pathways and planted areas of the park. All columns are located in areas of paving rather than planted areas meaning less disruption to the landscaping as well as allowing better access for construction or any maintenance. The shallow pile caps mean the columns will start closer to the surface with only paving over the base connections.

The column itself will be formed as a tapered ellipse profile with the smallest dimension of the column aligned to the axis of the bridge. This means the column is as small as possible in elevation while providing the lateral support against sway and sideways wind loading.

The dimensions of the columns are shown as 400mm x 300mm ellipse at the top tapering down to a 750mm x 500mm ellipse at the base. This is based on the max height column of approximately 8m. for the shorter columns the geometry of the larger column will be maintained and reduced from the bottom maintaining the top profile and shape but reducing the base profile.

The columns are precast concrete in order to reduce on site formwork and associated disruption including long build times. In addition, the precast solution will allow a higher degree of quality control, precision and consistency from the factory formwork.

Each column will require a bearing at the interface with the bridge deck, typically allowing rotation, with some also allowing longitudinal movements this being required for thermal expansion effects.

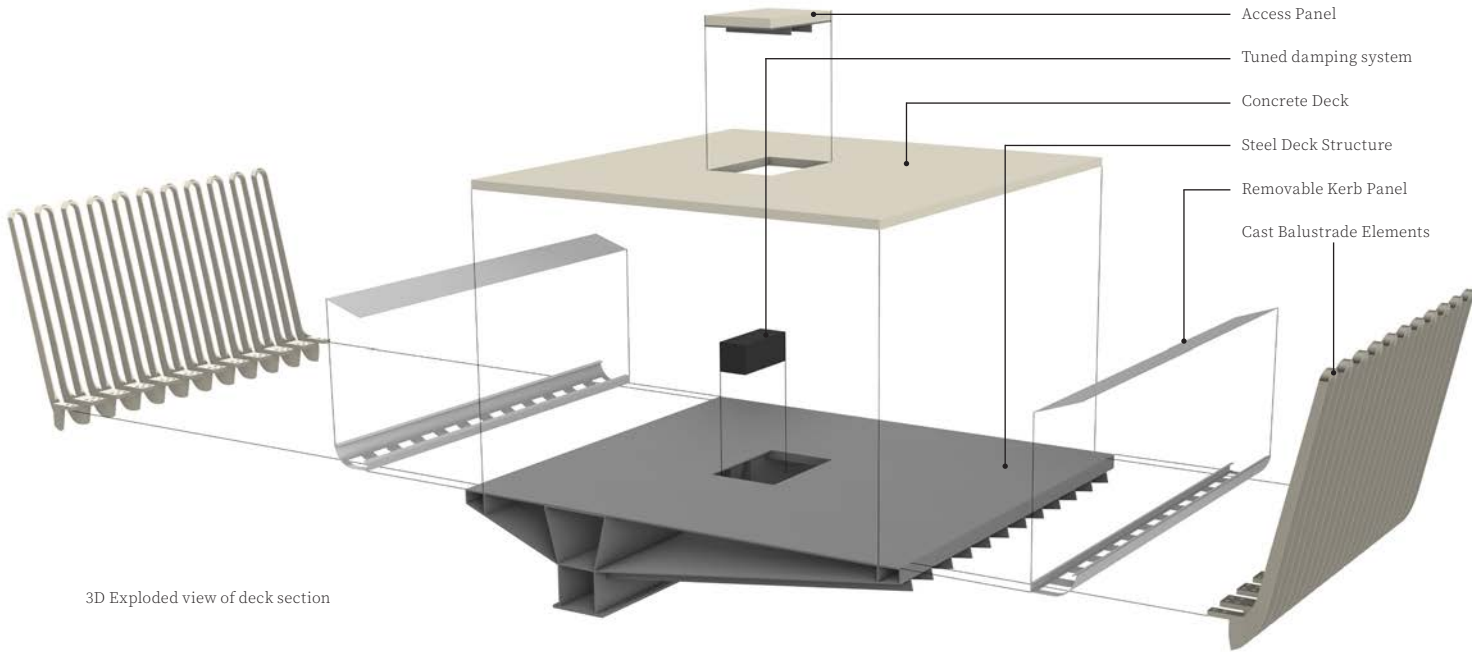
Central Beam and Deck Structure

The deck consists of a semi-monocoque structure with a main fabricated box beam, a stiffened deck plate and lower soffit plate. Both the deck and soffit plates meet at a small edge beam which maintains a consistent edge depth and acts as the fixing point for the balustrade. This forms a very strong cross section which is perfect for resisting the lateral and torsional loading imposed on the design. Additional stiffening ribs are provided on the lower plate to prevent buckling of a thinner steel plate and are also part of the architectural expression of the structure. The deck would be broken into sections for installation according to the bending moment diagram, placing internal bolted splices at points of contraflexure (zero bending moment).

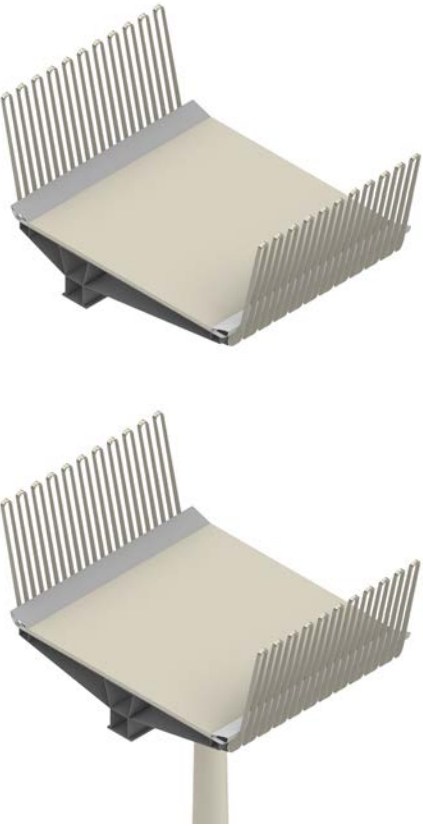
The main central beam sits at 400mm deep inside the deck structure. This datum is maintained as a consistent depth and acts as the interface point for the soffit plates. The beam extends below the soffit and includes an extended flange plate to interface with the columns but also provide a ledge to house lighting a fixture for up lighting the soffit.

The alignment of the beam does not always follow the centre of the deck but is designed with a range within the middle half of the deck width. At the outermost point therefor, it sits on the deck quartile. The variable location of the beam relative to the deck not only allows for a straighter beam line in areas of curvature but also facilitates the movement of columns into the best locations without the need for the deck to exactly follow.

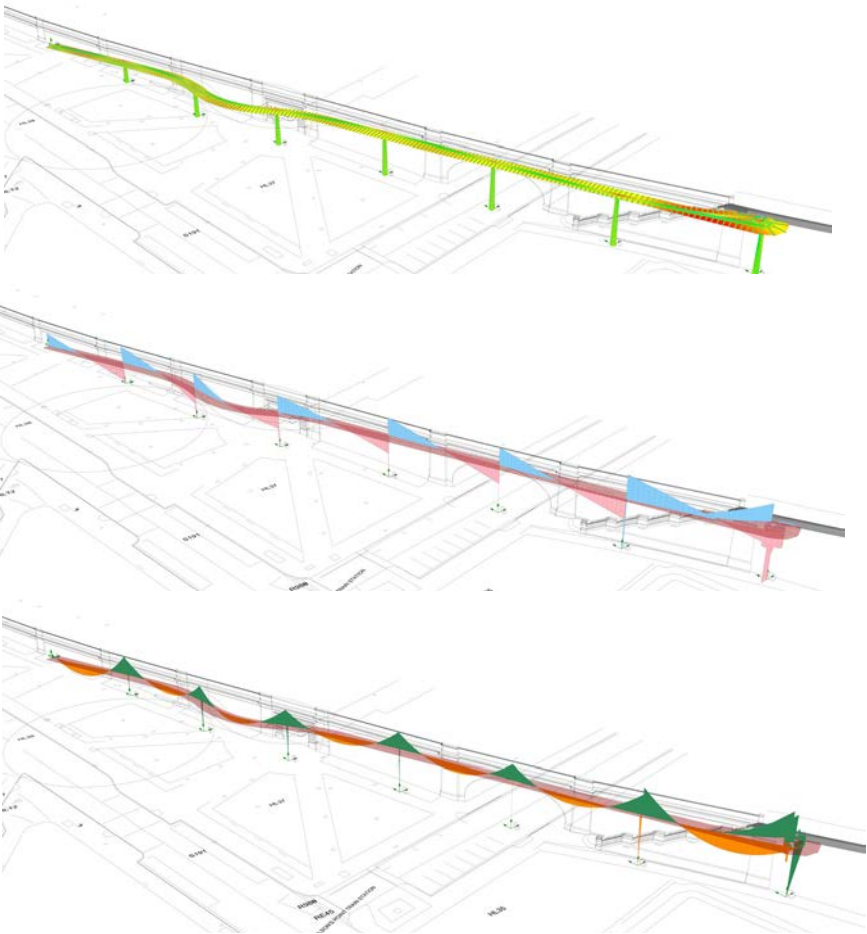
The deck surface consists of a precast concrete surface, which is debonded from the steelwork to add damping to the structure to mitigate against user induced vibrations. To further mitigate against both vertical and horizontal vibration effects a damping system would be installed within the deck section, most likely a tuned mass damper, although potentially a more lightweight system might be beneficial. Incorporating a damping system into the deck is a far more efficient, cost effective and lower embodied carbon solution than adding more steelwork or concrete to the structure to stiffen it to prevent vibration.



3D Exploded view of deck section



3D Axo view of central and offset beam instances



Extract of parametric structural analysis software

6.1 Structural Design

Balustrade design and fixing

The balustrade has been designed as a series of repeating elements that form a barrier up to 1400mm high. Each individual pair of verticals and the connecting arch at the top is connected back to the deck edge beam. This connection will be via a split baseplate with 2 vertical fixings for each side. The fixings will be accessible for installation, removal and replacement from the bridge deck via a removable kerb plate. The design of the balustrade element lends itself to be formed as a cast element and this allows us to accurately tailor the geometry for structural performance to use the minimum volume of material while maintaining the architectural aesthetic and performance requirements. Pending further design development, it may be possible rationalise this into a combination of casting and plate elements to form the same geometry.

Interface with existing bridge and lookout

The lookout forms not only the end of the bridge but also the interface with the existing cycle way. The design maintains the clear cycleway but utilises the end of the bridge as a lookout and gathering space. Structurally this increases the overall dimensions of the deck and in order to maintain the overall depth the single beam transitions into a ring beam arrangement concentric to the circular platform. This ring beam is supported from a central circular column with outriggers allowing for the outer part of the lookout platform to maintain the same construction and aesthetic as the bridge deck.

The interface with the existing bridge is conceived to be as light as possible with the bridge deck structure cantilevering out from the column up to the existing structure with a small gap. The gap is bridged with a cover plate allowing for differential movement and designed to maintain a smooth transition surface for cyclists. The specification of this element will be critical in order to maintain the structural requirements and slip resistance.

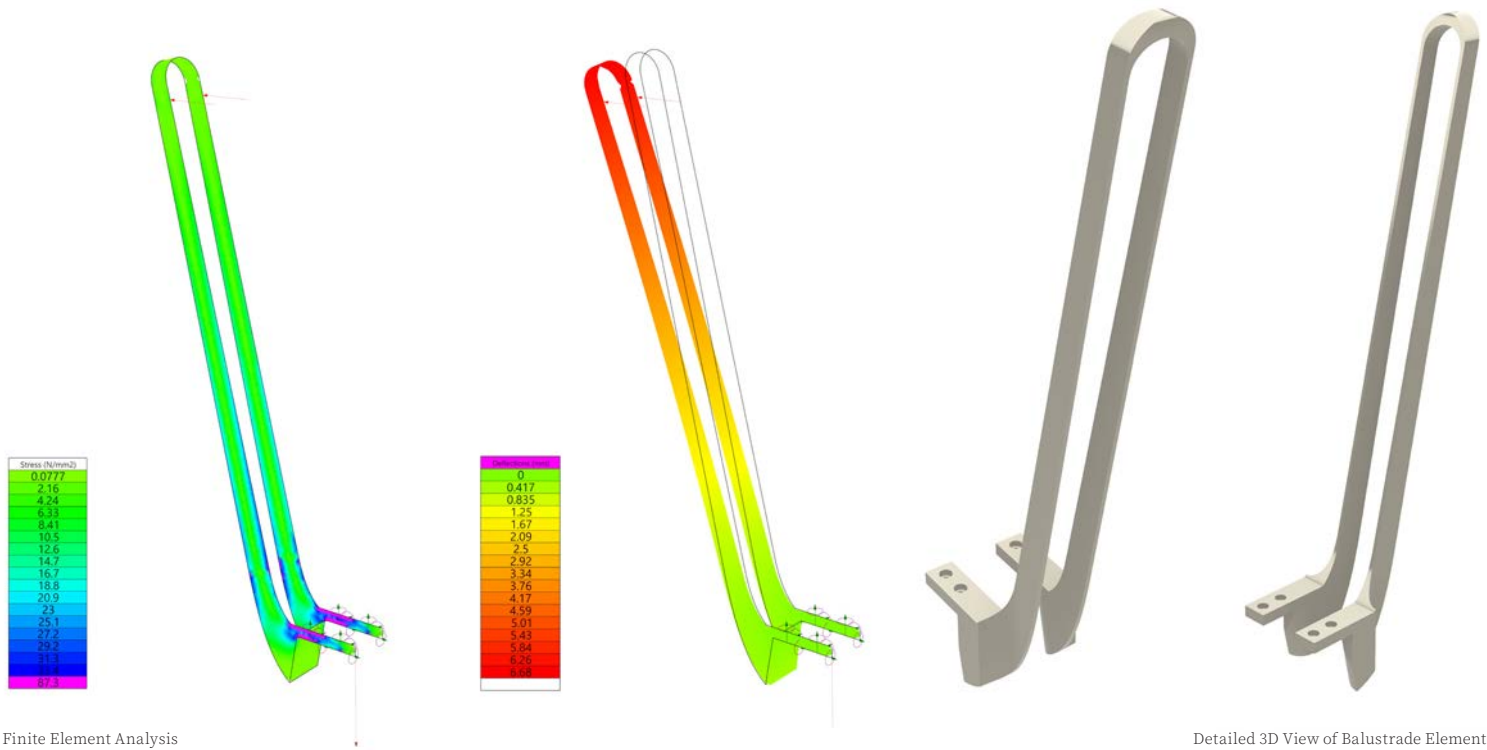
Sustainability, construction efficiency

Careful consideration has been paid the choice of materials and their durability over the life span of the cycleway. For each element we have chosen the most appropriate material from a performance point of view and in keeping with the overall context of the site. For all tactile elements we use raw unfinished materials reducing the need for surface treatments that can be scratched or damaged.

In order to reduce the embodied carbon of the construction we are specifying a low carbon concrete mix for the precast columns and foundations such Holcim ECOPact Zero. The concrete for the bridge deck would similarly use this mix but could also incorporate a high percentage of recycled aggregate both for durability and aesthetics. The bridge deck creates a durable surface with the correct slip resistance, colour contrast and aesthetic quality.

The construction of the deck allows us to very efficiently tailor the internal support structure to minimise weight and embodied carbon. A damping system further allows us to minimise overall mass and associated embodied carbon.

The lightweight modular design of the deck and precast columns allows a high degree of off site construction and associated efficiency. Once the foundations are formed the construction is designed to be installed as a kit of parts without the need for onsite formwork, temporary works or long closure periods of the park.



Top View of balustrade elements and wave geometry. - Fixings exposed for illustration but will be covered by kerb plate

7 Materials

7.1 Fabrication, Finishes and Maintenance

We honour the spirit of the original structure in our proposed construction and finishes for the new cycleway.

State of the art construction techniques were employed by bridge builders Dorman, Long and Co. in the creation of the original, and we similarly envisage utilising contemporary fabrication techniques in the construction of the new cycleway where appropriate.

Our design envisages a refined skeletal structure, visually delicate but robust in its construction, achieved sustainably with the minimum of means.

Combining both ancient and contemporary fabrication techniques, the result is a uniquely conceived form that will provide visual delight whilst enabling safe access to the bridge for cyclists with a wide range of ages and skills.

Minimisation of maintenance over the 100+ year life span of the structure has been a key consideration in the finalisation of the key aspects of our proposal.

Columns - fabrication, colour and surface finish

Precast concrete is proposed for the column structure - a single CNC routed mould will be utilised for the columns of varying heights.

The colour and surface texture of the concrete mix will be carefully selected to respect and compliment the aged appearance of the viaduct revetment walls adjacent.

Options include a smooth texture, sandblasted finish or finely profiled surface formed using the CNC produced moulds.

Cycleway Structure

Similar to an aircraft wing, the serpentine form of the deck will be constructed as a prefabricated monocoque steel assembly, with an expressed skeletal soffit characterised by the meandering central beam below. The steel deck design and fabrication will maximise the potential and efficiencies of contemporary CAD-CAM fabrication techniques.

It is envisaged that a high corrosion resistant paint system will be utilised for the soffit corrosion protection. Options including hydrophilic paint systems will be investigated with industry specialists

during the design development stage of the project, with the aim of maximising the period between re-painting. The proposal envisages that all painted steel is located below the trafficable deck and as such is less exposed to weathering from the elements than would be the case with surfaces exposed directly to inclement weather and U.V.

Cycleway Deck

We envisage that a modular custom concrete paving panel be used for the trafficable cycleway surface. Custom precast using Moruya granite aggregate, the planks will provide a direct and powerful visual connection to the stone clad superstructure of the bridge adjacent.

A precast solution allows the utilisation of casting mould including an anti-slip indentation pattern. The anti-slip pattern presents the potential opportunity for development with a first nations artist to provide a subtle but symbolic connection to country for every journey made across the surface of the new structure.

Cycleway Screen

From the lowest point of the bridge at its northern touch-point to the contact point with the Harbour Bridge western access-way, a flowing woven metallic ‘thread’ will form the screen that provides safety for cyclists at the perimeter of the deck.

Formed from a non-ferrous alloy, the ‘hair-pin’ elements of the screen will be self finished and designed to subtly complement the tones of the existing bridge, and age gracefully without maintenance.

The proposed detail can be achieved with a range of alternative alloys. Metallurgical options will be developed in detail with industry specialists during the design development stage, with the ambition of determining the optimum balance of project budget and long term maintenance requirements. Options will likely include zinc based alloys, light bronze and other alternatives such gunmetal.

Rapid prototyping techniques will allow refinement of the detail, and be used as part of a 1:1 working mock-up that will be used to evaluate and test the assembly of details and finishes as the project progresses.

Maintenance and Cleaning

In the development of our concept, close attention has been given to likely maintenance requirements of the above materials over the lifespan of the structure. Where possible, self finished materials have been proposed, with an emphasis on finishes that age gracefully, developing an attractive patina over time.

Columns

Columns are proposed in off-form concrete with a colourless anti-graffiti coating. Off-form concrete will require no cleaning, however we anticipate that graffiti removal will be required from time to time, with a process determined by the manufacturers guidelines.

Deck soffit

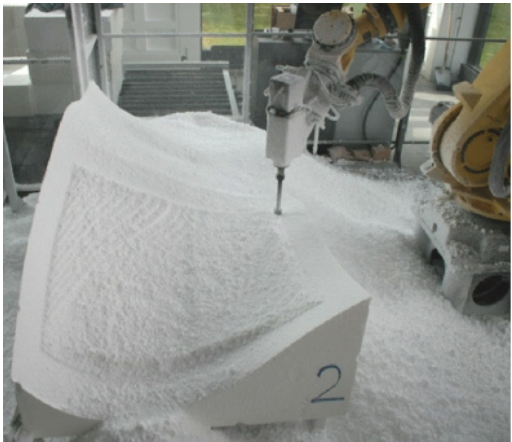
The steel structure and soffit is proposed with a high performance paint finish, suitable for a marine environment. It’s location below the surface of the structure ensures that the paint system is well protected from inclement weather including U.V. It is envisaged that the paint system will likely require re-coating every 25 years, with access easily enabled via mobile elevated working platform from the adjacent pathways.

Cycle screen

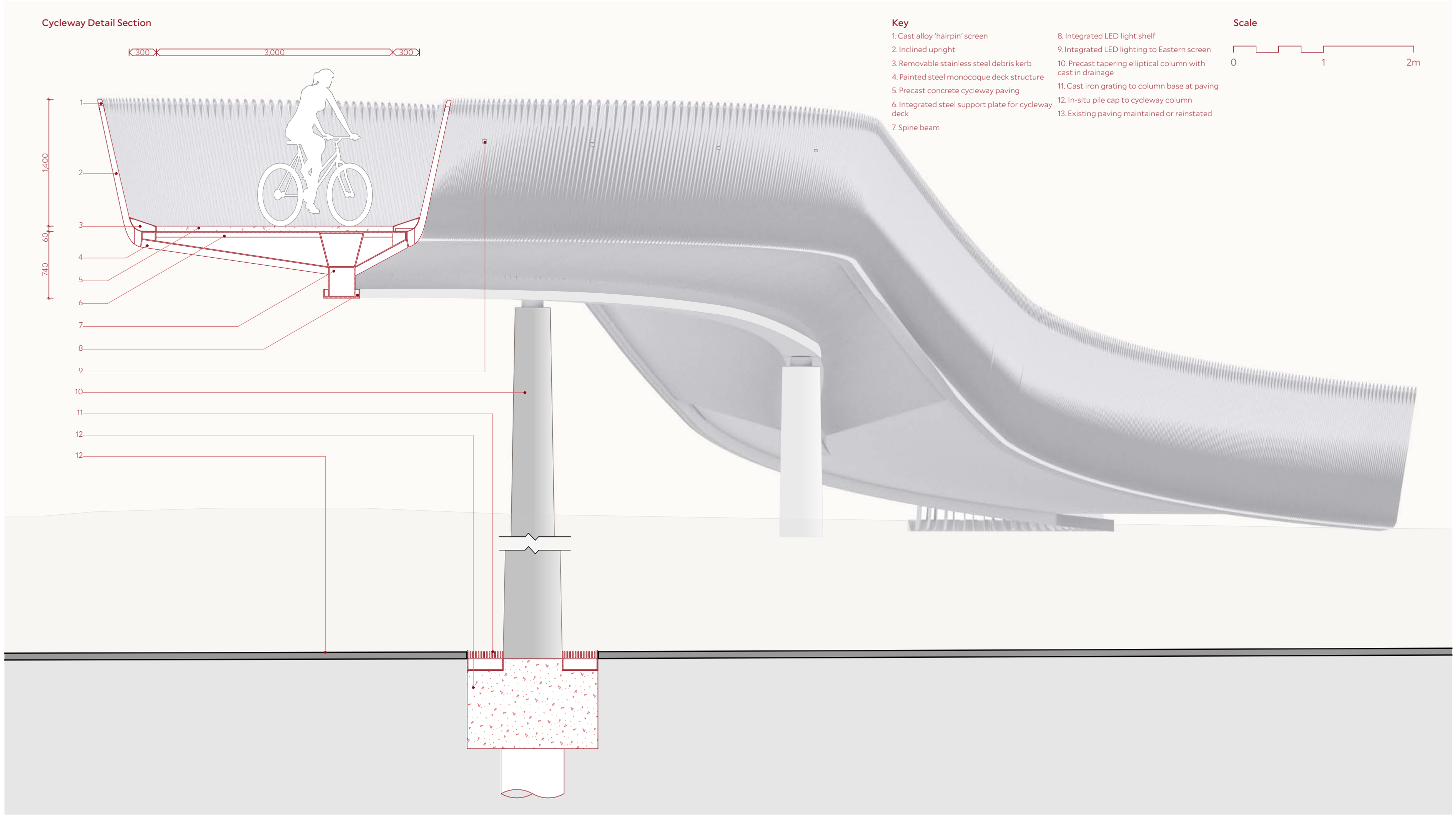
The selection criteria for the choice of non-ferrous alloy for the cast side screen elements will include the material’s ability to age gracefully with no maintenance.

Cycleway deck

It is envisaged that periodic pressure washing of the pre-cast pavers will keep the cycleway ride surface looking good over the lifespan of the structure.



7.2 Assembly



8 Lighting

8.1 Lighting

Lighting will play an essential role in the success of the SHB Cycleway project. We see this project as an opportunity to lead by example, with a lighting approach that is functional, beautiful and sustainable - a considered design approach which applies light in a fresh and creative way, enhancing functionality, wayfinding, safety and character of place. The lighting should work towards how we see illumination, not only how it is measured. Intelligent design is the first step in a sustainable and functional application.

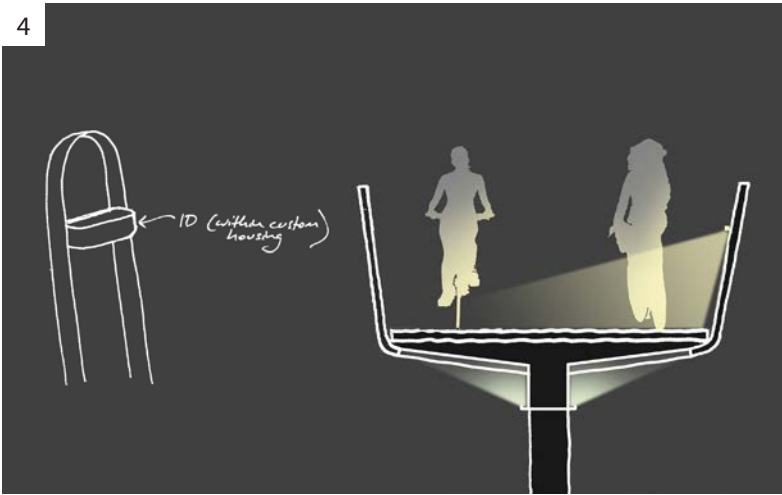
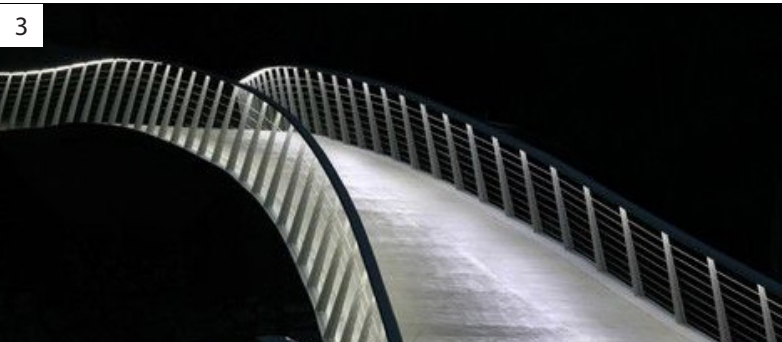
Our minds see only what the eye reveals, and both have an amazing but limited ability to adapt to their surroundings. Too much light or poorly directed sources can often create more extreme contrast and inherently a more visually challenging and apprehensive experience, particularly in large-scale landscapes or where swift motion is a consideration. We also need to look beyond the immediate surrounds to consider the night-time vistas which the area offers, allowing appreciation of distance and bordering realms.

The cycleway lighting should exist without feeling imposing in any way. The presence of the Sydney Harbour Bridge heritage wall to the East is a significant consideration in the lighting scheme. Lighting of the cycleway, both functional and expressive, should work in partnership with the illumination of the heritage wall – allowing it to retain a sense of dominance.

Our approach looks to capture the cycle platform with carefully curated lensed LED system, providing an illuminated ribbon with near flawless uniformity and concealed sources, integrated within the bridge balustrade structures. This provides a strong technical approach which covers the requirements of AS1158.3.1 Cat. PP1, but at the same time creating a beautiful expression of the ramp platform. The resultant silhouetting effect through the balustrade forms creates a delicate play of light and shadow, capturing the elongated and sinuous geometry without challenging the illumination of the heritage wall to the East.

The underside of the structure offers a unique opportunity to tell a story of both physical form and the bringing together of two local indigenous lands. Using subtle illumination and mild variations in light temperatures – representative of the Cammeraygal and Gadigal lands - this interactive application connects the North to South through an interplay of light. This delicately ephemeral shift of light ripples through the middle section, responsive to direction and volume of the overhead cycle traffic during the darker hours.

- 1 - Plan - Feature lighting to underside of bridge
- 2 - Application image - Bridge soffit feature lighting
- 3 - Application image - Cycleway lighting
- 4 - Section and 'Hairpin' detail
- 5 - Calculation renderings



9 Public Domain

9.1 Public Domain Interface

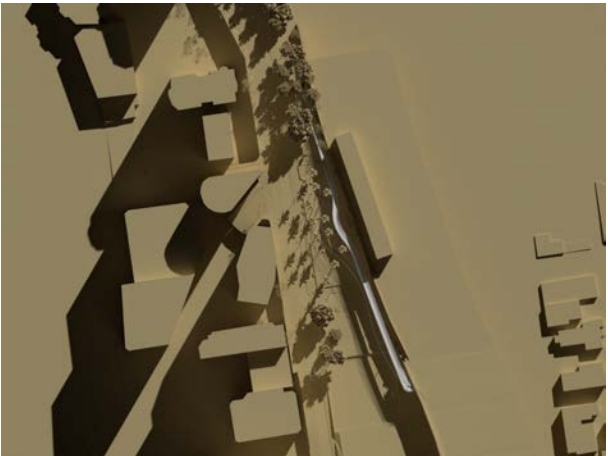
Our concept is underpinned by the four key moves of celebrating country, preserving the Sublime experience of the bridge, minimising impact on Bradfield Park, and creating a safe and delightful example of cycling infrastructure.

The public domain interfaces have been carefully tuned to ensure that conflicts are minimised through design and where impacts occur, they are mitigated and transformed into memorable experiences. Two such examples are the North and South connection points.

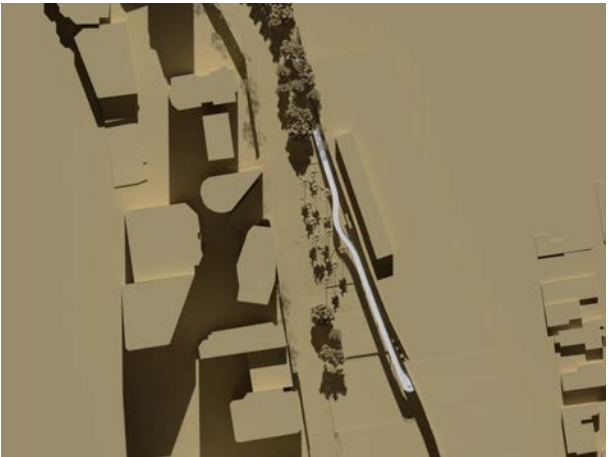
On the south at the connection to the Sydney Harbour Bridge, a look out has been designed outside of the movement flow to capture the opportunity for taking in the sweep of the bridge and the city and Harbour views beyond.

On the north, the bridge lands on the existing eastern most north south path and gracefully curves to terminate at Alfred Street at the former alignment of Willoughby Road. We have proposed an additional public domain amenity in Bradfield Park north which is a resting and gathering spot for cyclists and park users alike. This is A place to ‘read country’ through the interpretation of Cammeraygal narratives framed by native planting.

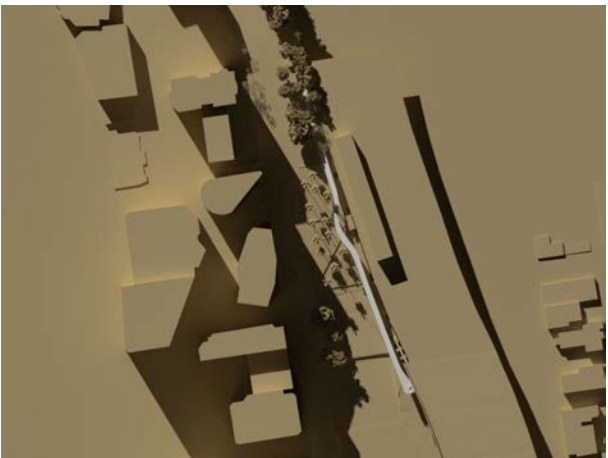
- ||||| 1. Repurposed path
- ↔ 2. Cycleway infrastructure
- ↔ 3. Retained paths



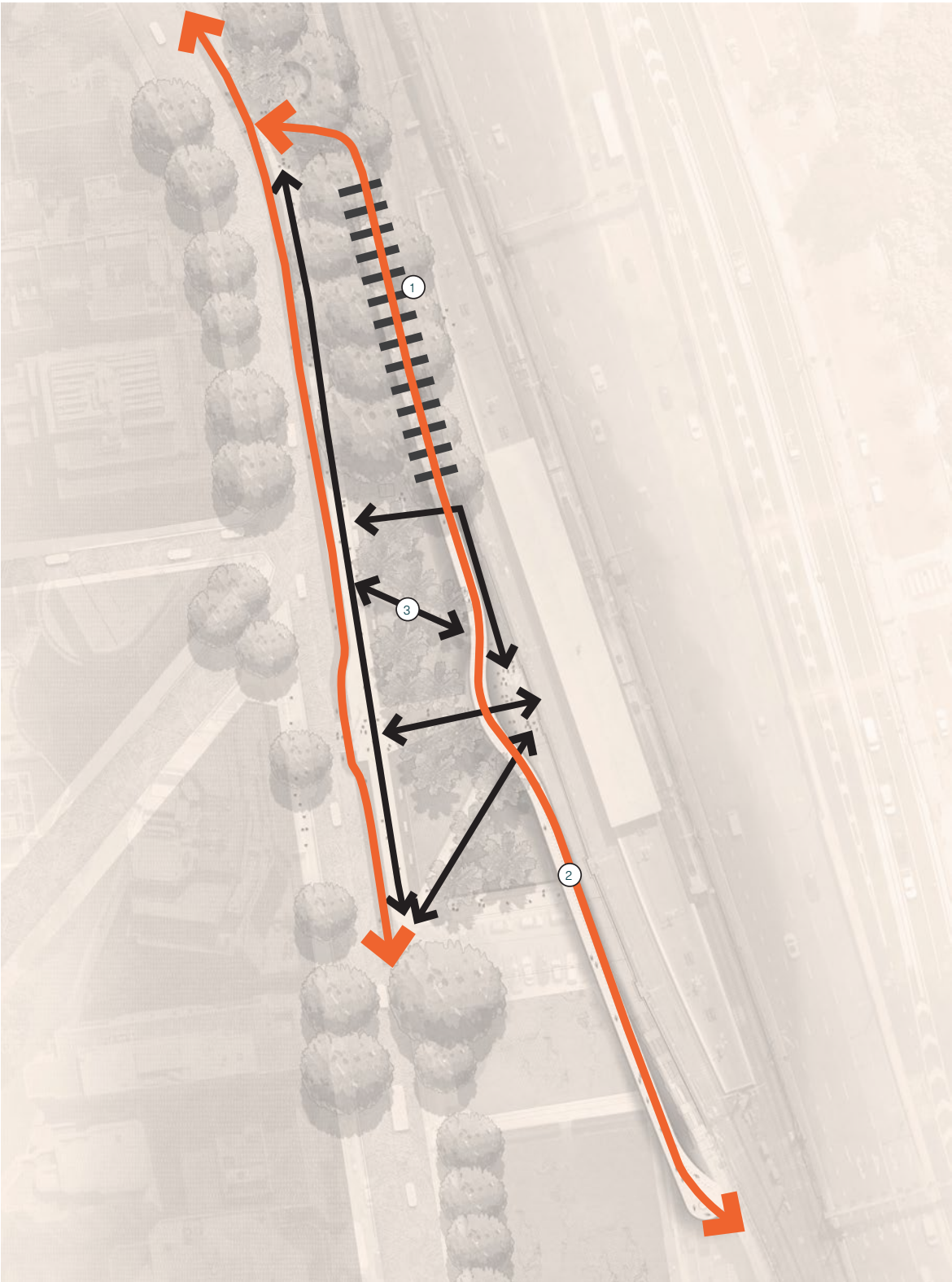
Winter Solstice - 10am Shadow



Winter Solstice - Midday Shadow

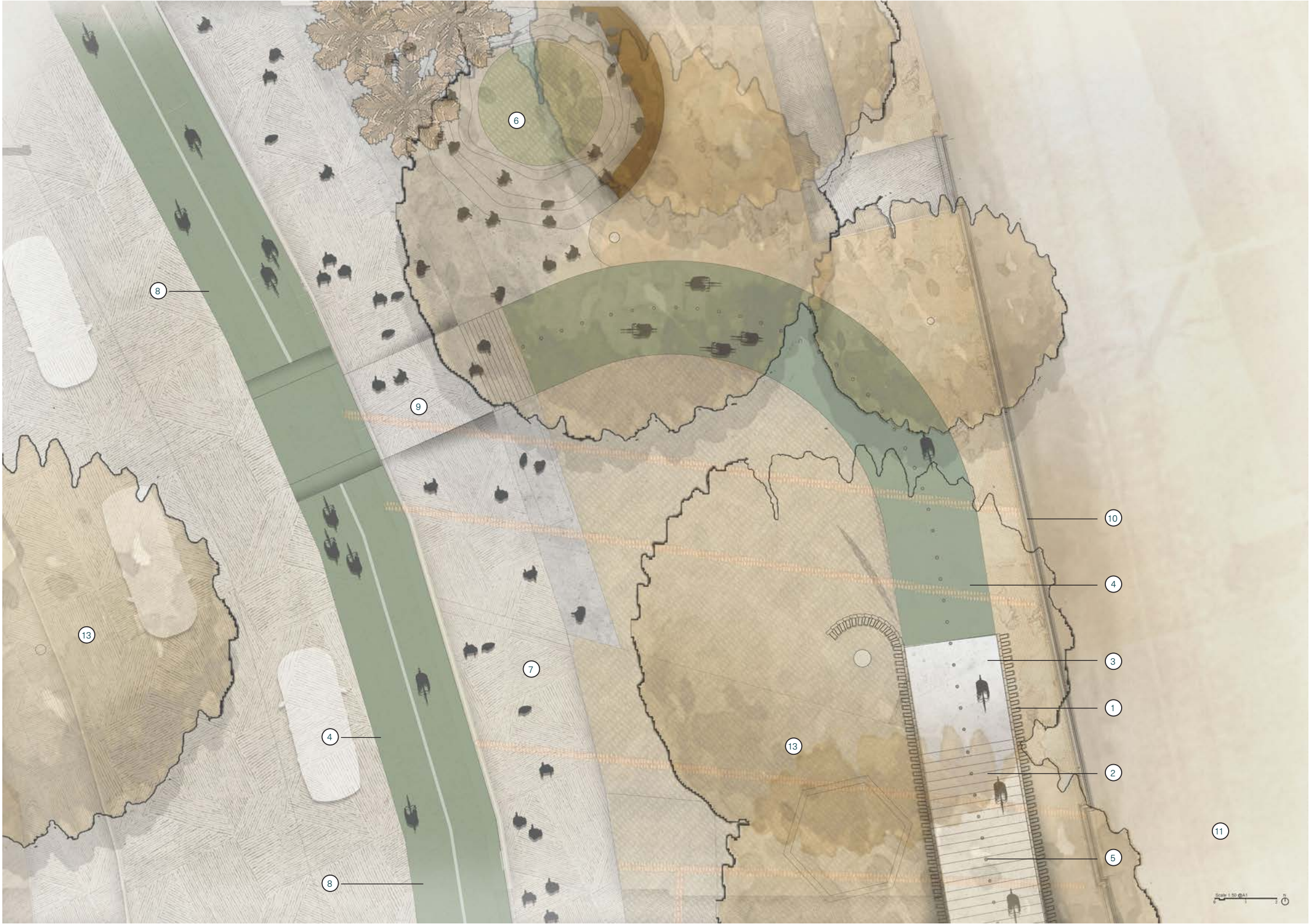


Winter Solstice - 2pm Shadow



Movement Diagram

9.1 Public Domain Interface



- 1. Cast alloy cycle screen
- 2. Pre-cast concrete cycleway surface
- 3. In-situ concrete transition
- 4. Paint applied cycleway surface
- 5. Reflective metallic laneway marker
- 6. Cammeraygal Place
- 7. Existing Alfred Street footpath
- 8. Alfred Street cycleway
- 9. Footpath crossing
- 10. Warringah Freeway viaduct wall
- 11. Warringah Freeway
- 12. Existing trees and soft landscape
- 13. Alfred Street

10 Response to Requirements

10.1 Response To Requirements

Design Principles	
(a) Sensitively respond to the heritage values articulated in the Statements of Significance for the National Heritage Listing and the State Heritage Listing of the Sydney Harbour Bridge and the State Heritage Listing of the Milsons Point Railway Station Group.	The heritage values of the Sydney Harbour Bridge, Milsons Point Railway Station Group and Bradfield Park have guided the design proposal. The proposal retains and respects the National Heritage Values of the Sydney Harbour Bridge including the significance of Sydney Harbour Bridge as a famous and enduring national icon that remains Australia’s most identifiable symbol.
(b) Embed Aboriginal design and cultural expression, revealing and celebrating the deep, rich history of Aboriginal people and stories relevant to this Country in all aspects of the Project.	First Nations narratives a fundamental generator to every aspect of our design from the macro through to micro levels. The embedding of Indigenous knowledges and membership in our team is part of the ongoing process for the project that we will undertake.
(c) Be consistent with the Sydney Harbour Bridge Conservation Management Plan (July 2021) and other relevant heritage management documents (such as The Burra Charter, Design in Context, Better Design for Heritage etc.) applicable policies and Project documents.	The proposed design meets the policies and objectives of the CMP and is consistent with the relevant guiding documents.
(d) Assess what collateral benefits may be possible through integration and/ or complementary forms.	The principle collateral benefit is the retention of the forecourt of Bradfield Park as a powerful and uncluttered public domain.
(e) Be capable of achieving design excellence in every aspect and consistent with the Project Design Excellence Strategy.	The design has responded to the many factors which need to be considered to achieve design excellence and has considered the commentary provided during the design excellence process already undertaken by TfNSW to inform the refinement of our design approach.
(f) Be innovative, creative, site-responsive, refined, elegant, slender and beautiful.	Our proposed design has directly responded to these identified drivers.
(g) Minimise physical and visual impacts.	The minimisation of physical and visual impact is a fundamental generator of the approaches taken within our design across alignment, form, structural placement, materiality, constructibility/maintenance.
(h) Embed measurable sustainability initiatives and benefits.	Sustainability initiatives and benefits are a fundamental generator of our design.
(i) Minimise impacts on Milson’s Point Station forecourt and Bradfield Park public open spaces, trees and pedestrian movement, and ‘touch lightly’ on the landscape.	See (d)
(j) Integrate seamlessly with the public domain, proposed Alfred Street cycleway and desired landscape character including the Bradfield Park Masterplan.	The proposed design balances public domain impacts with cycling and pedestrian safety. The integration with Alfred Street cycleway is a key design move.
(k) Achieve the Project Objectives. <div><div><div><div>•</div><div>improve cycling mode share;</div></div><div><div>•</div><div>reduce number of safety incidents on the Sydney Harbour Bridge cycleway;</div></div><div><div>•</div><div>respect heritage and open space amenities; and</div></div><div><div>•</div><div>provide equity of access.</div></div></div></div>	<div>The design of the cyclway has been driven by the need to improve cycling mode share and safety to support the broadening the appeal of this key link within the regional cycling network. The needs of all cyclists have been considered in determining the cycleway design.</div> <div>The design, configuration and alignment of our proposed ramp will retain and respect the significant cultural heritage values of the SHB and its immediate context and setting and actually enhance its significant function and potentially its social values.</div>
Customer, Technical, Constructability and Cost Requirements	
(a) Complies with applicable laws and Australian standards.	Achieved
(b) Aligns with the Project Business Requirements Specification (Refer Appendix 4(Business Requirements Specification)).	Achieved

10.1 Response To Requirements

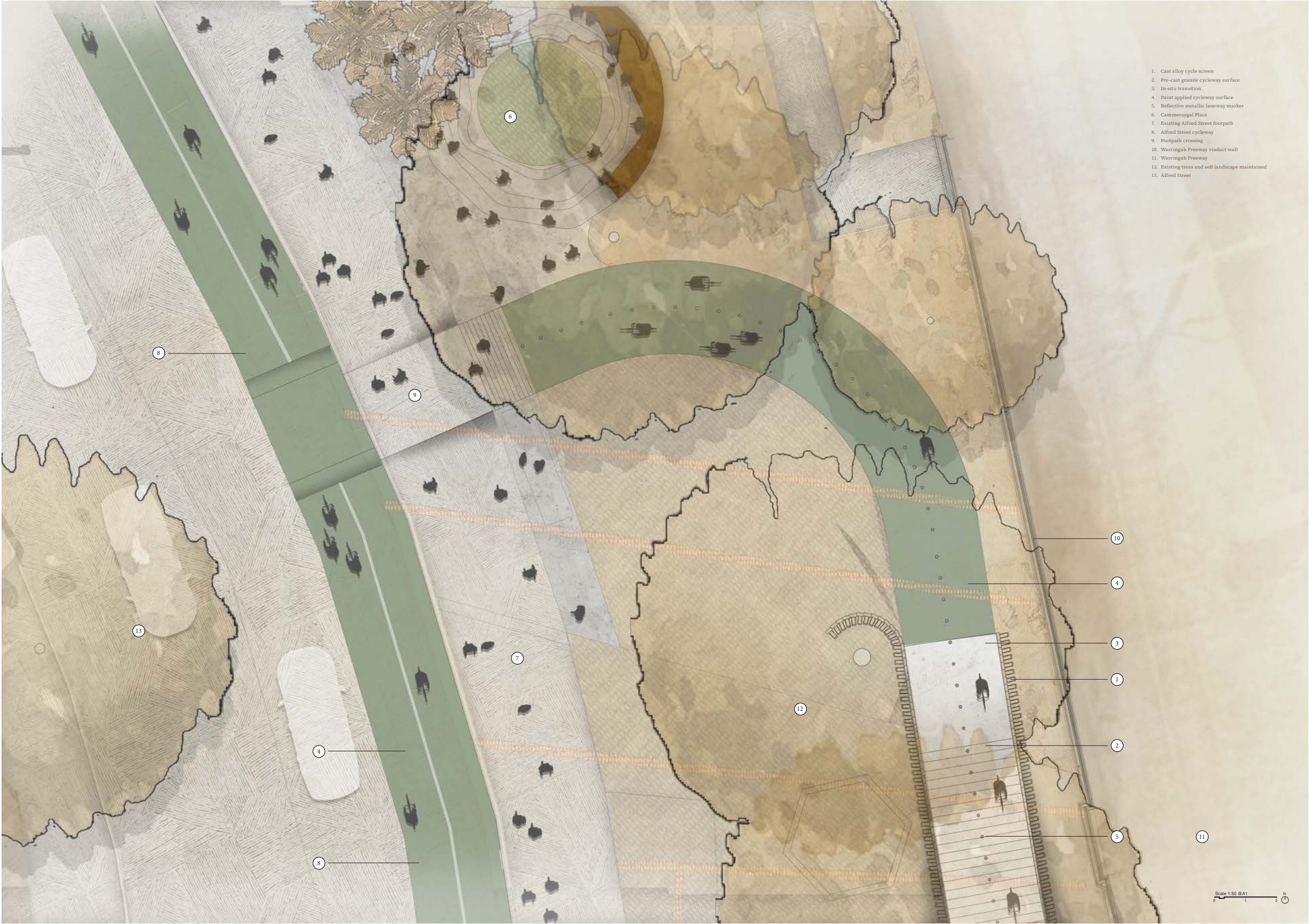
(c) Functionally the ramp is to have: (i) a usable deck width of minimum 3 metres clear; (ii) a maximum gradient as per Cycling Aspects of Austroads Guides (Figure 7.4: Desirable uphill gradients for ease of cycling); and (iii) changes in direction with a maximum indicative horizontal radius of 10 metres where practicable.	Achieved
(d) Minimise impacts such as glare, noise and light spill on adjacent properties and uses.	Achieved
(e) Be accessible, inviting and safe for all cyclists and the public using the surrounding precinct.	Achieved
(f) Minimises risk of exceeding the cost estimate and carefully considers whole of life costs.	Achieved

11 Appendices

11.1 General Arrangement Plan



11.2 Detail Plan



11.3 Western Elevation



11.4 Typical Section



11.5 View 1



11.6 View 2



11.7 View 3



11.8 Detail Sketches

