Redfern North Eveleigh Paint Shop Precinct

Bridge catchment analysis

7 July 2023 | Version 5.0

Quality Assurance

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Version	Date	Details
1.0	11 October 2021	Issued to TfNSW
2.0	18 April 2023	Updated to reflect bridge design
3.0	19 April 2023	Refinement of land-use areas to rezoning approval
4.0	1 July 2023	Addition of ATP trips
5.0	7 July 2023	Addition of ATP trips (LES update)

Questions to be answered

Is there a need and/or benefit of an active transport bridge between North and South Eveleigh?

1. Who would benefit from the bridge?
   - Spatial catchment analysis

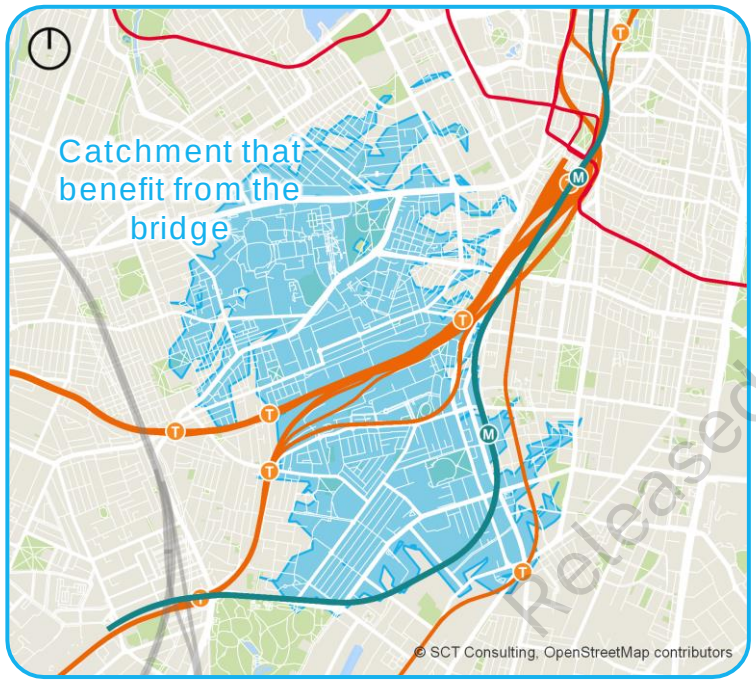
2. What quantum of people are likely to use the bridge?
   - Review of existing travel patterns (analysis of mobile phone data)
   - Confidence in data
   - Expected users of the bridge

3. How integral is the Redfern-North Eveleigh development to improving use of the bridge?
   - Potential increase in users of the bridge based on changes in land-use (including retail)

Executive summary

Catchment analysis

Determine who benefits from the bridge compared to the existing scenario and future scenario (with Redfern Station southern concourse).



Travel time saving

An estimate of the average travel time benefits for a customer using the bridge (compared to other alternative corridor crossings).

Average travel time saving

3 minutes

per cross-corridor journey.

Executive summary

Current demand

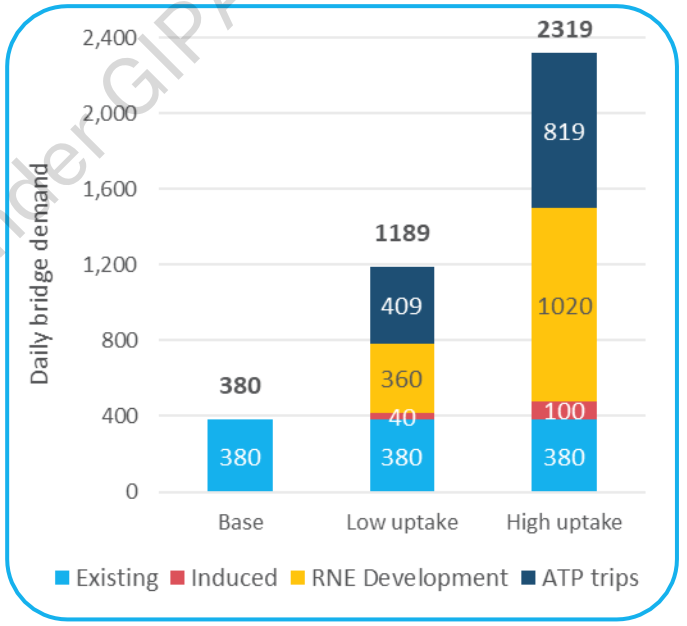
Who may use the bridge based on existing travel patterns?

340-420 journeys per weekday

Future demand

Increase in customers due to:

- Provision of the bridge (induced trips)
- Development of Redfern North Eveleigh Precinct



Productivity

The cumulative benefit of the bridge.

59-116 people-hours saved

per typical weekday.

[01]

Who would benefit from the bridge?

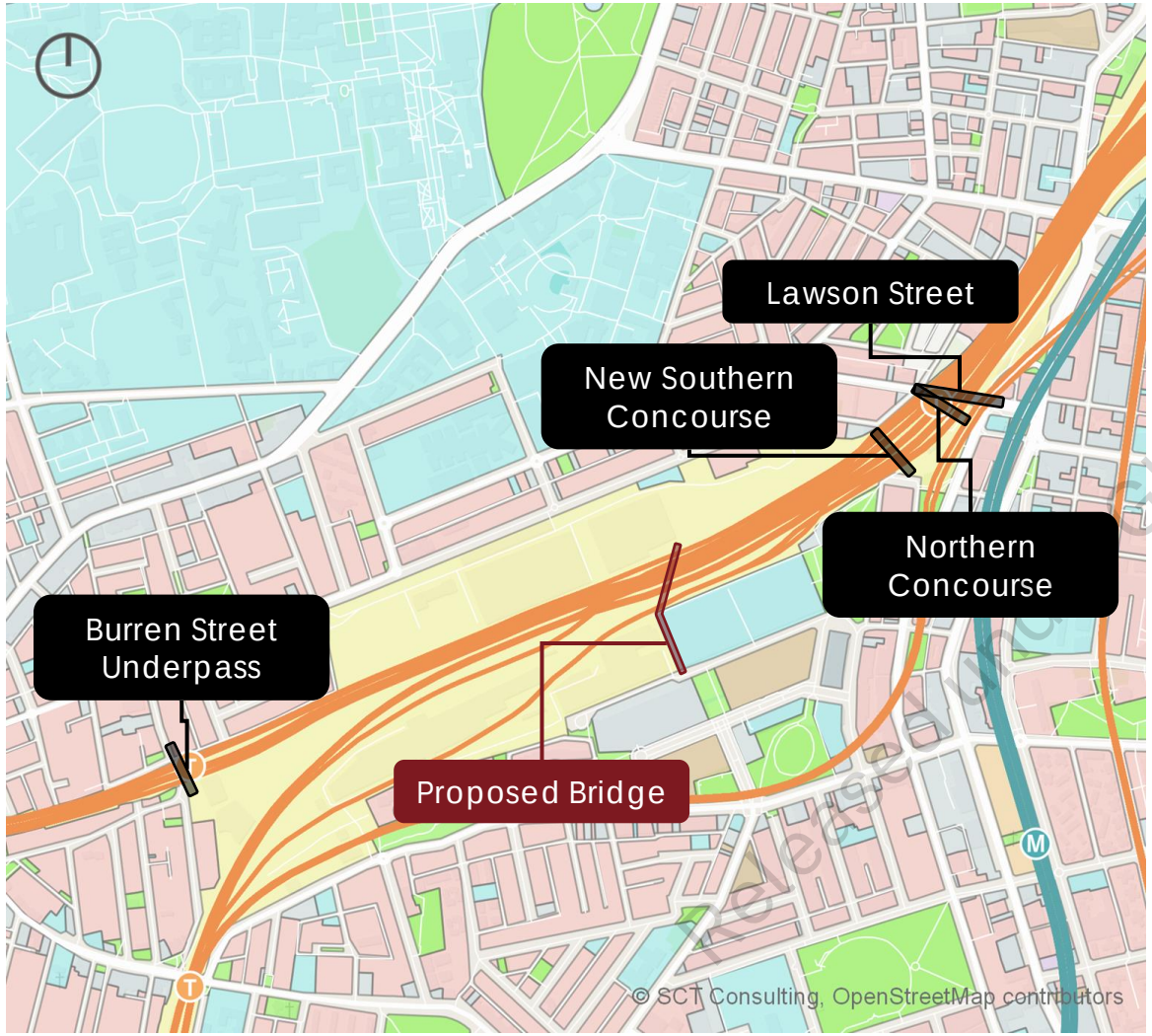
Existing rail corridor crossings

All existing crossings included in analysis.

- Travel time for each route is calculated based on a typical walk speed of 1.35 metres per section
- Additional travel time has been added for:
  - Vertical transport (including stairs or lifts)
  - Road crossings (penalty by type: signalised, zebra and uncontrolled).

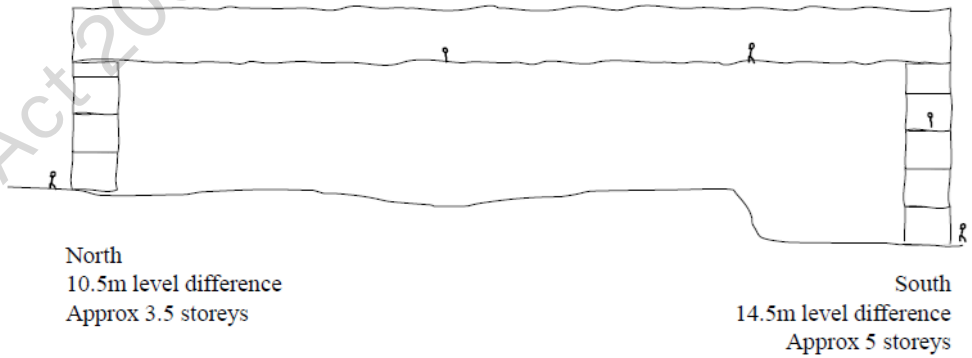
Example Extract:
Redfern Station concourses (existing northern and new southern).

Proposed rail corridor crossing



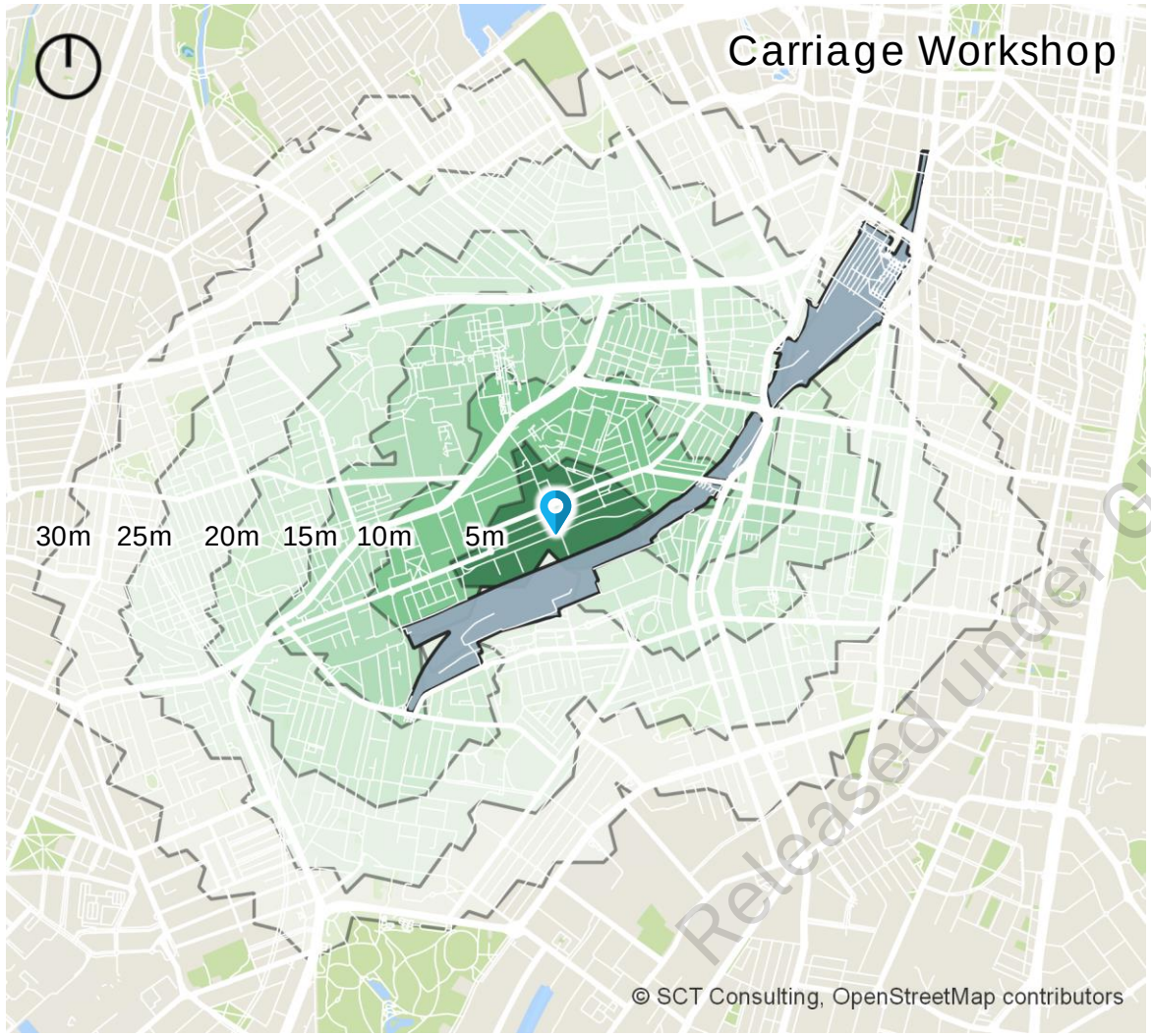
Proposed bridge included in assessment. Based on Arup (November 2022) design pack, the following characteristics have been included:

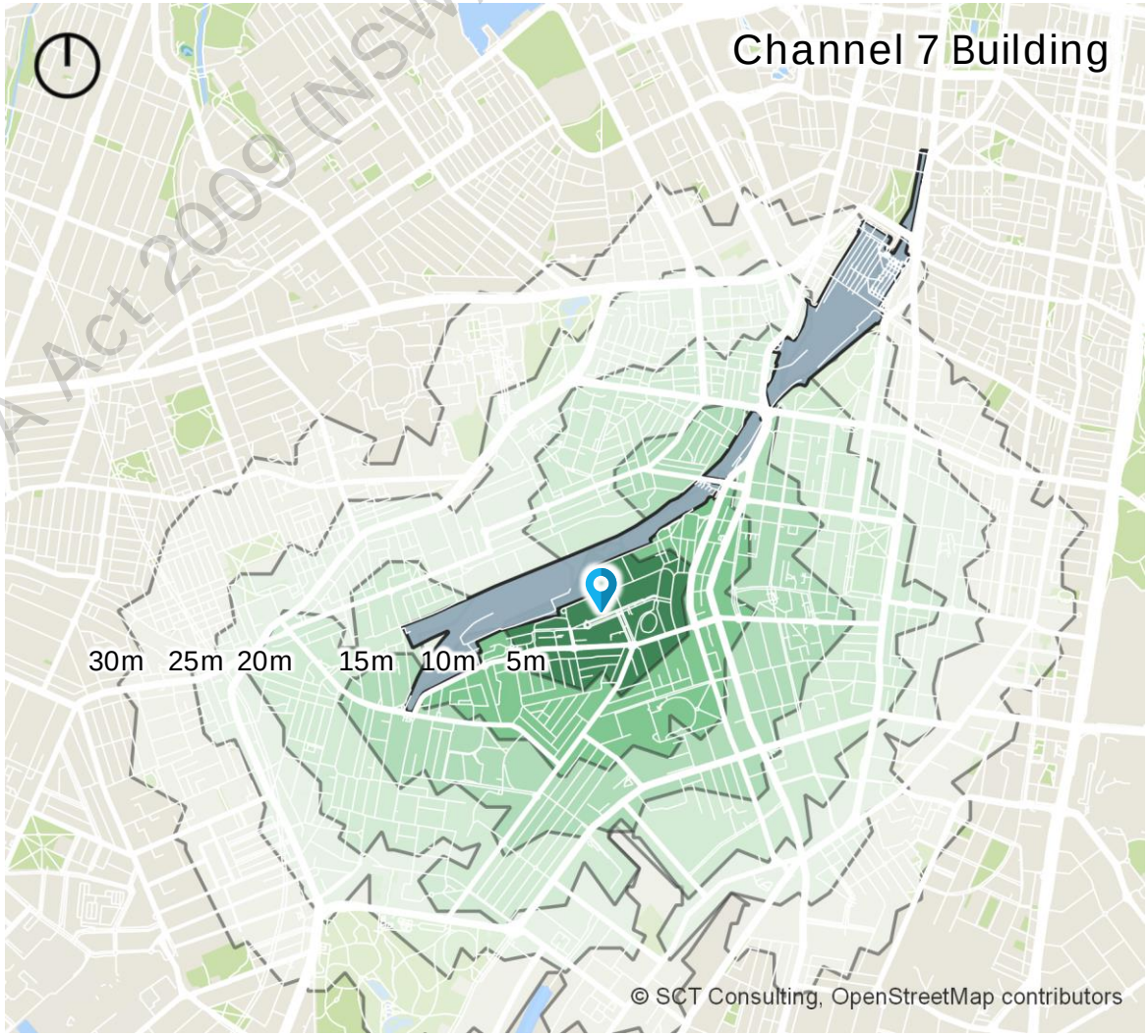
- Bridge connecting North and South Eveleigh
- Lift access is provided on both ends, based on indicative heights:



- Due to the height of the bridge, it is unlikely users would utilise the stairs as the main form of vertical transport (unless they opt to do so from a hedonic perspective i.e. for exercise).
- Therefore the travel time of the bridge has been based on a first-principles lift travel time assessment.
- With two lifts at each end, the average trip time (including wait and travel time) is estimated at 33 seconds (north) and 39 seconds (south).
- Including the lifts and extended deck (over the maintenance facility) on the southern end to Locomotive Street, the total crossing time is approximately 4 minutes.

Existing 30-minute walking catchments

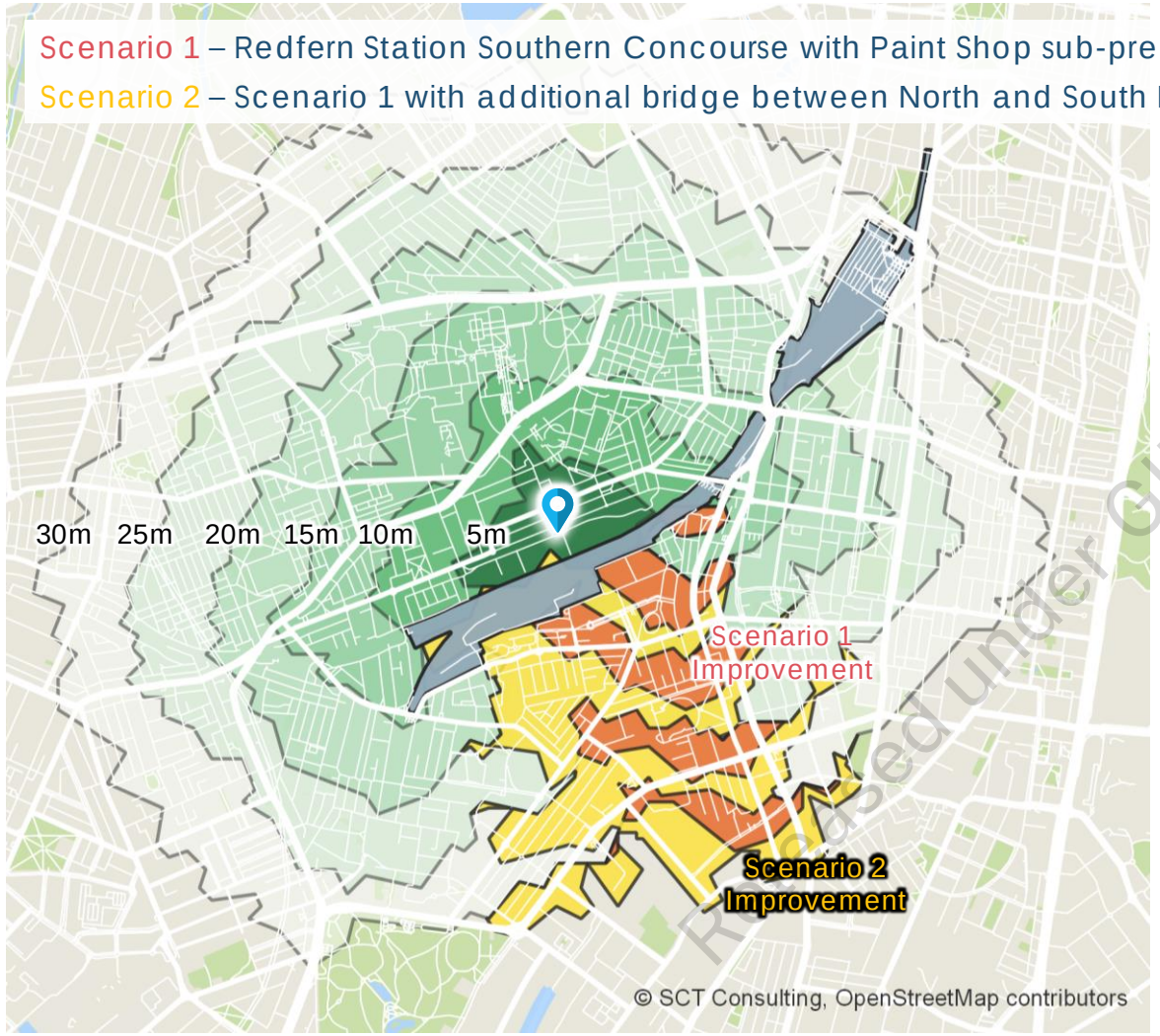


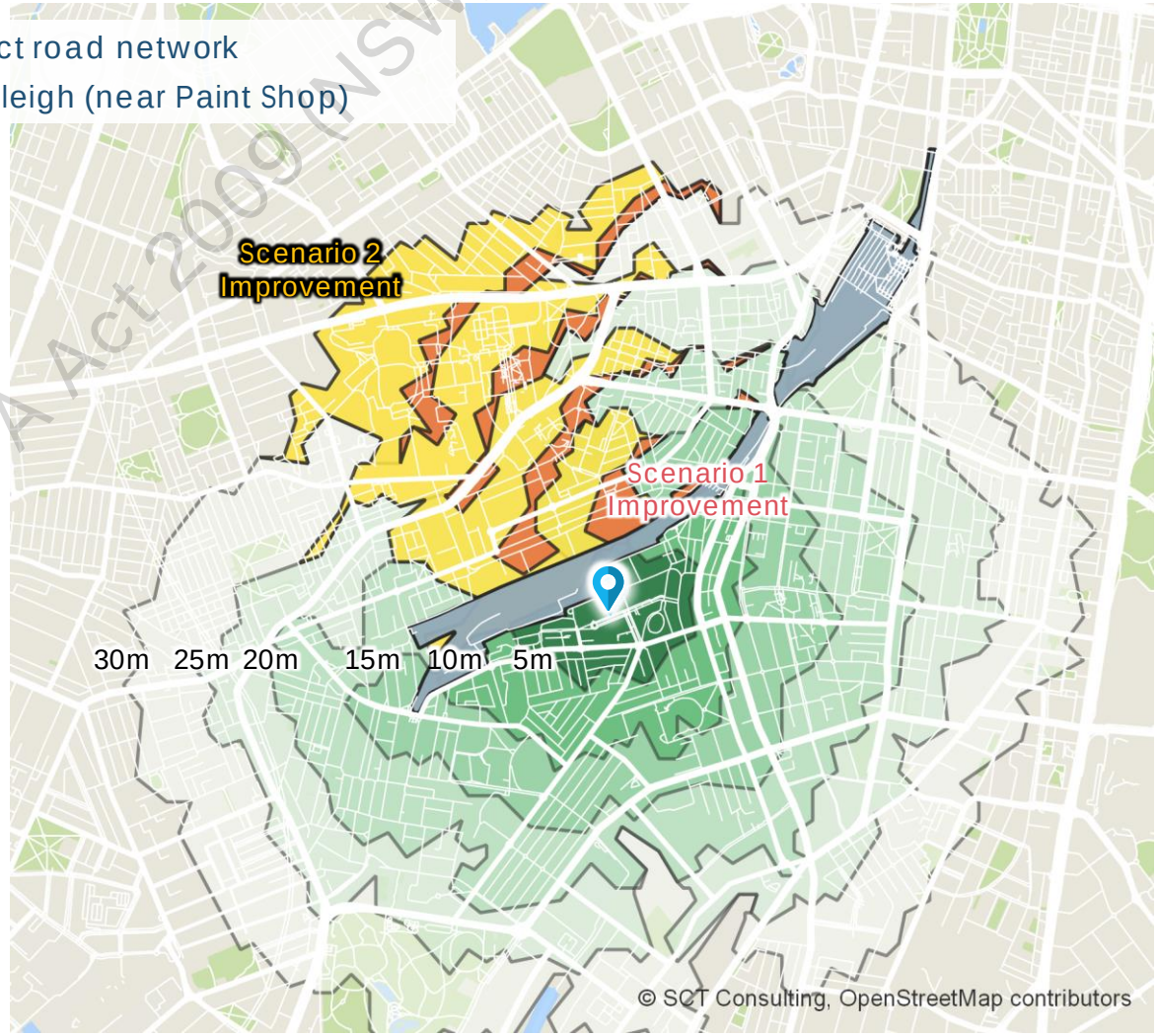


Improvements to 30-minute walking catchments

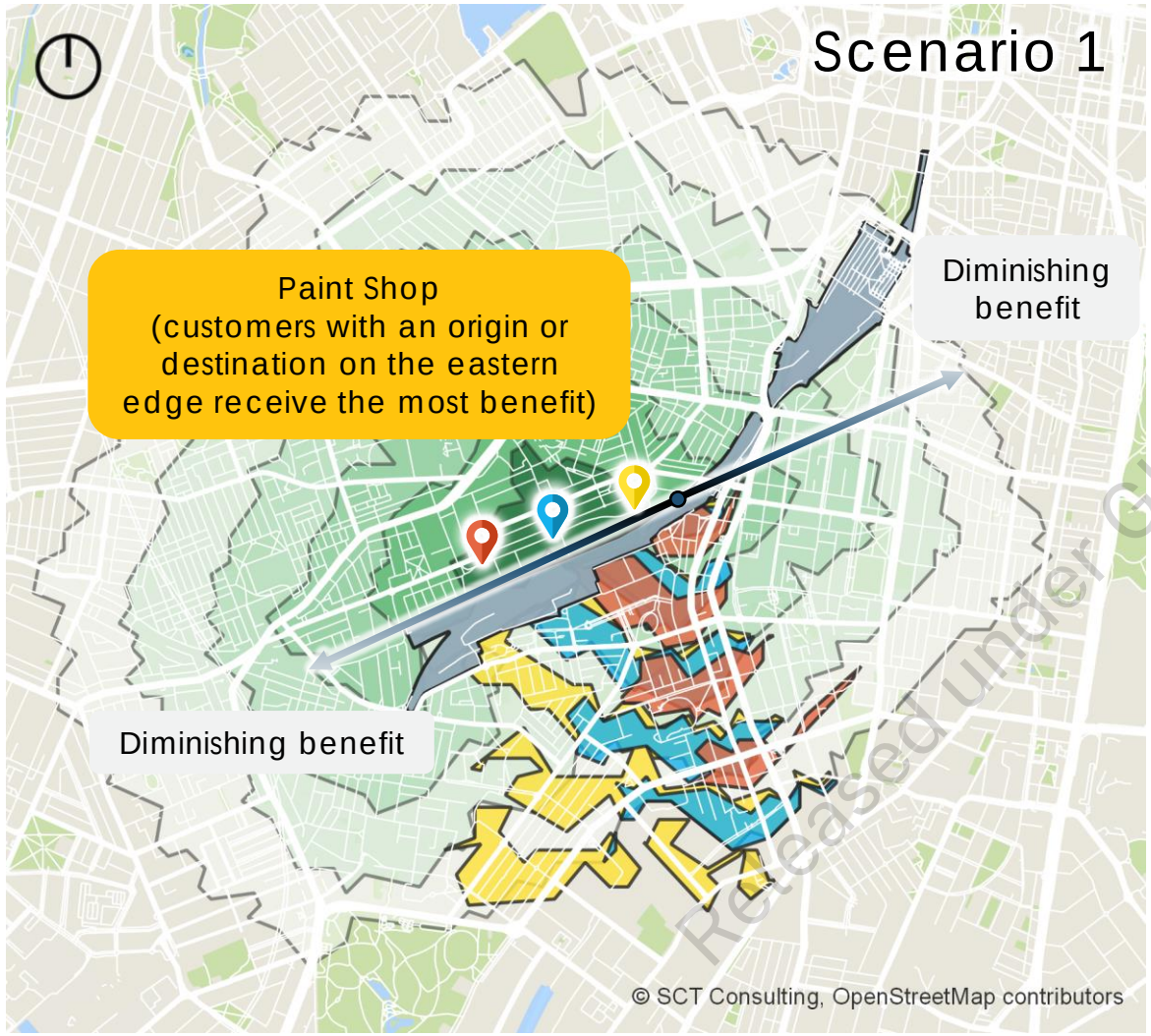
Scenario 1 – Redfern Station Southern Concourse with Paint Shop sub-precinct road network

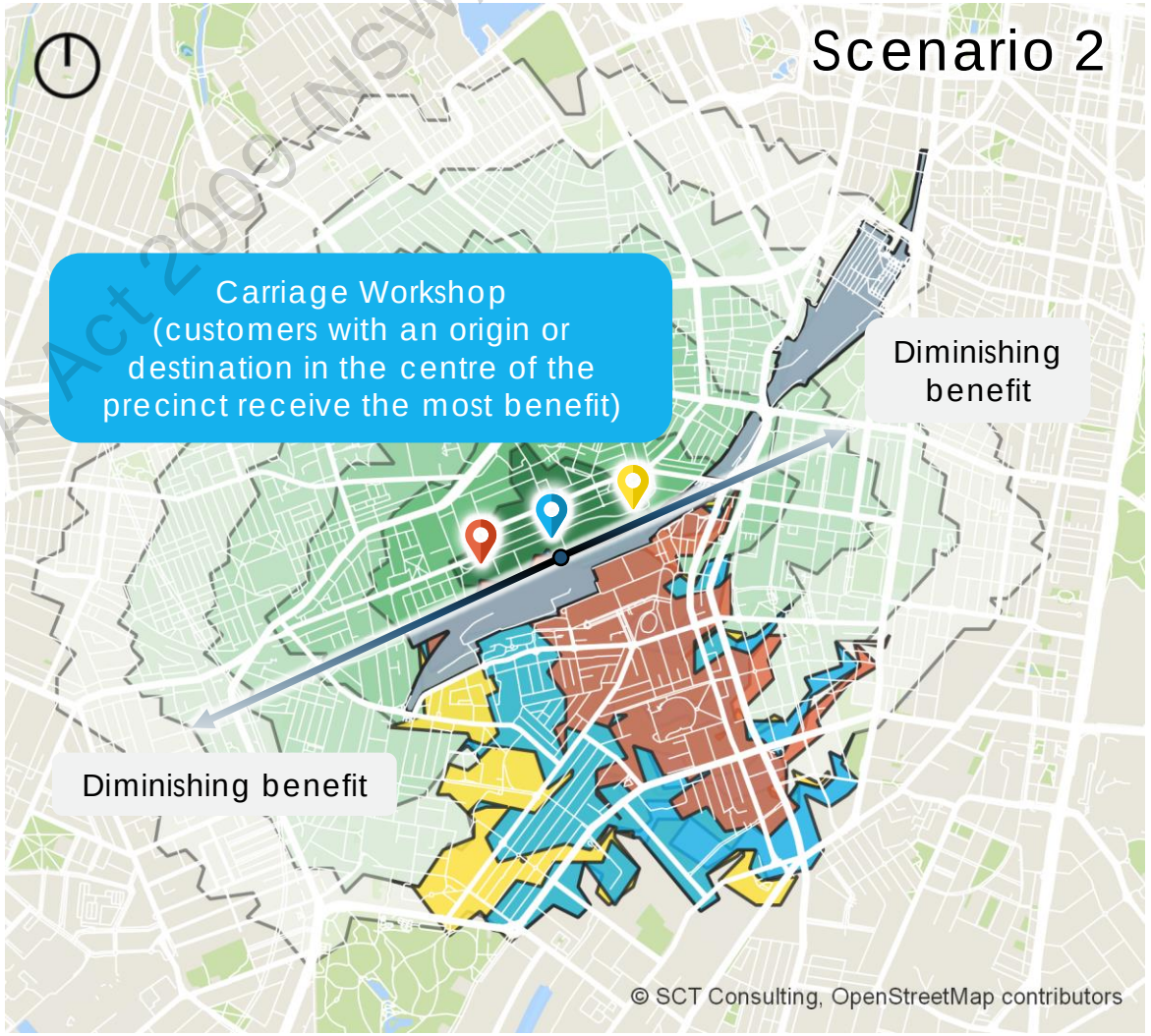
Scenario 2 – Scenario 1 with additional bridge between North and South Eveleigh (near Paint Shop)



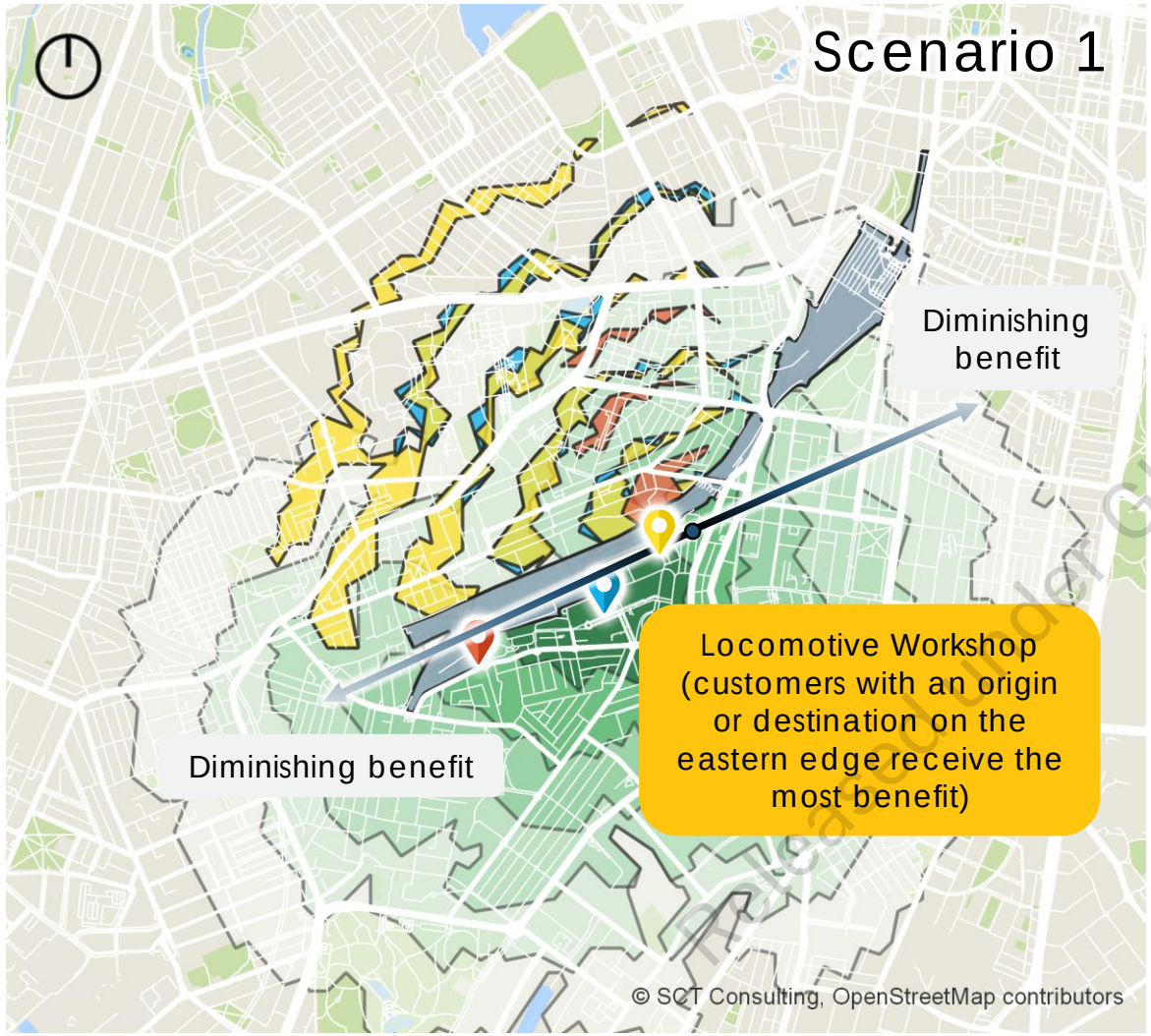


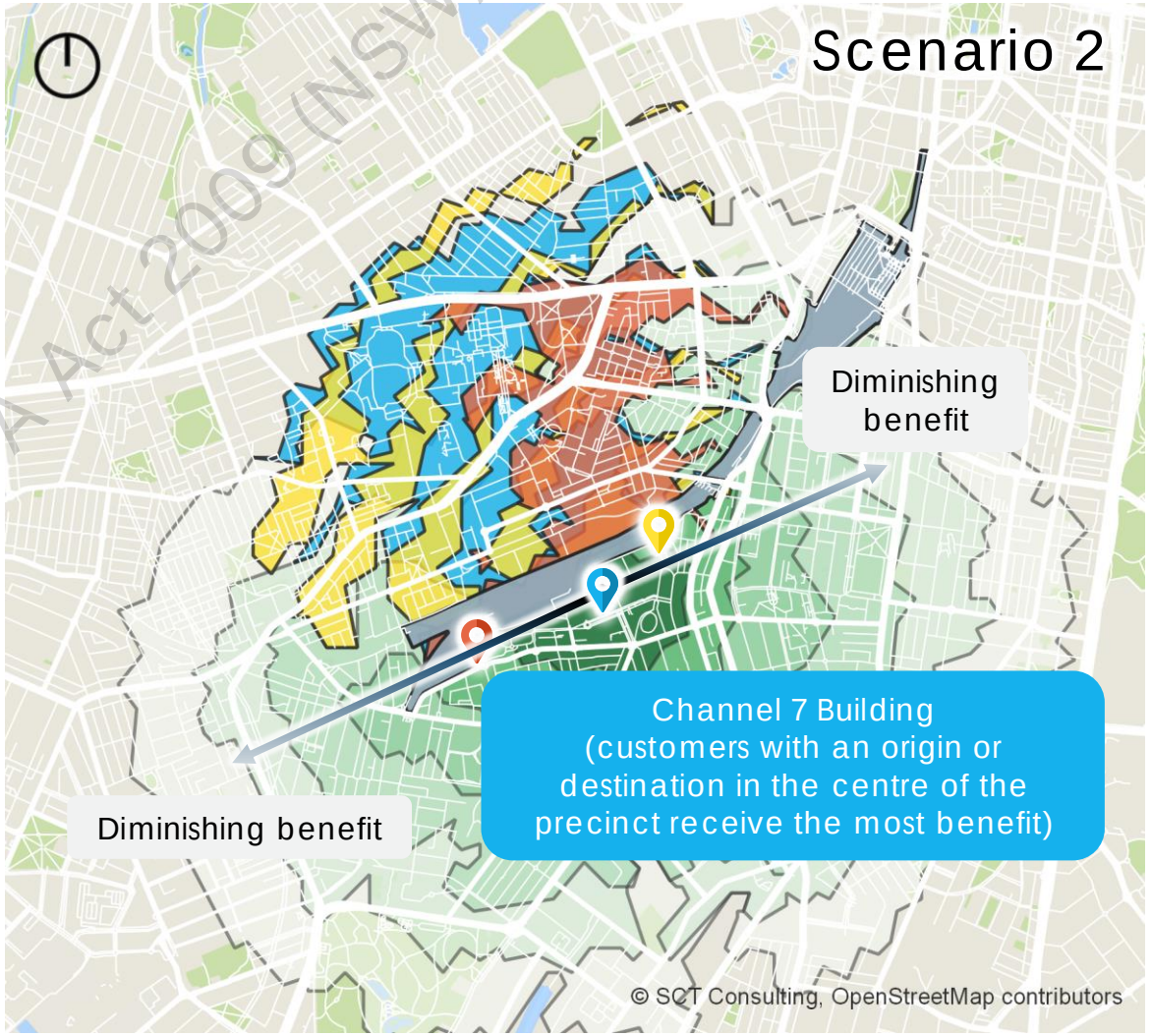
Northern Sites – Improvements by location



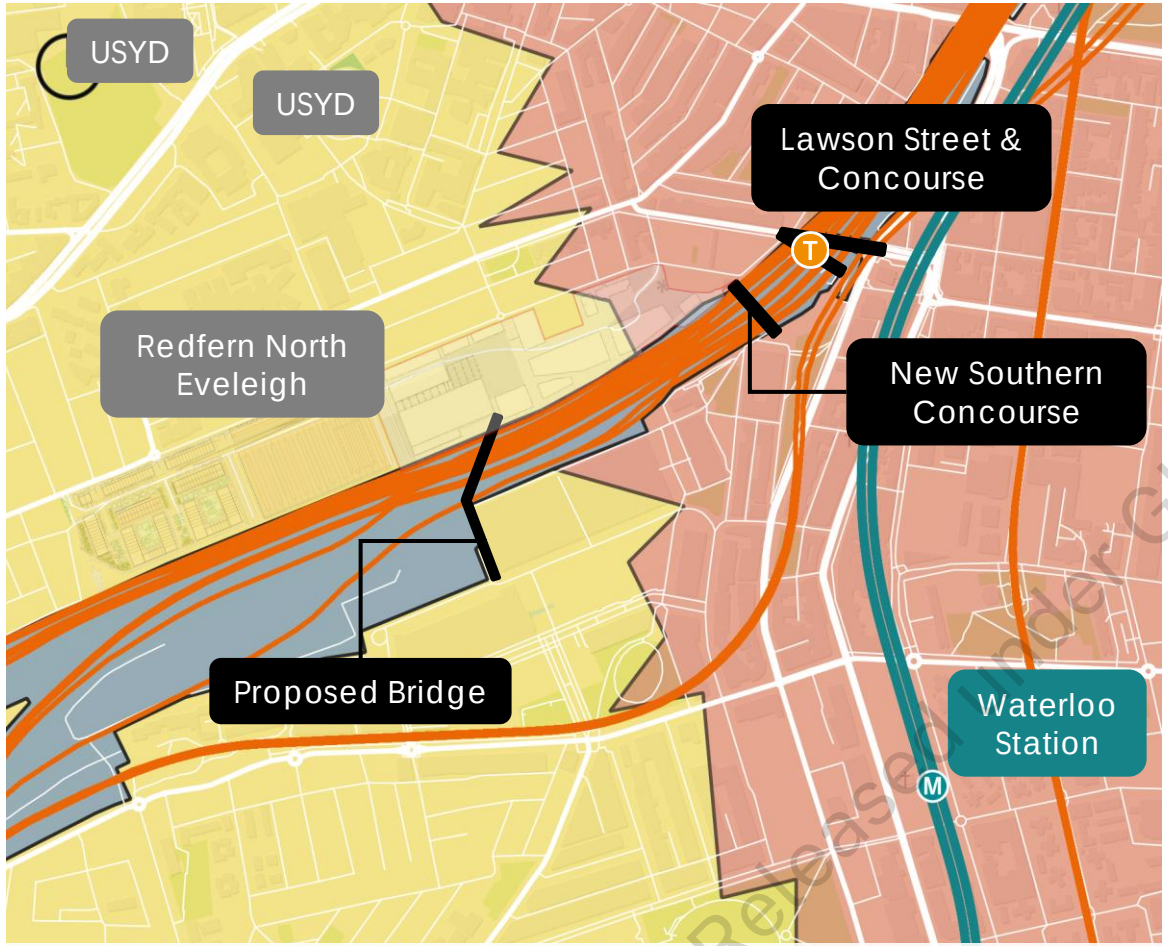


Southern Sites – Improvements by location





Southern Concourse versus Proposed bridge



Scenario 1 – Redfern Station Existing and Southern Concourse

Scenario 2 – Proposed bridge between North and South Eveleigh

A comparison of the two alternative groups of crossing options, resulted in the following observations of cross-corridor journeys:

- Bridge connecting North and South Eveleigh is the most attractive (from a travel time perspective) for majority of the RNE precinct.
- The New Southern Concourse is more attractive for access to the commercial developments on the eastern end of RNE.
- Customers (in particular students) who may travel between Waterloo Station (Sydney Metro City & Southwest) and the University of Sydney (USYD) Campus may find it more attractive to use the new proposed bridge between the station and campus.
- Other key destinations such as Broadway Shopping Centre, University of Technology Sydney (UTS) are better served by the New Southern Concourse and existing connections to the north.

Scenario 2 benefit – land use

Main beneficiaries of the additional bridge are cross-rail corridor journeys to/from:

- Urban residential
- Public services (University of Sydney)
- Commercial (North and South Eveleigh precincts). Noting RNE precinct is currently listed as infrastructure (railways).
- Light industrial and commercial (Waterloo and Green Square)

Travel time saving (range)

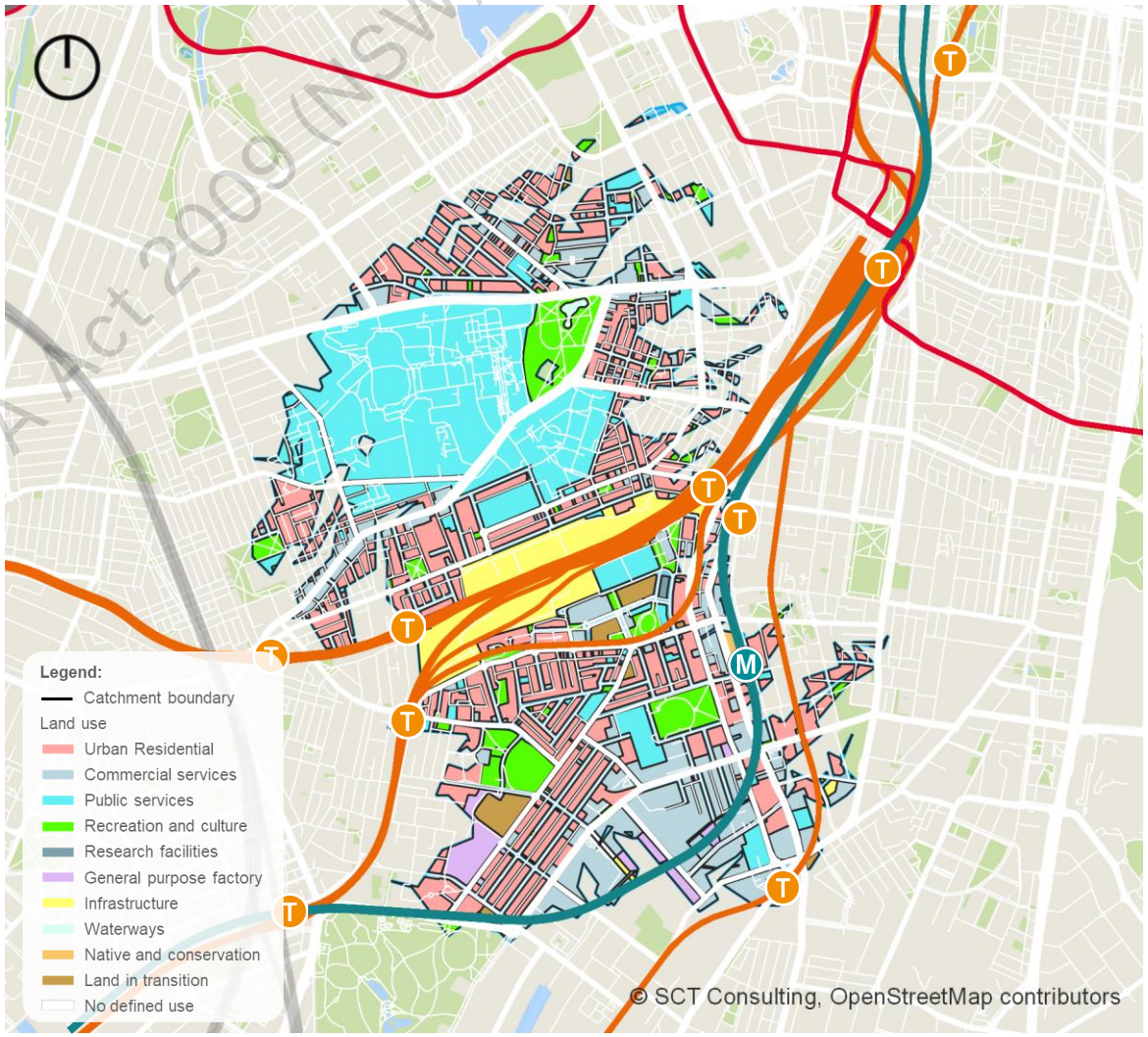
Up to 12 minutes

For cross-corridor journeys in the highlighted regions. For some customers, the benefit may be more; likewise, the benefit may be less for others.

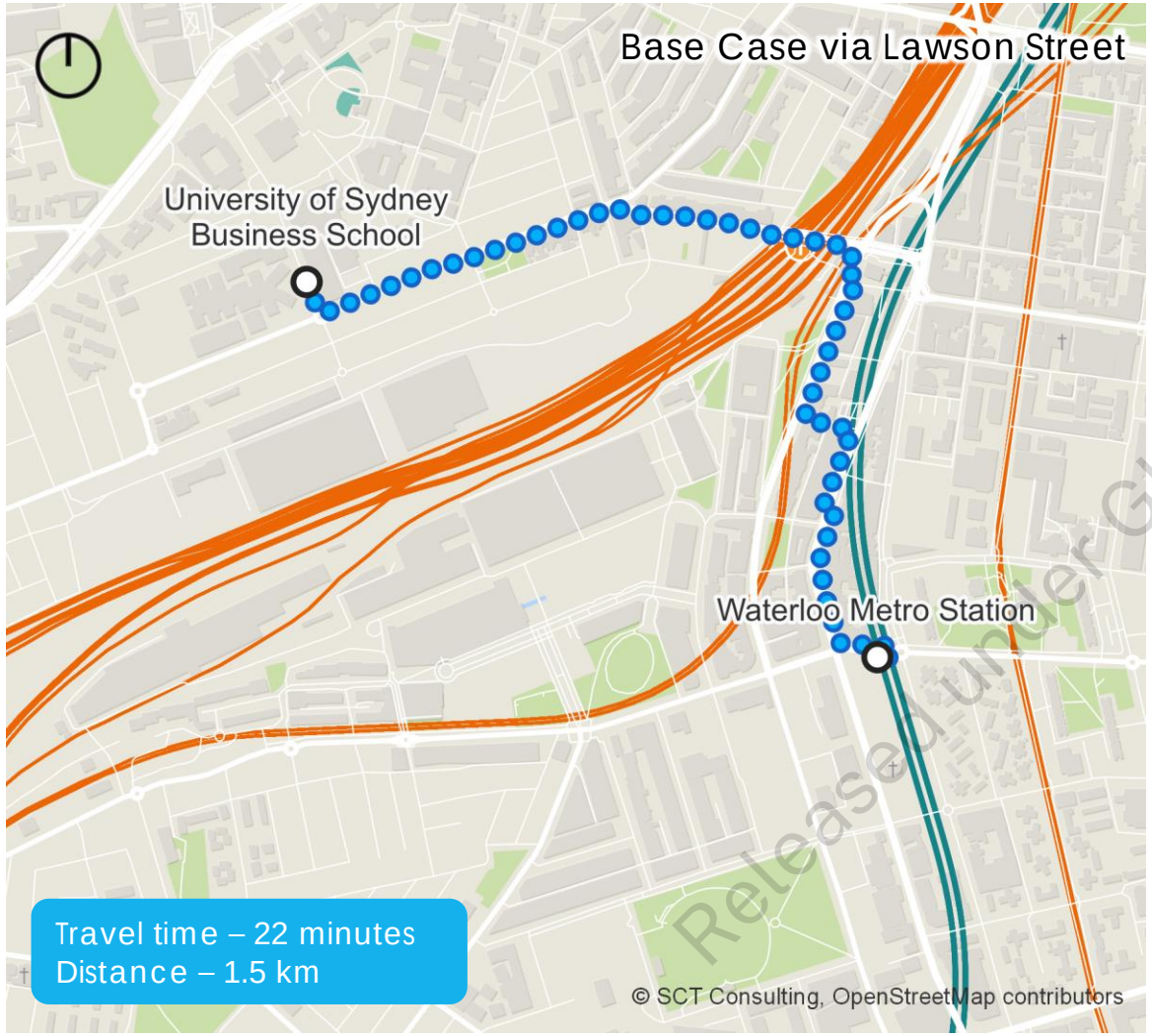
Average of travel-time saving

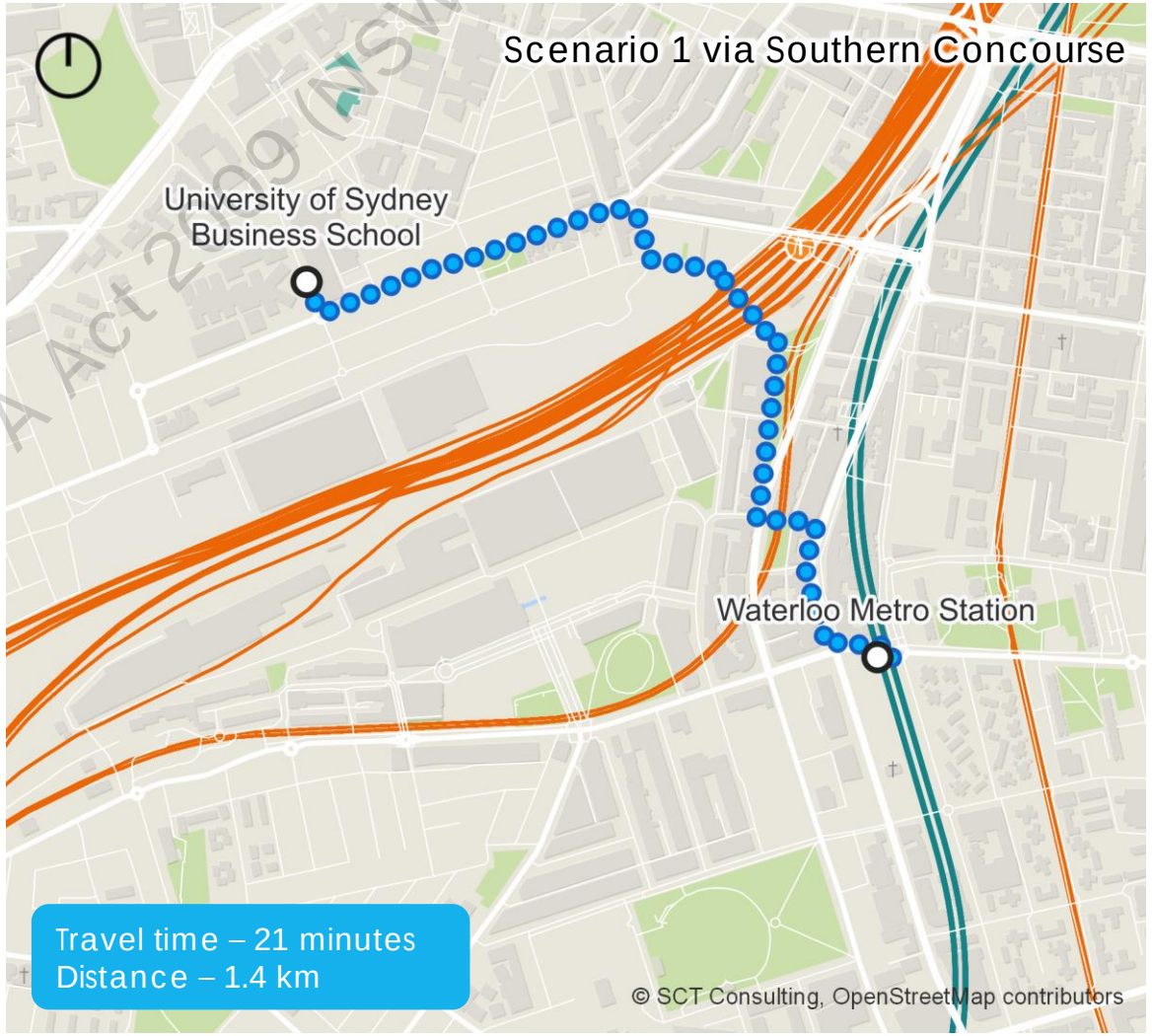
3 minutes

Weighted average based on forecast population and employment data (2036) across the walking catchment.

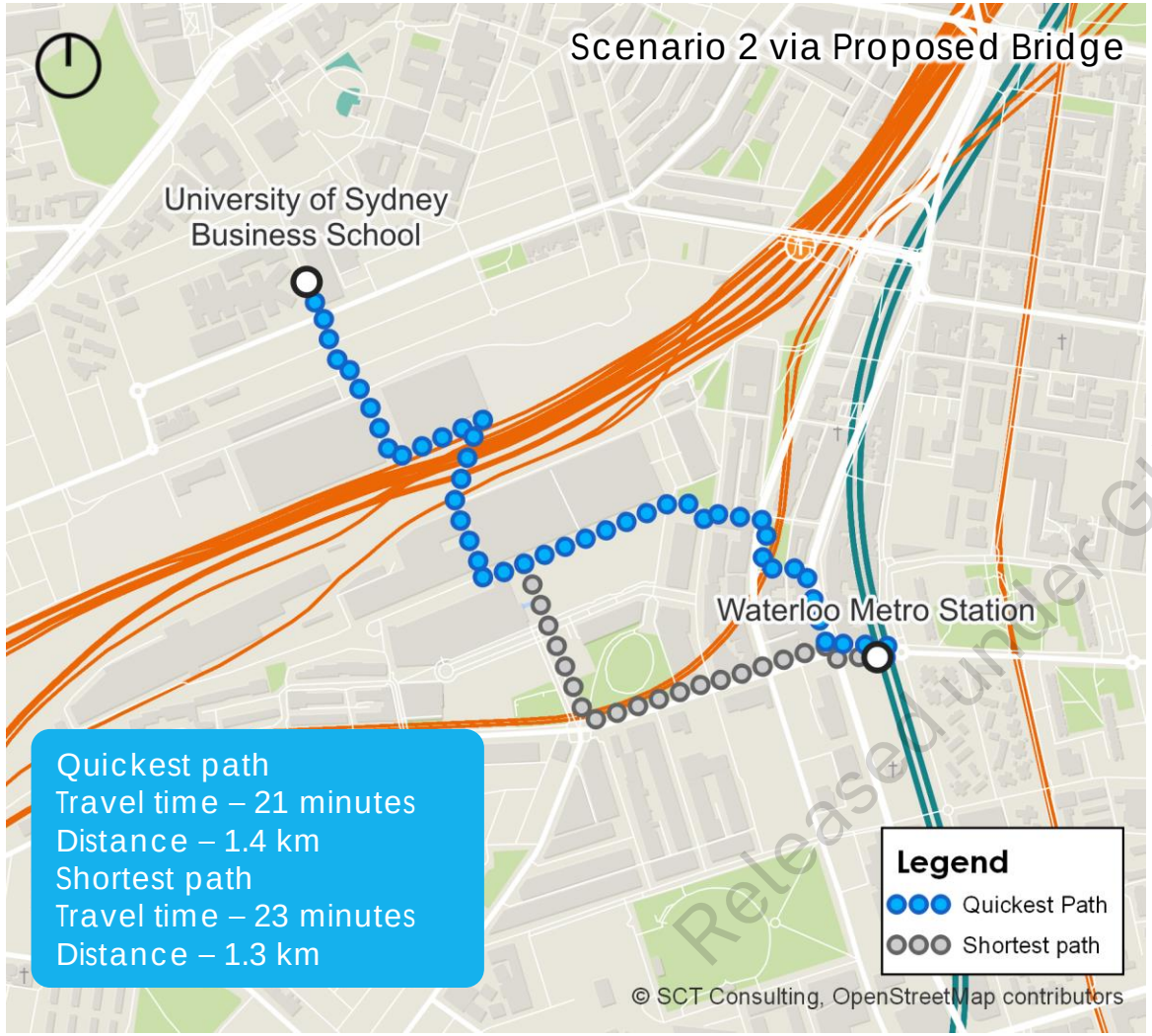


Travel time savings – example route





Travel time savings – example route



A comparison of the paths between *Waterloo Metro Station* and the *University of Sydney Business School* under multiple scenarios resulted in the following observations of cross-corridor journeys:

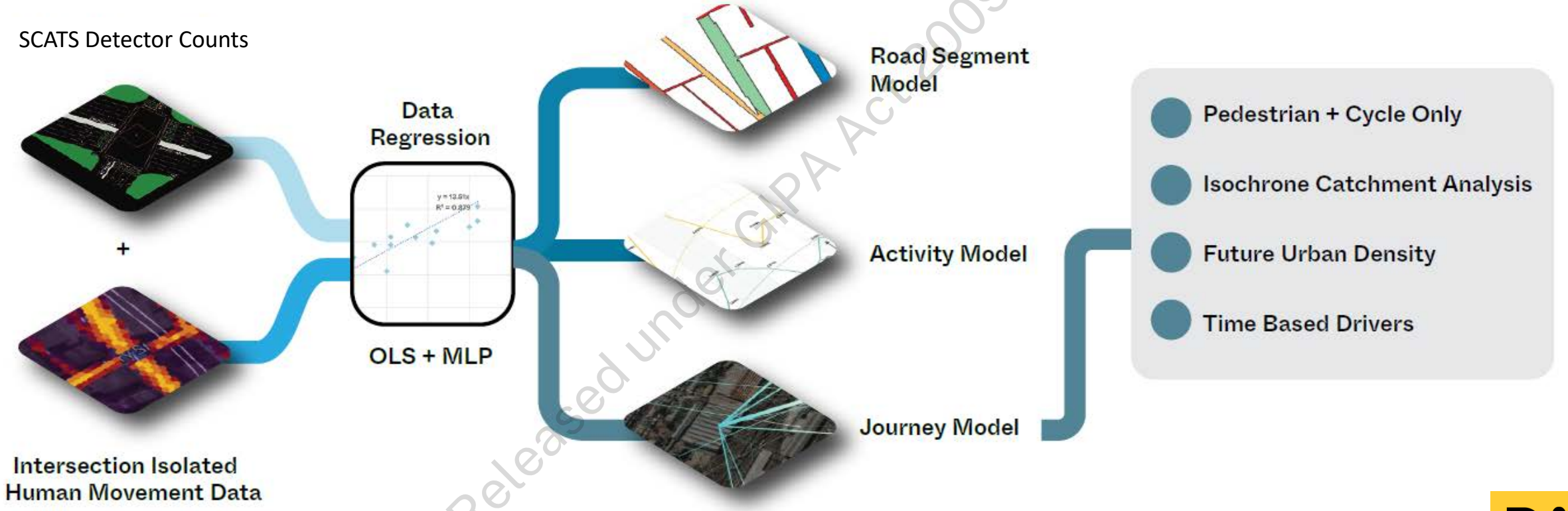
- Access through the southern concourse or proposed bridge are equally as attractive from a travel time and walk distance perspective.
  - The proposed bridge will not require Opal tap-on/off and may provide a better walking environment with less congestion (compared to the southern concourse) which may increase its attractiveness.
- The new proposed bridge provides an improved travel time and distance compared to the base case (via Lawson Street).
- With the proposed bridge option, the lift waiting time and time spent in the lift contributes to ~1-minute of the total travel time.

[02]

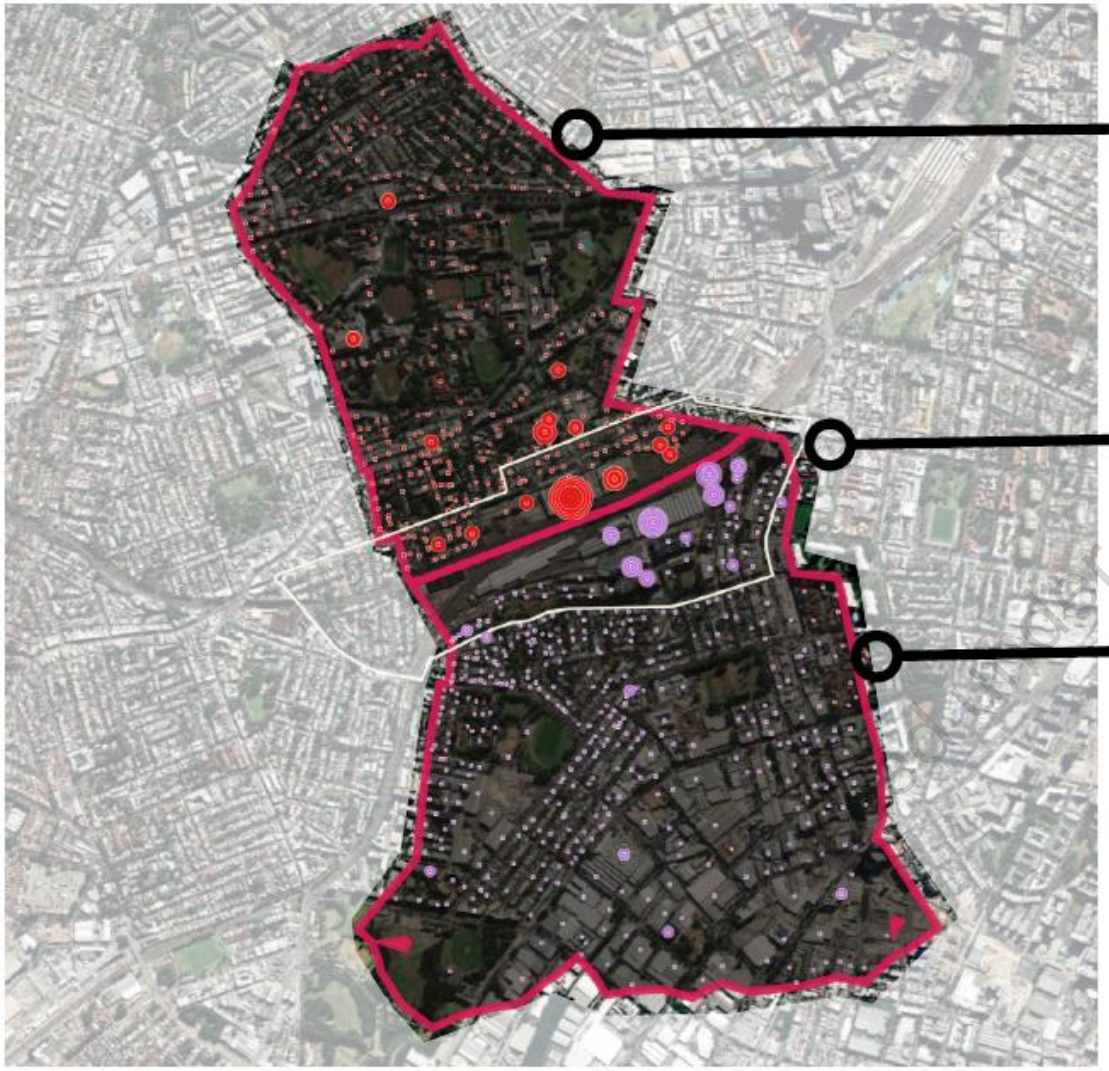
What quantum of people are likely to use the bridge?

Bridge demand analysis - process

We used a number of data processing methods to predict the number of journeys per hour that would use the proposed bridge.



Current observed cross-corridor origins and destinations



North

Primary Generator: University of Sydney

Precinct Boundary

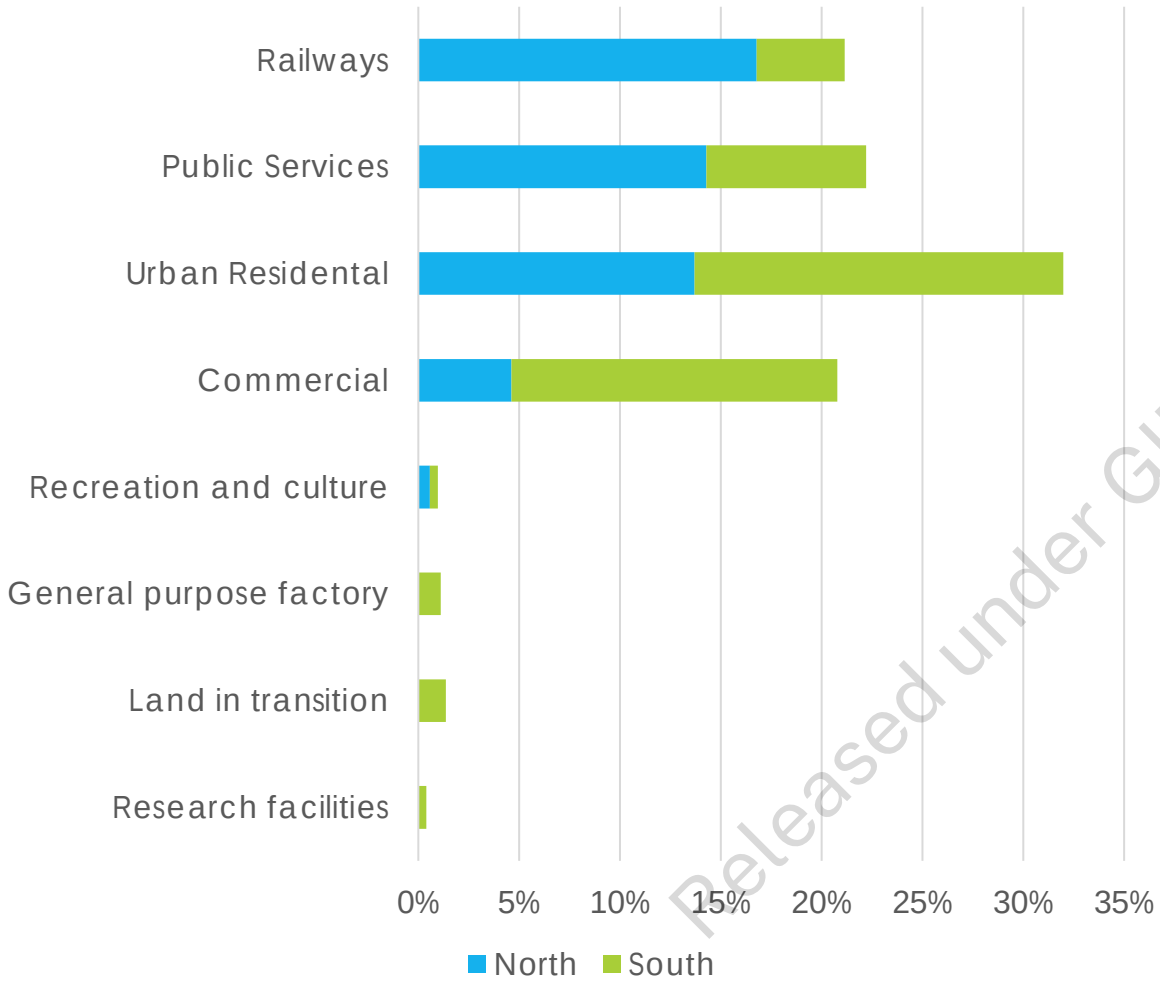
Percent of Total Journeys: 26%

(Excludes Redfern Station activity)

South

Primary Generator: Urban Residential

Cross-corridor trips by land-use



(Excludes Redfern Station activity – some areas around corridor including RNE precinct are classified as Railways)

Journey origins

(the reciprocal can be assumed for a return journey)

32%

Journeys originate from residential land-uses

<2%

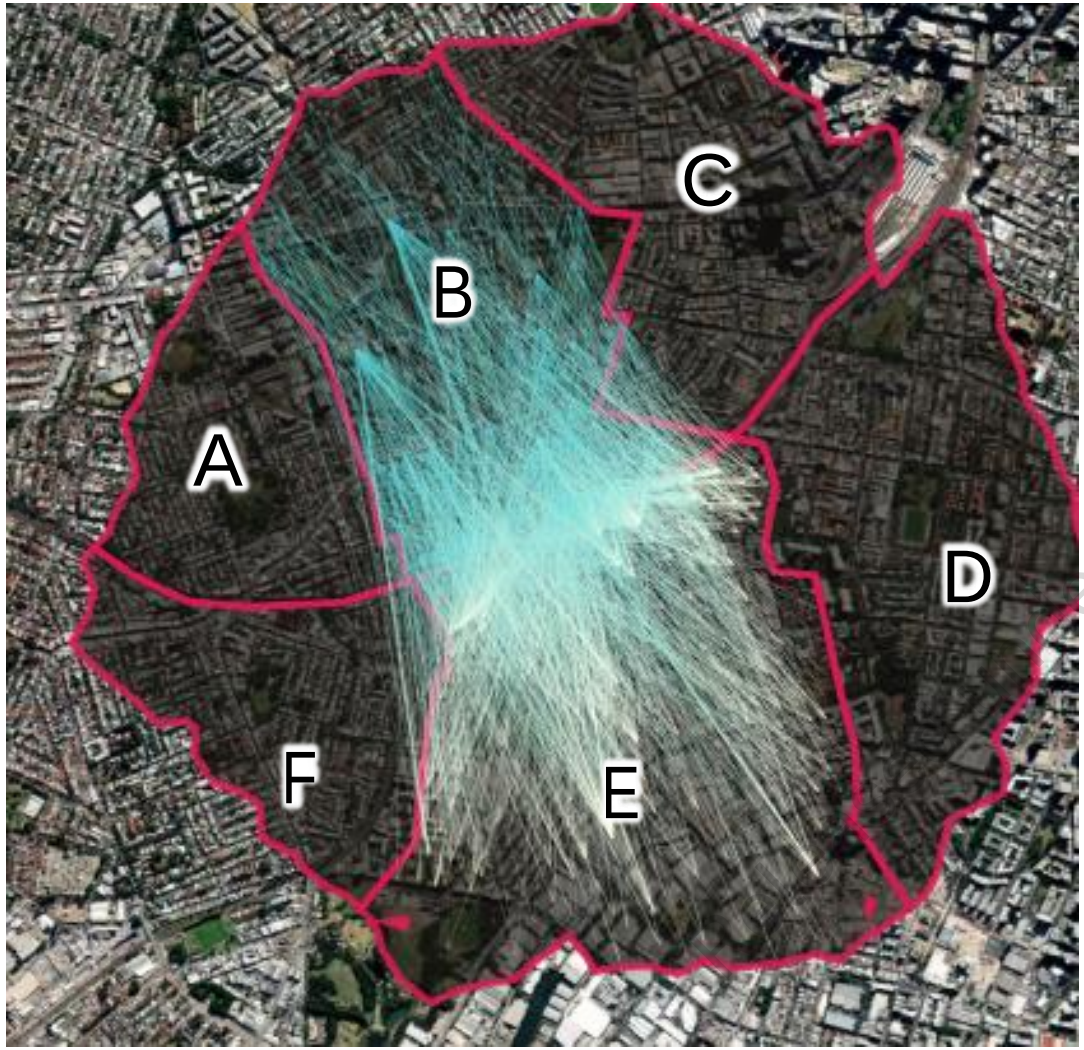
Journeys originate from land-uses classified as recreation and culture.

Study area - benefiting regions (and O-D connections)

Catchment analysis indicates greatest benefit to Regions B and E (and travel to and from these locations).

Regions A – F and C –D already have high levels of permeability, which is corroborated by high observed trips.

Current demand for bridge



Validated trips

340-420 journeys per day

R^2 Average

0.8875

Typical walking characteristics

53% less than 1000m in length

Peaks:

8:15-9:15 AM

4:45-5:45 PM

About the model:

Model Size: 152,470 Journeys

Number of Buildings: 1,391

Time Interval: 15 minutes

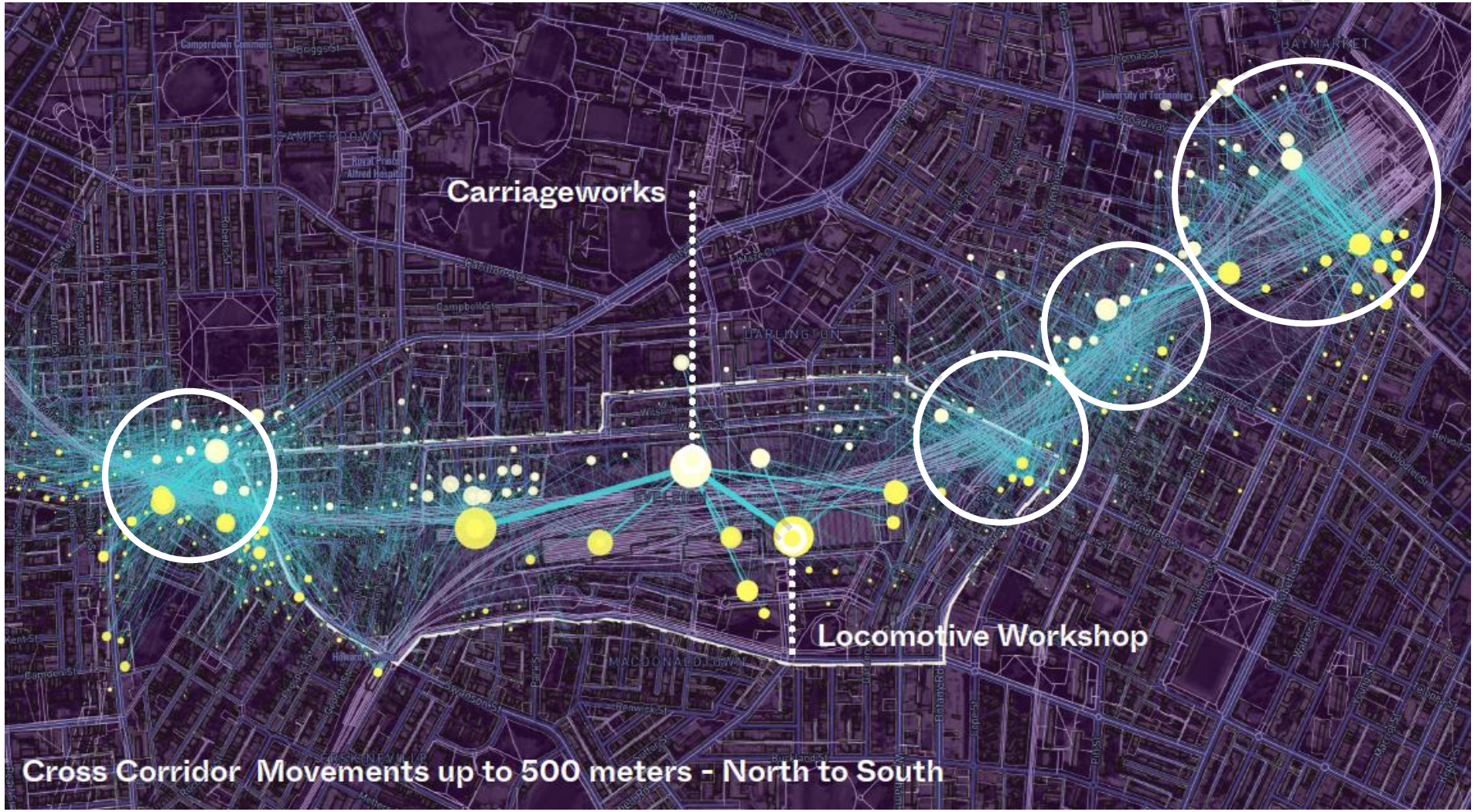
Time Series: Weekdays Only

Mode: Non-Vehicle

[03]

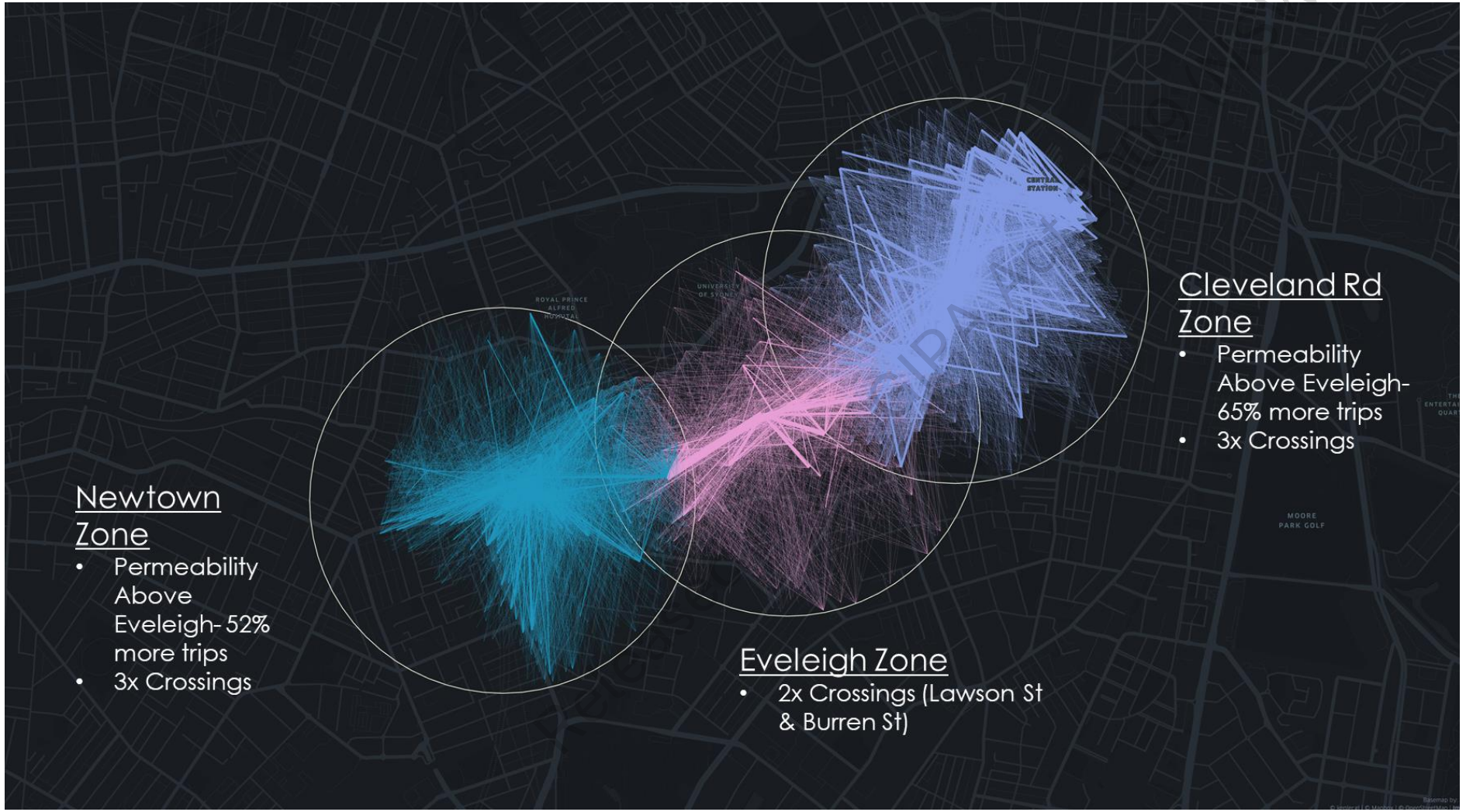
Role of Redfern-North Eveleigh development?

Increased activity due to attractions



Observed activity due to generators and attractions either side of the rail corridor (with a nearby crossing).

Increased activity due to attractions



Conservative assumption for uptake in activity

+10% to +25%

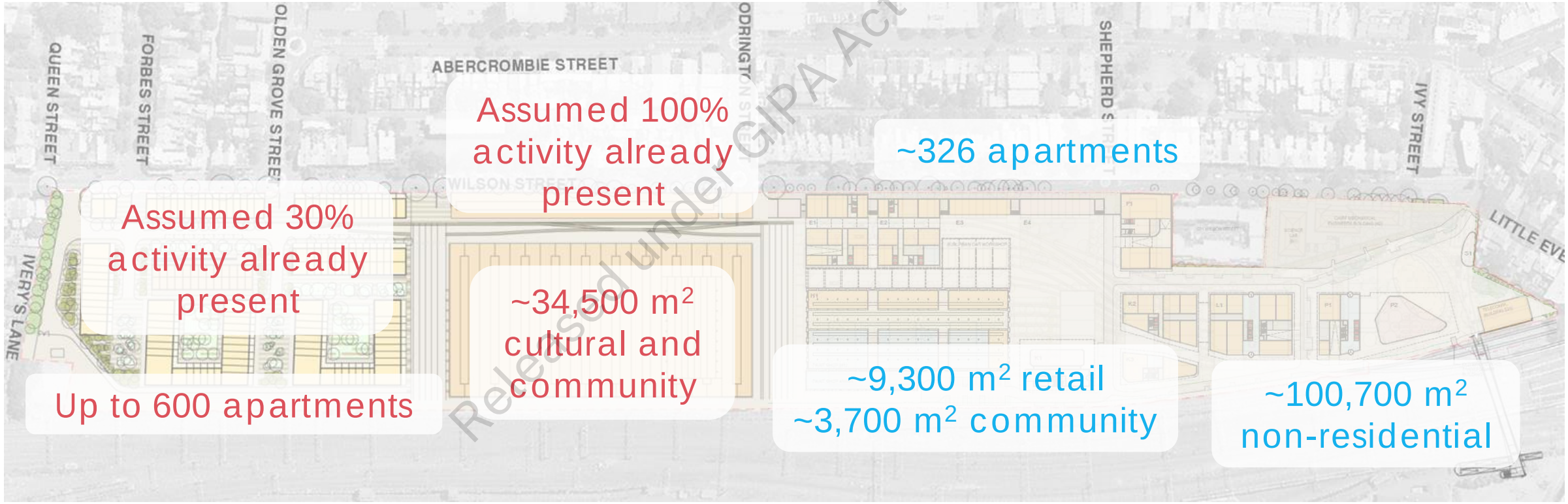
Based on observed activity in adjacent regions.

Increased activity due to land-use uplift

Proportion of Redfern-North Eveleigh precinct will utilise the bridge. Bridge may be used for access to and from the precinct and recreational purposes including lunch breaks to move between attractions at either the north or south precinct.

+10-20% of RNE precinct daily population

(includes customers who would use the bridge multiple times per day – with current 10-20% walk mode share for the precinct)



[04]

Outcomes

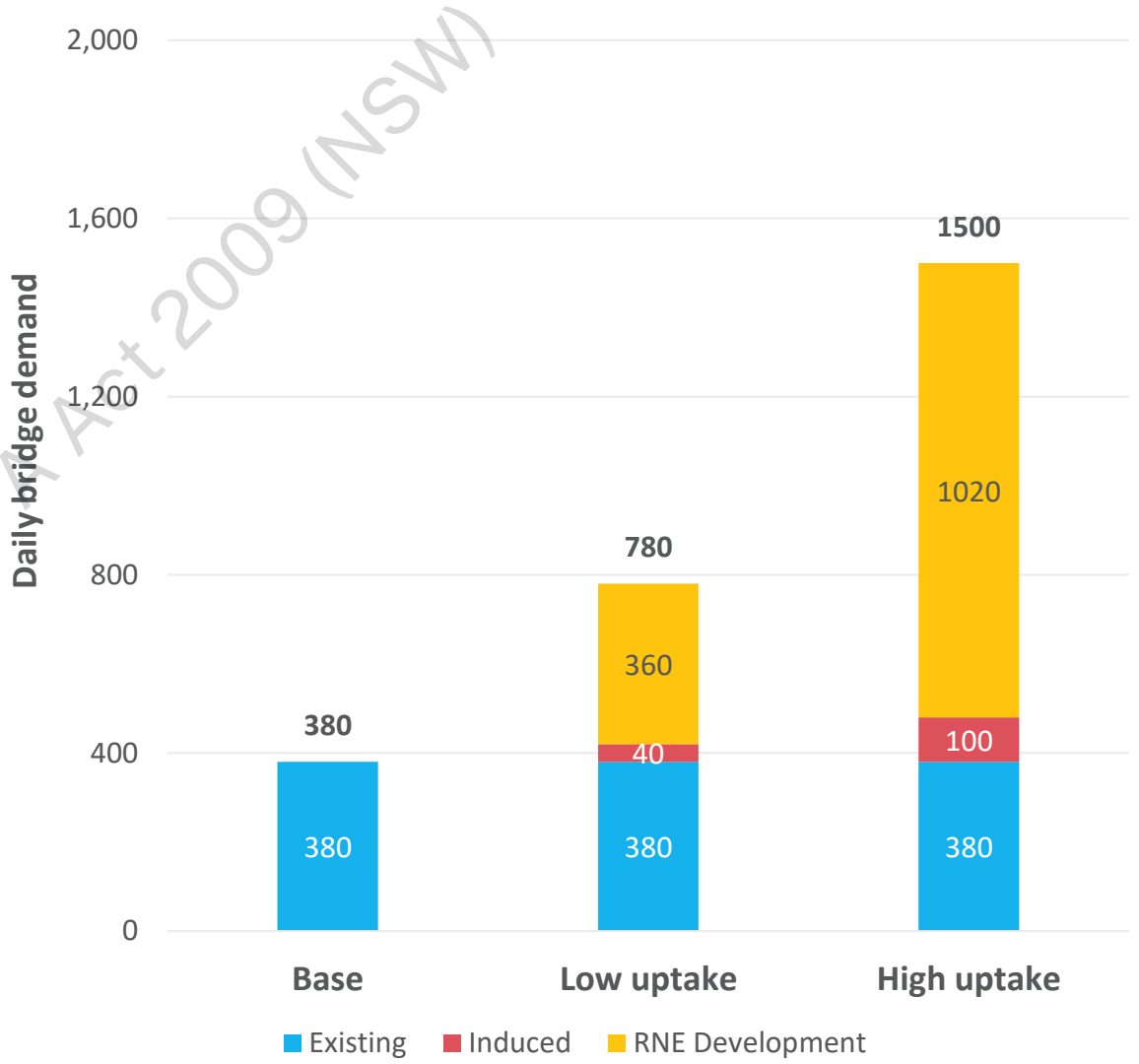
Potential bridge users

Induced demand:

- Increased permeability between generators and attracts
- Lower level of activity either side of rail corridor compared to regions like Newtown

RNE development related demand:

- Single largest contributor to use. The daily count includes an estimate for trips to and from the precinct.
- Assumes the proposed bridge is the most attractive option for:
  - 100% of residential, community and cultural land uses.
  - 70% of commercial land use. Some high-density commercial is located on the eastern edge, closer to the southern concourse, making the proposed bridge less attractive for these customers.
- Assumes precincts are being established as self-serving for residents and employees.
  - If land uses are linked between RNE and South Eveleigh, we would expect more daily trips.



Potential benefit – daily productivity

Average travel time saving

3 minutes

per cross-corridor journey.

Base scenario

19 hours

Reduced travel time for customers daily (typical weekday).

Low uptake scenario

39 hours

Reduced travel time for customers daily (typical weekday).

High uptake scenario

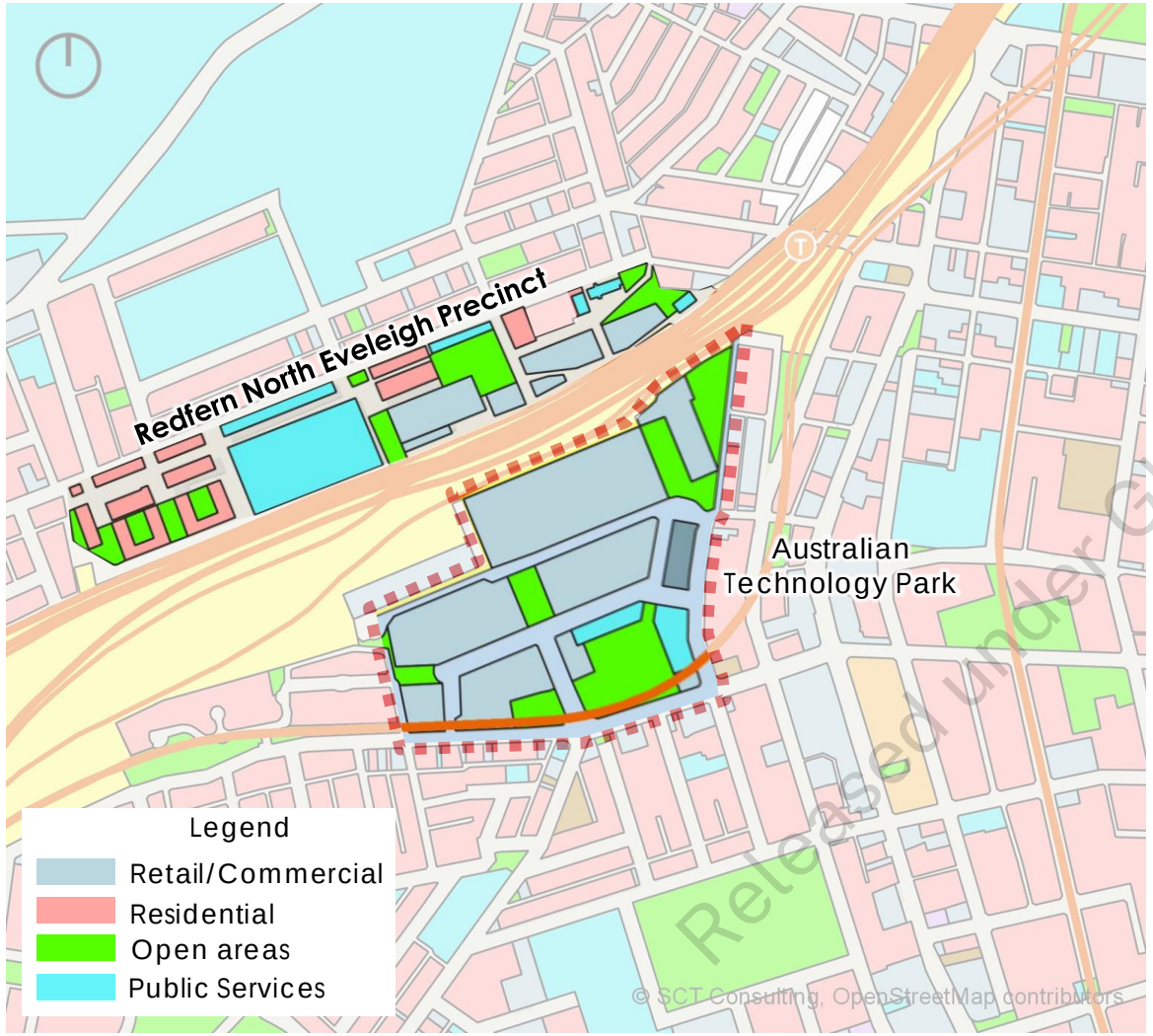
75 hours

Reduced travel time for customers daily (typical weekday).

[05]

Australia Technology Park – Sensitivity analysis (Retail)

Overview of Australian Technology Park (ATP) Land Use



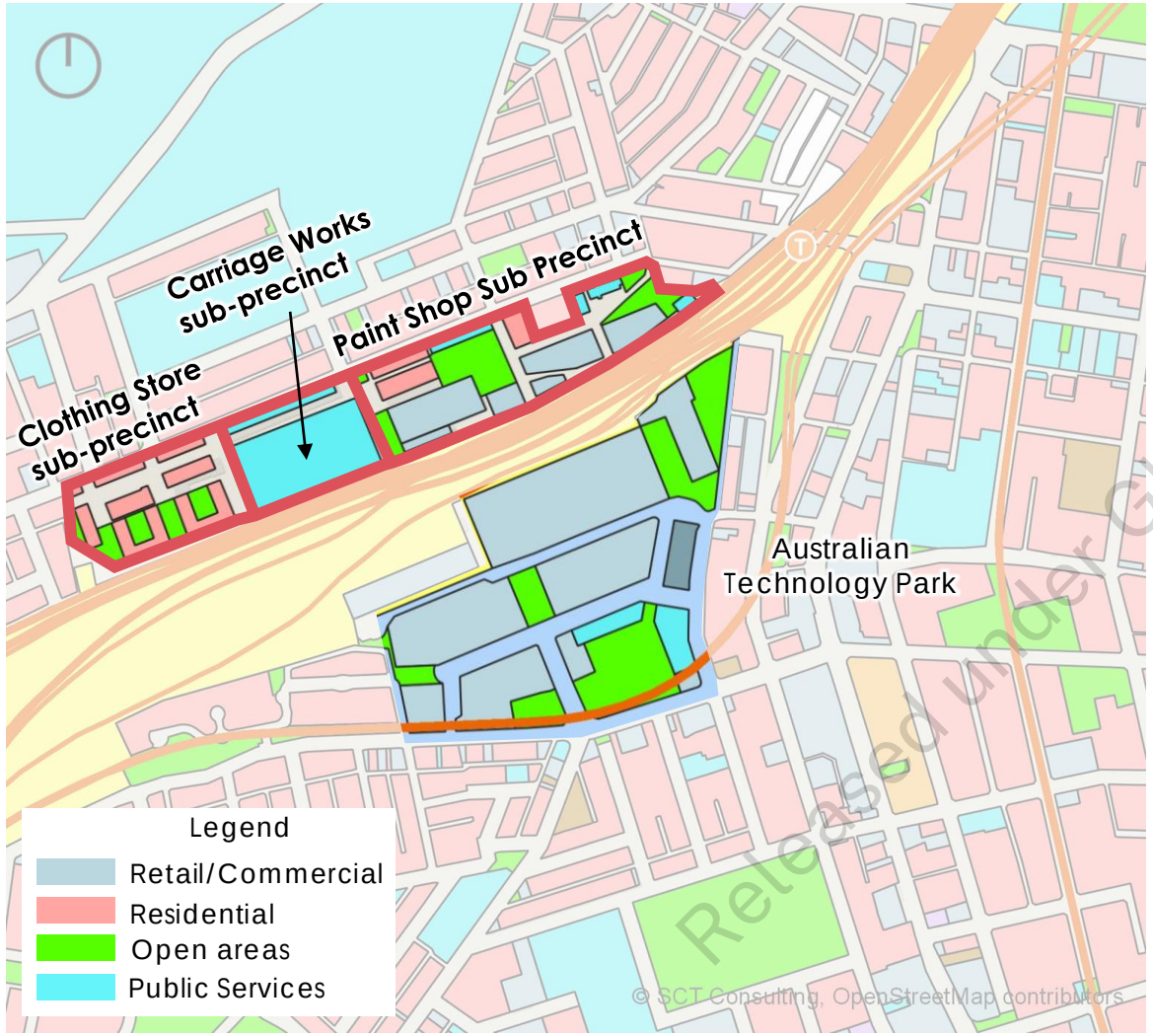
- Stage 1
  - Media Centre Building (Channel 7 Building ~40,000m^2 GFA)
  - Biomedical Building (~7,600m^2 GFA)
  - NICTA Building (~11,200m^2 GFA)
  - National Innovation Centre (NIC) (~7,000m^2 GFA)
  - International Business Centre (IBC) (~950m^2 GFA)
  - Locomotive Workshop (Conference and Exhibition Centre ~25,000m2 GFA)
- Stage 2
  - Commercial/ office premises – 102,542m^2 GFA
  - Retail – 2,790m^2 GFA
  - Childcare -1,649m^2 GFA
- The Large Erecting Shop (LES) with 15,000 m2 GFA has been considered for trip calculations despite falling outside the ATP.

Key outcomes

Combined GFA: 214,181 m^2 GFA

Approximate employees: 11,750, based on an employee rate of:
- 1:18 m2 GFA (commercial)
- 1:35 m2 GFA (retail and other)

Overview of Redfern-North Eveleigh Precinct Land Use



There are three sub-precincts within the Redfern-North Eveleigh Precinct

- Paint Shop sub-precinct
  - Up to 326 apartments
  - 9,300m^2 retail
  - 3,700m^2 community area
  - 100,700m^2 non-residential area
- Carriage Works sub-precinct
  - 34,500m^2 community area (assumed 100% delivered)
- Clothing Store sub-precinct
  - Already partially delivered (some trips already observed)
  - Up to 600 apartments (assumed 30% delivered)

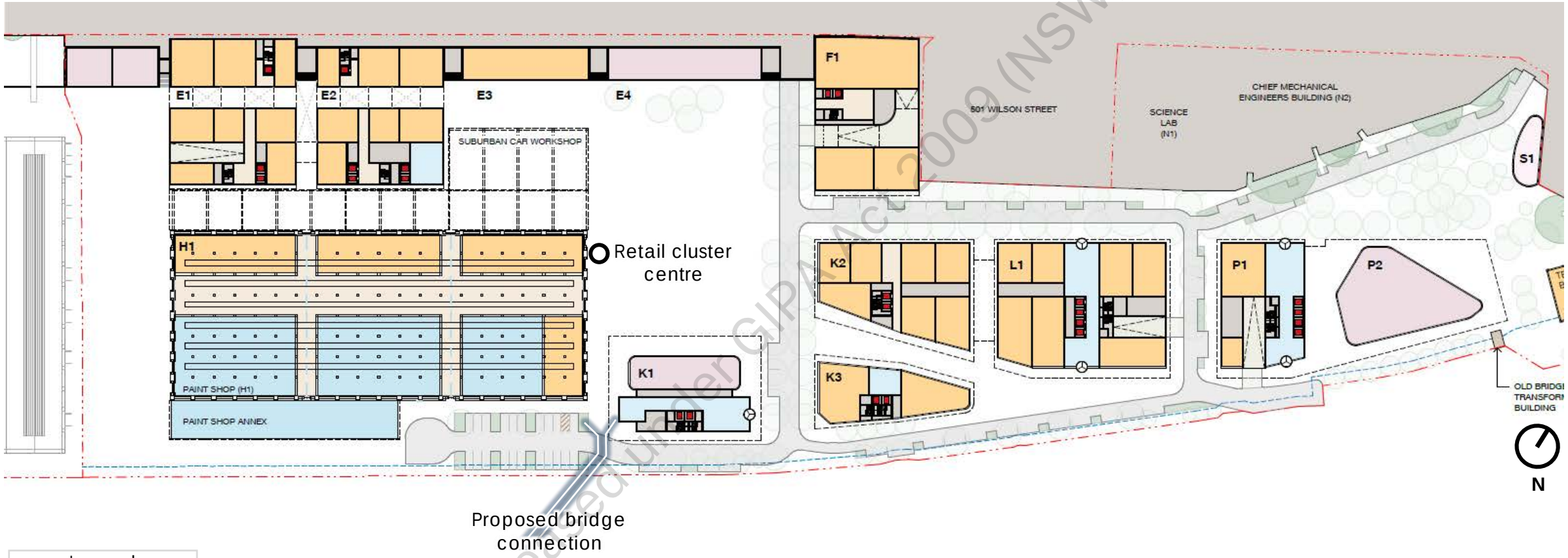
Key outcomes

Approximate "new" employees: 5,930 based on an employee rate of:

- 1:18 m2 GFA (commercial)
- 1:35 m2 GFA (retail)
- 1:50 m2 GFA (community)

Approximate "new" residents : 1,570 based on dwelling rate of 2.1 persons per apartment.

Paint Shop Sub-Precinct Land use



Key outcome
The proposed bridge connects to the Paint shop precinct at the central location close to the majority of the retail areas.

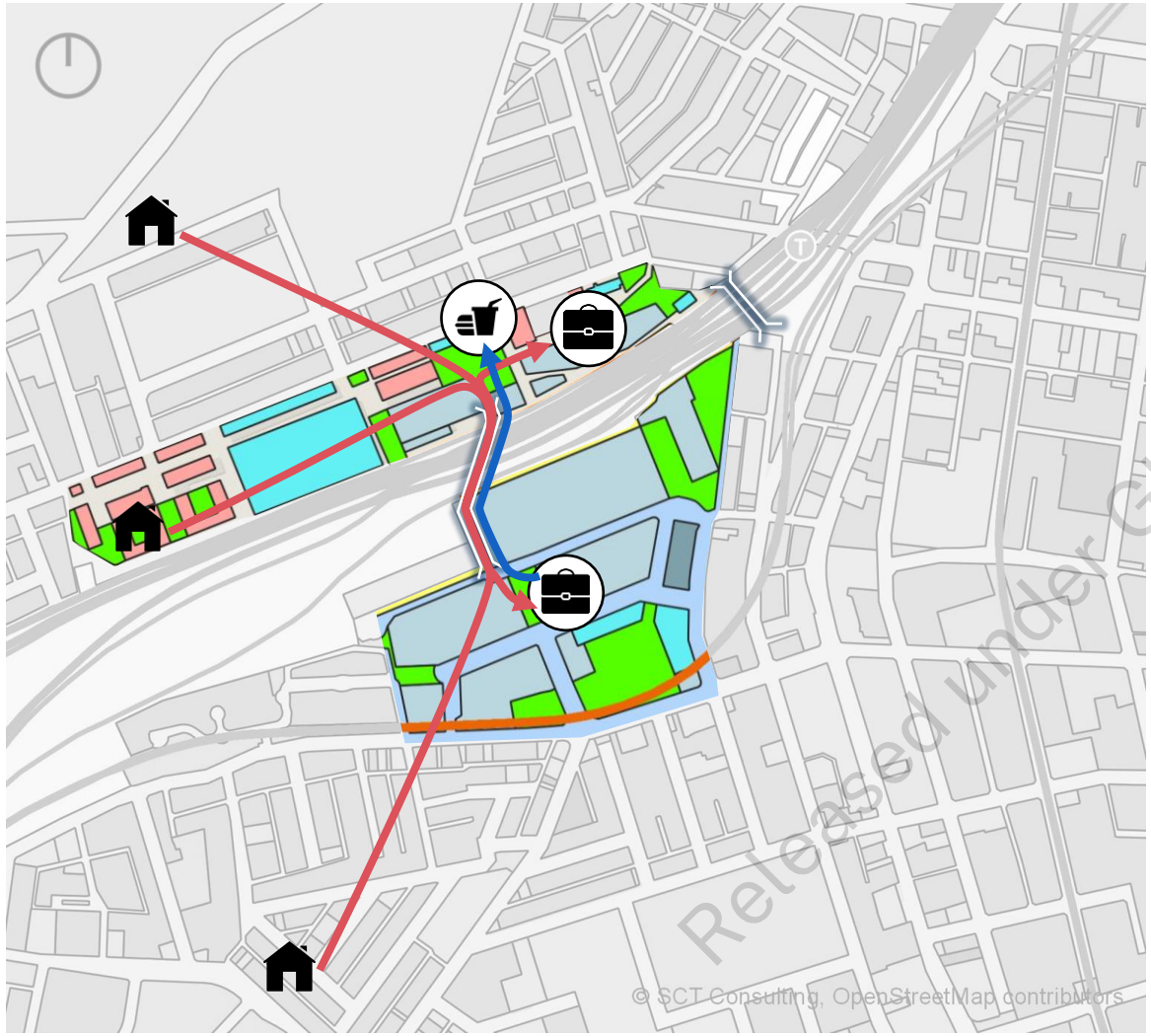
Paint Shop Sub-Precinct Land use

- Proposed bridge connection on the northern side of the rail corridor is located near the Paint Shop sub-precinct retail cluster.
- On the southern side, the bridge is near Village Square Park, between Media Centre Building and Commonwealth Bank (Foundry) Building.

Key outcomes

Both of the proposed bridge end connections are near high-demand land uses.

Trip type overview



The overarching analysis, which considers trips within a 2-kilometre catchment, leverages existing travel patterns. This analysis has already included the following trips:

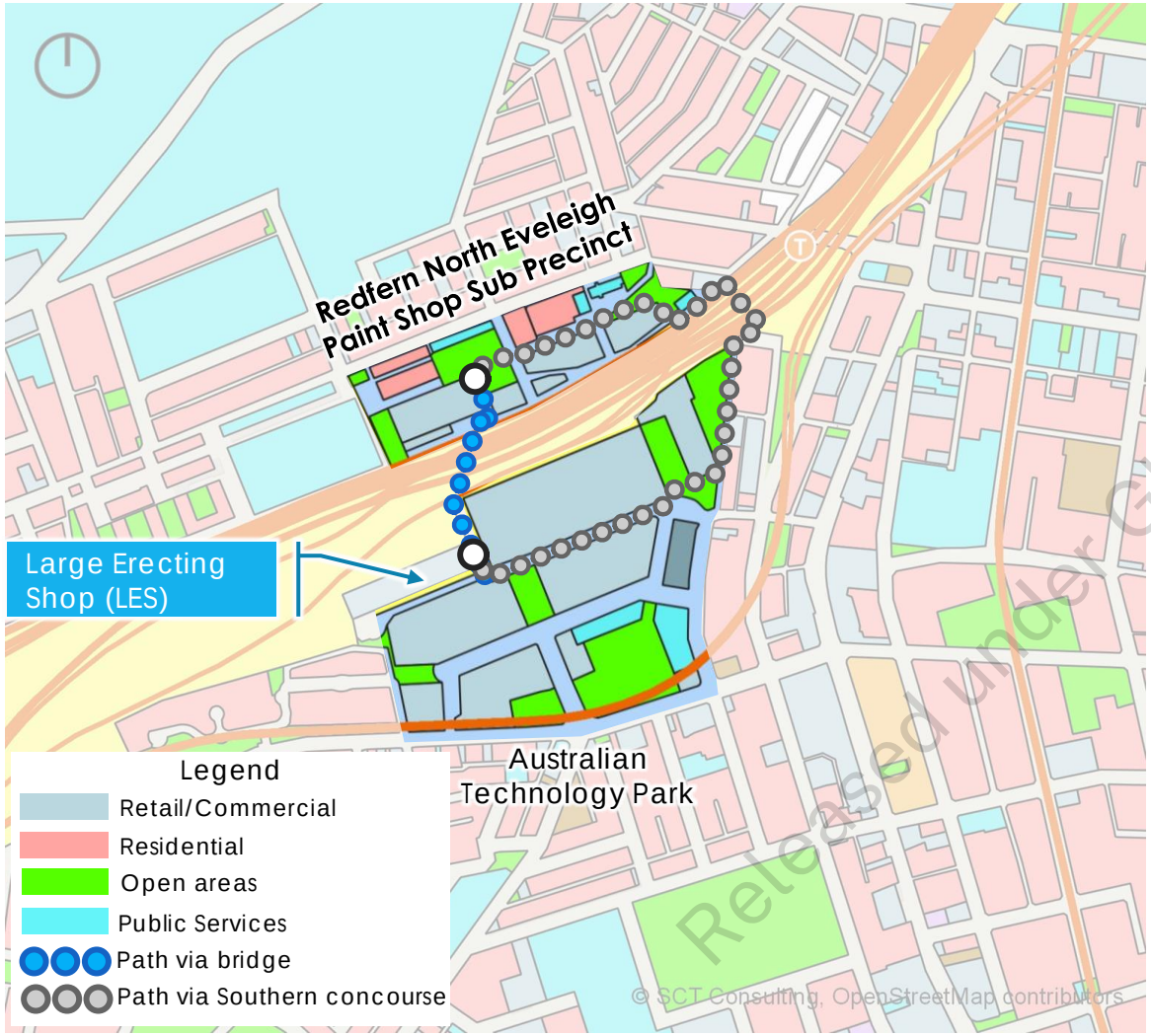
- External origins/destinations to ATP or RNE – captured in the overarching analysis
- ATP to/from RNE commercial-residential – partially captured in the overarching analysis

Trips between ATP and RNE which are work-related business trips (i.e. commercial-commercial), would be limited in number and are difficult to estimate without inherent knowledge of the future tenants. Hence these have not been estimated. However, it is envisaged that the conservatism within the overarching analysis would sufficiently capture these trips.

A key trip category that has not been considered is trips between ATP and RNE commercial/residential to retail (such as food and beverage) throughout the day. These trips (and their respective likelihood of using the proposed bridge) are considered in this chapter.

- Assumptions for trip estimation
  - 70% of total employees attend office on a typical day
  - 50% purchase lunch/visit any other retail facility
  - ~5-10% likely to go to the RNE Paint shop precinct. 5% is being used as a low uptake and 10% for the high uptake scenario.
  - Return trip is assumed to be via the same route

Large Erecting Shop (LES) to RNE retail cluster



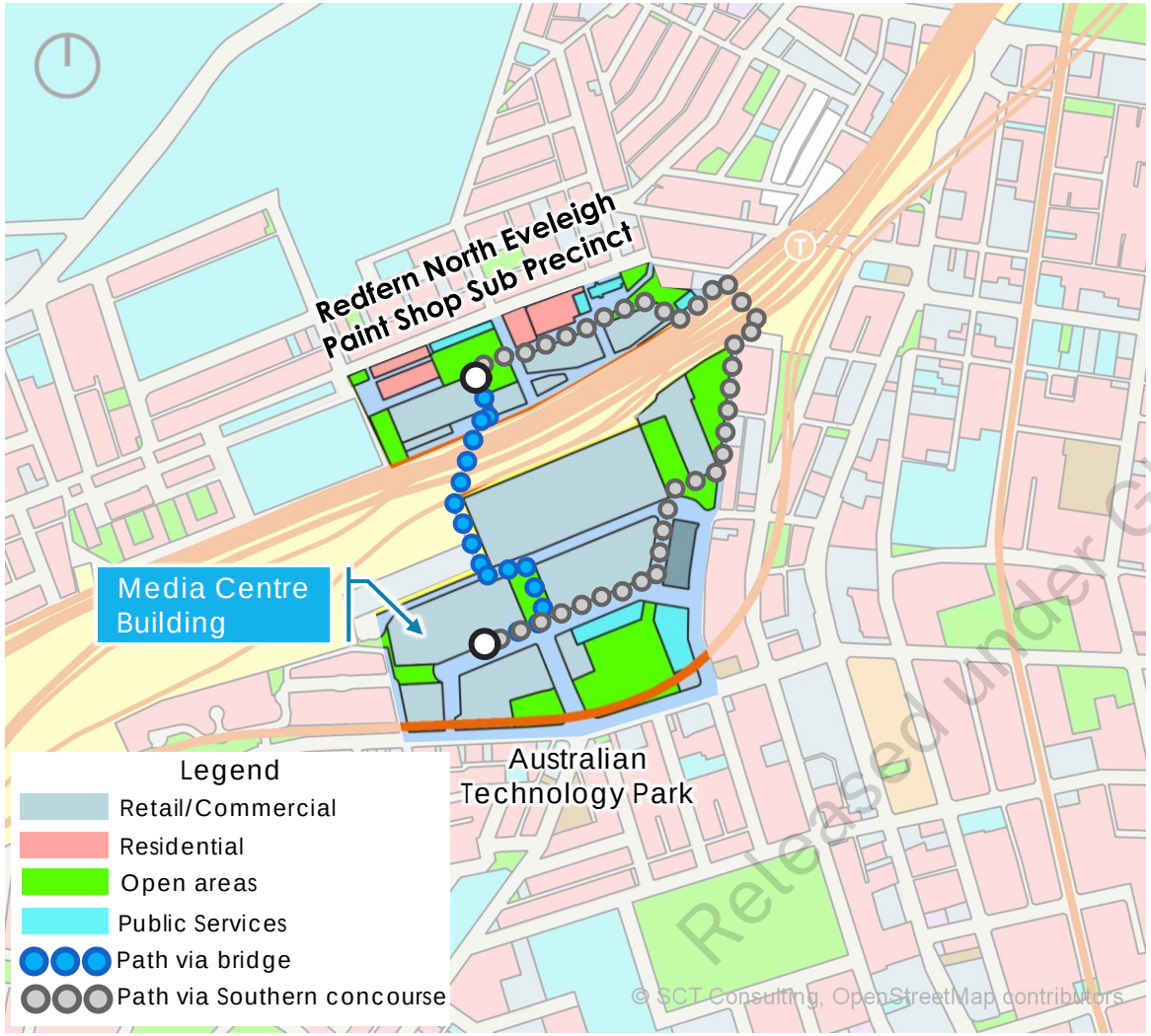
Large Erecting Shop (LES)

- Land use:
  - Commercial/ office premises – 15,000 m2 GFA
- Number of employees – 833
- Travel time to RNE retail cluster
  - via southern concourse – 14 minutes
  - via proposed bridge – 5 minutes 17 seconds
- Number of daily trips via bridge – 29 to 58 trips

Key outcomes

Travel time saving due to proposed bridge – 8 minutes 43 seconds
Number of daily trips via bridge – 29 to 58 trips

Media Centre Building to RNE retail cluster



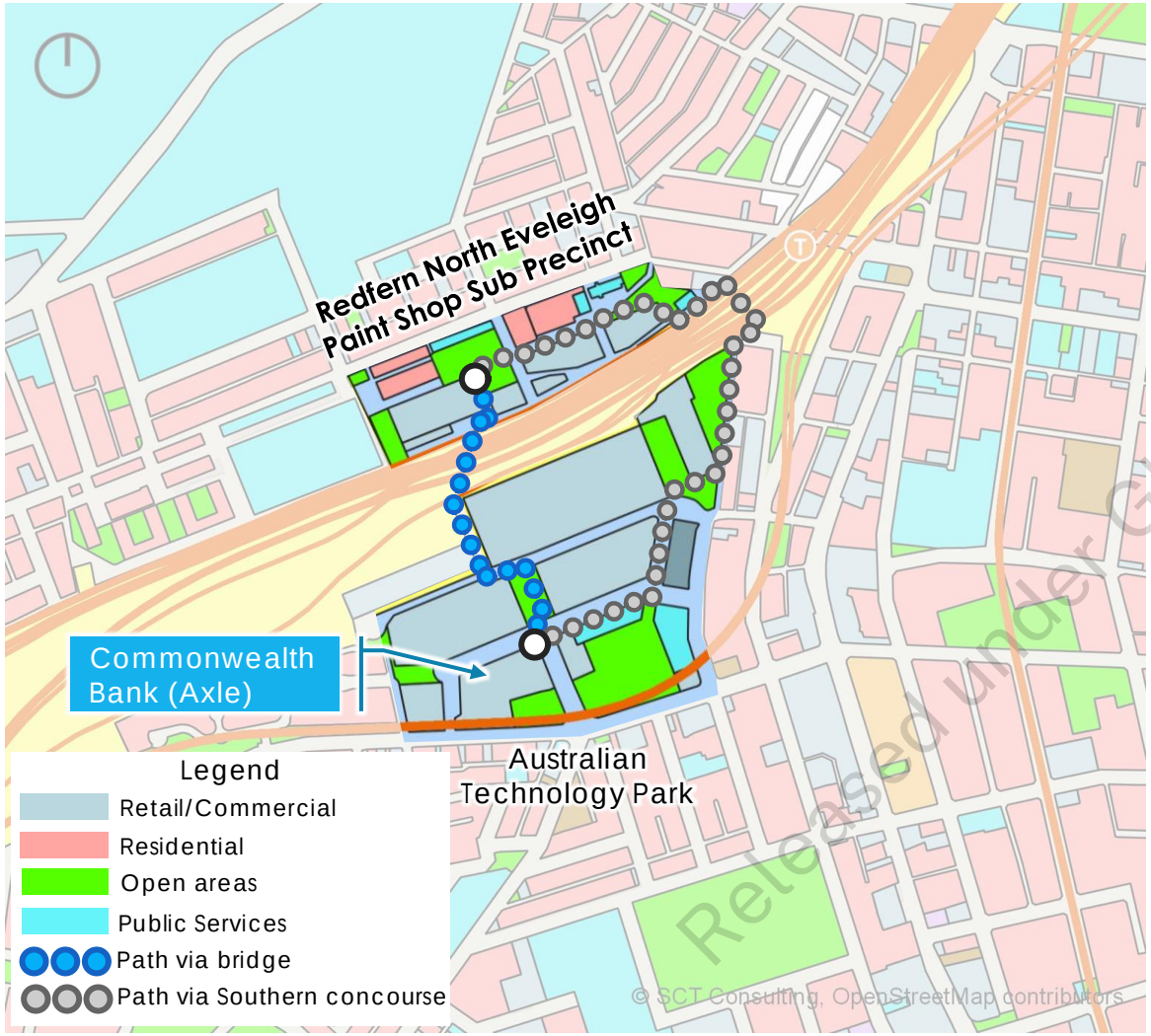
Media Centre Building (Channel 7, NEP, etc.)

- Land use:
  - Commercial/ office premises – 40,000 m2 GFA
- Number of employees – 2,222
- Travel time to RNE retail cluster
  - via southern concourse – 14 minutes 43 seconds
  - via proposed bridge – 8 minutes
- Number of daily trips via bridge – 78 to156 trips

Key outcomes

Travel time saving due to proposed bridge – 6 minutes 43 seconds
Number of daily trips via bridge – 78 to156 trips

Commonwealth Bank (Axle) to RNE retail cluster



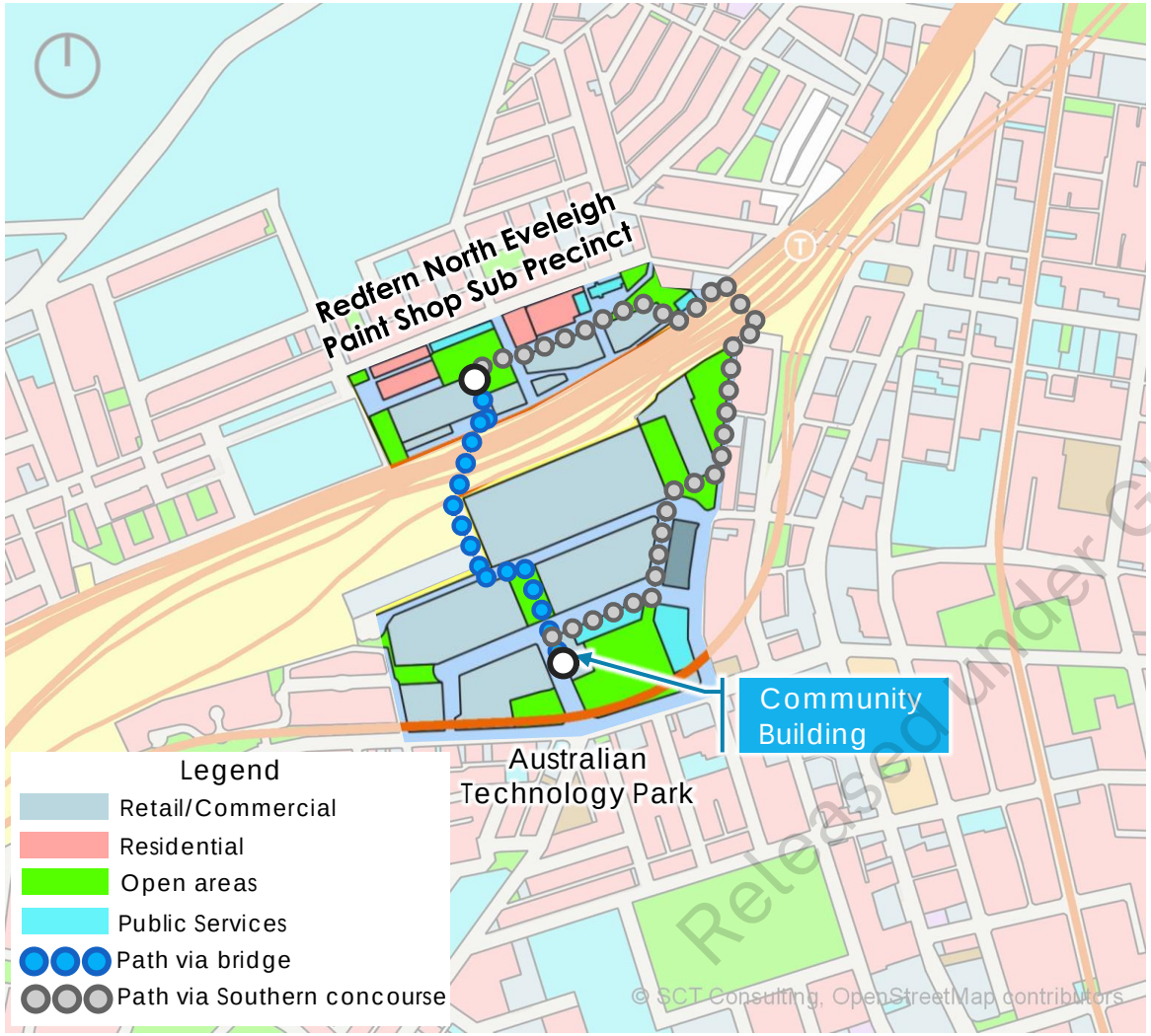
Commonwealth Bank (Axle)

- Land use:
  - Commercial/ office premises – 45,663 m2 GFA
  - Retail – 314 m2 GFA
  - Childcare – 855 m2 GFA
- Number of employees – 2,570
- Travel time to RNE retail cluster
  - via southern concourse – 14 minutes 11 seconds
  - via proposed bridge – 7 minutes 33 seconds
- Number of daily trips via bridge – 90 to180 trips

Key outcomes

Travel time saving due to proposed bridge – 6 minutes 37 seconds
Number of daily trips via bridge – 90 to180 trips

Community Building to RNE retail cluster



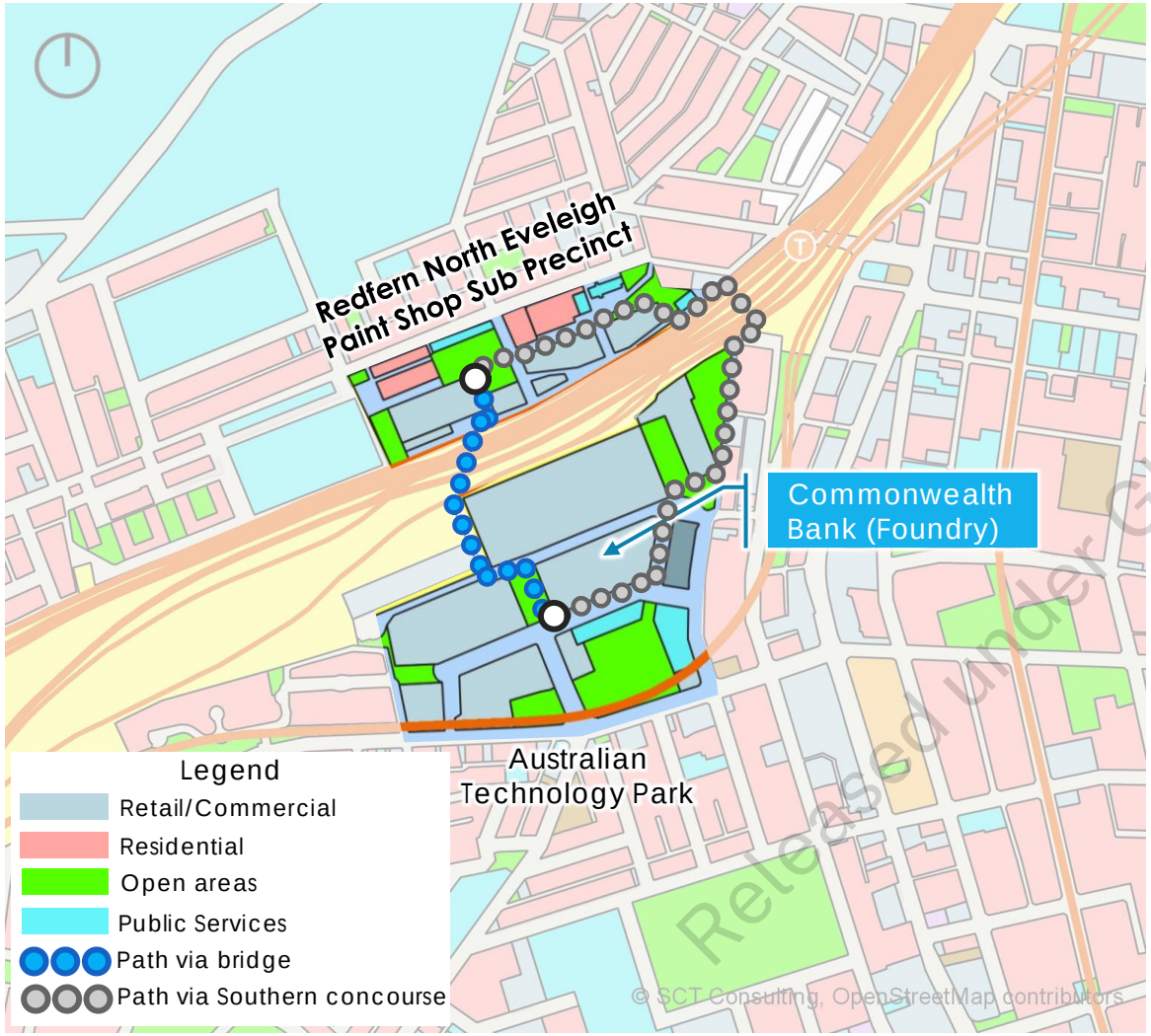
Community Building

- Land use:
  - Commercial/ office premises – 2,286 m2 GFA
  - Retail – 381 m2 GFA
  - Childcare – 794 m2 GFA
- Number of employees – 161
- Travel time to RNE retail cluster
  - via southern concourse – 14 minutes 15 seconds
  - via proposed bridge – 7 minutes 42 seconds
- Number of daily trips via bridge – 6 to 11 trips

Key outcomes

Travel time saving due to proposed bridge – 6 minutes 34 seconds
Number of daily trips via bridge – 6 to 11 trips

Commonwealth Bank (Foundry) to RNE retail cluster



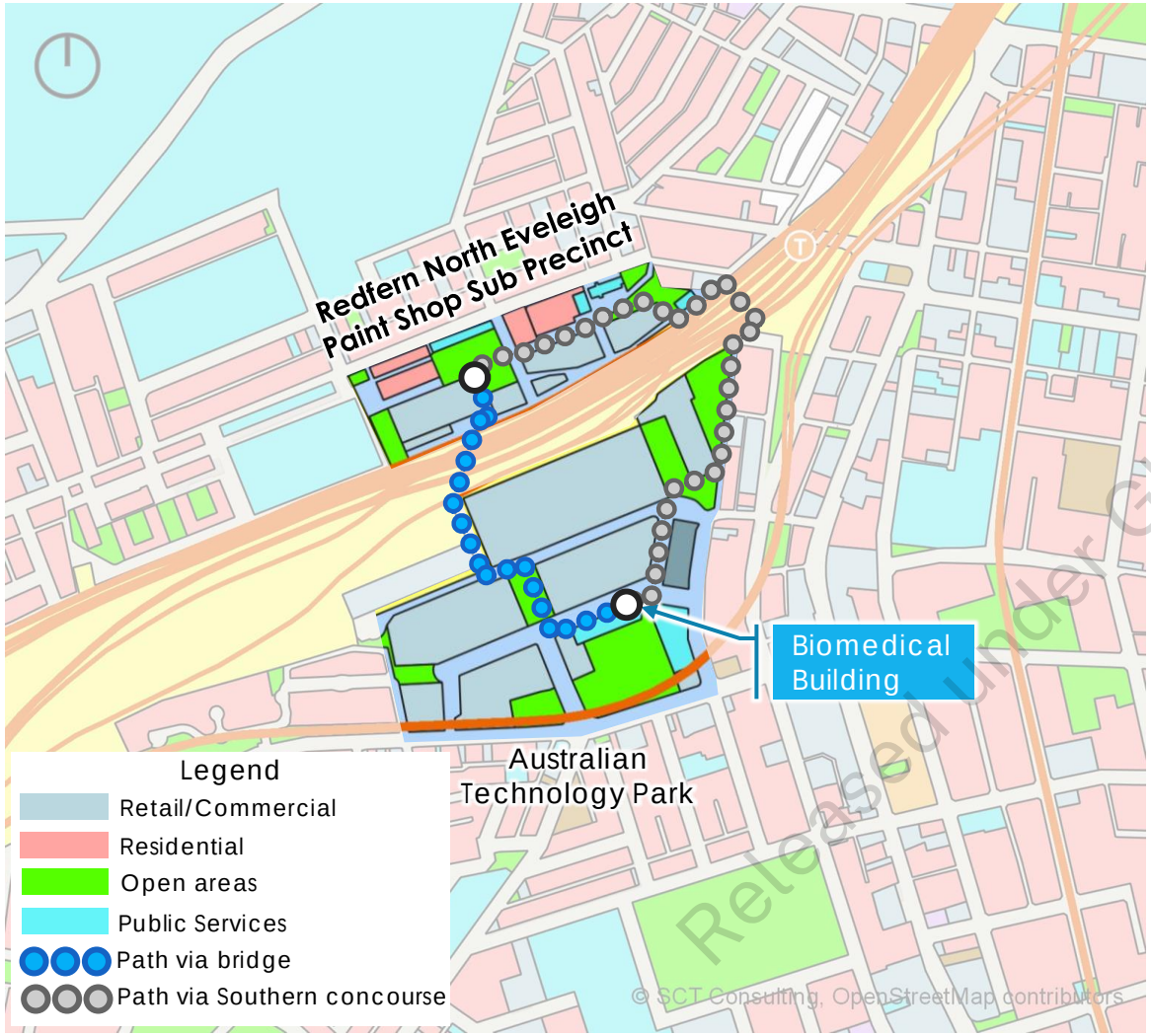
Commonwealth Bank (Foundry)

- Land use:
  - Commercial/ office premises – 54,593 m2 GFA
  - Retail – 2,095 m2 GFA
- Number of employees – 3,093
- Travel time to RNE retail cluster
  - via southern concourse – 13 minutes 27 seconds
  - via proposed bridge – 6 minutes 59 seconds
- Number of daily trips via bridge – 108 to 216 trips

Key outcomes

Travel time saving due to proposed bridge – 6 minutes 28 seconds
Number of daily trips via bridge – 108 to 216 trips

Biomedical Building to RNE retail cluster



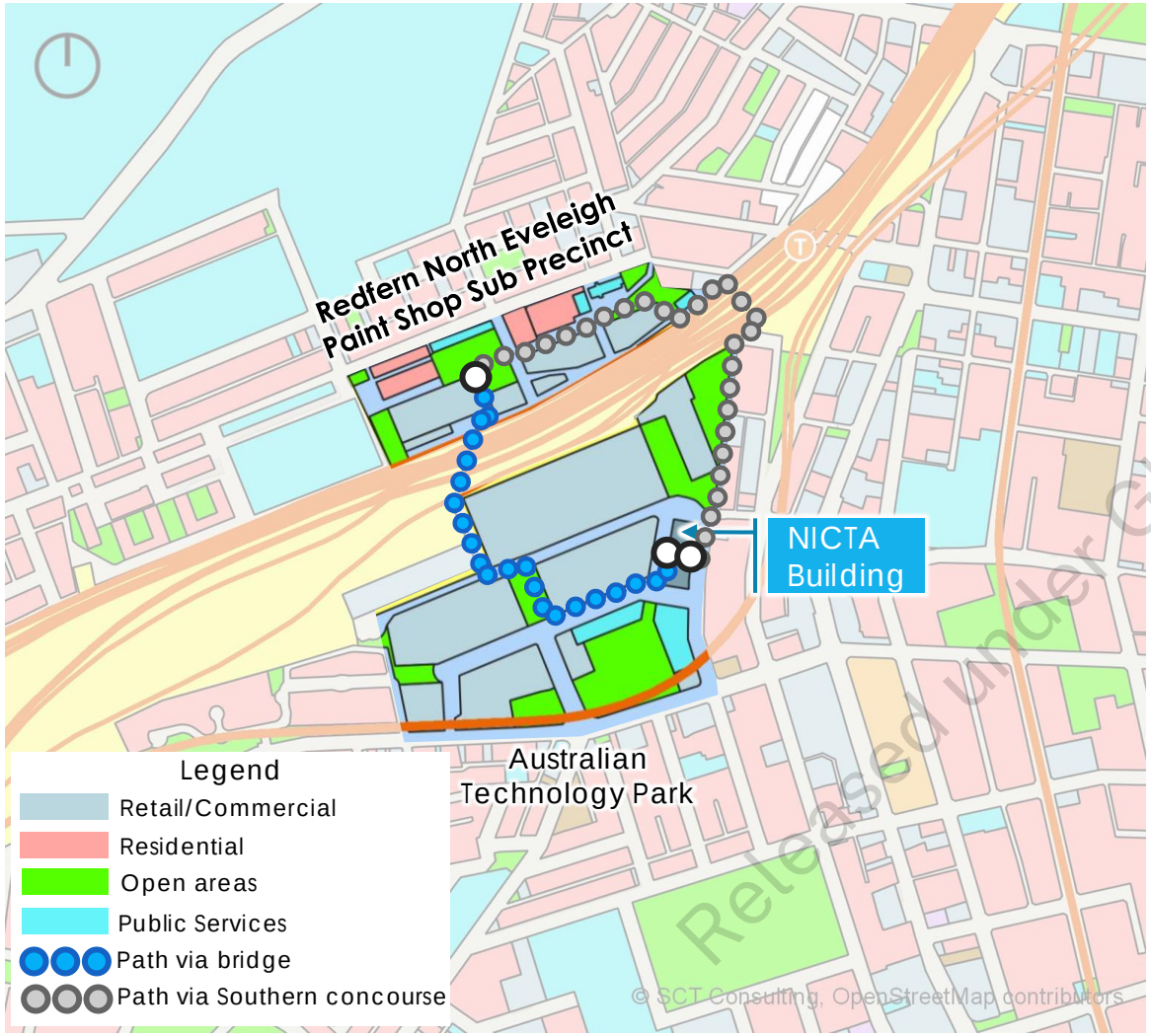
Biomedical Building

- Land use:
  - Commercial/ office premises – 7,600 m2 GFA
- Number of employees – 422
- Travel time to RNE retail cluster
  - via southern concourse – 12 minutes 25 seconds
  - via proposed bridge – 8 minutes 34 seconds
- Number of daily trips via bridge – 15 to 30 trips

Key outcomes

Travel time saving due to proposed bridge – 3 minutes 51 seconds
Number of daily trips via bridge – 15 to 30 trips

NICTA Building to RNE retail cluster



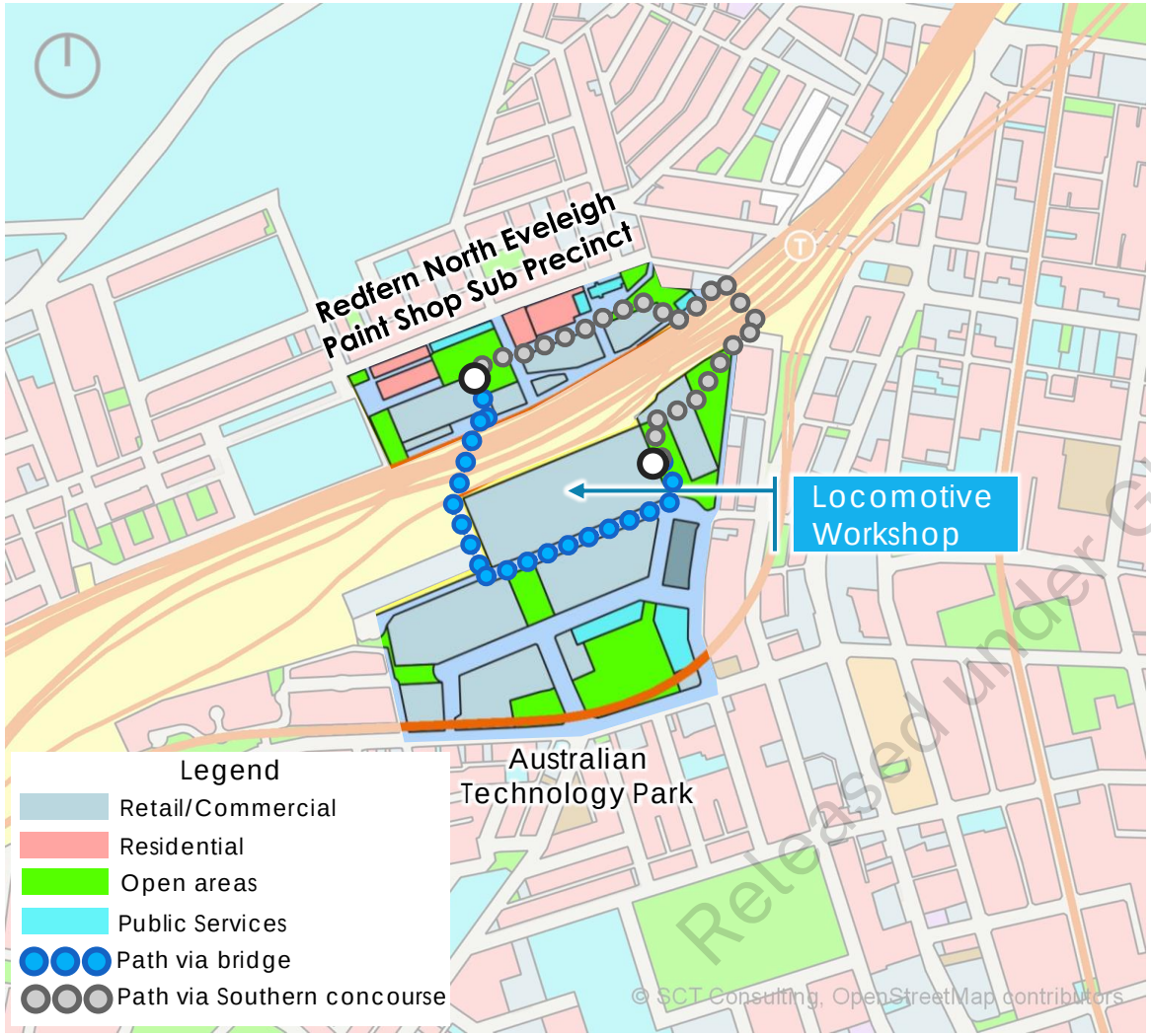
NICTA Building

- Land use:
  - Commercial/ office premises – 11,200 m2 GFA
- Number of employees – 622
- Travel time to RNE retail cluster
  - via southern concourse – 10 minutes 46 seconds
  - via proposed bridge – 9 minutes 33 seconds
- Number of daily trips via bridge – 22 to 44 trips

Key outcomes

Travel time saving due to proposed bridge – 1 minute 12 seconds
Number of daily trips via bridge – 22 to 44 trips

Locomotive Workshop to RNE retail cluster



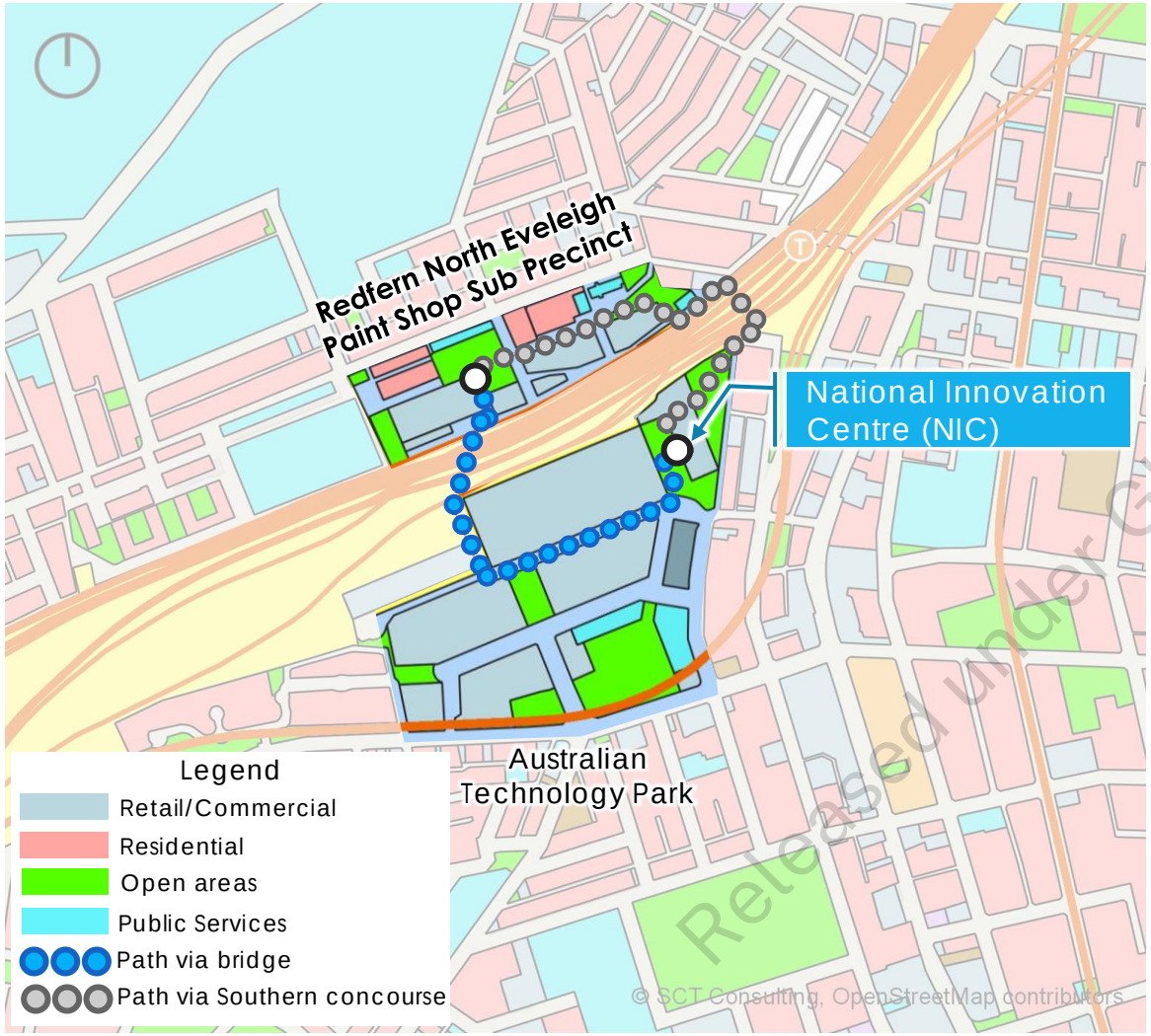
Locomotive Workshop

- Land use:
  - Commercial/ office premises – 25,000 m2 GFA
- Number of employees – 1,388
- Travel time to RNE retail cluster
  - via southern concourse – 9 minutes 49 seconds
  - via proposed bridge – 9 minutes 12 seconds
- Number of daily trips via bridge – 49 to 97 trips

Key outcomes

Travel time saving due to proposed bridge – 38 seconds
Number of daily trips via bridge – 49 to 97 trips

National Innovation Centre (NIC) to RNE retail cluster



National Innovation Centre (NIC)

Land use:

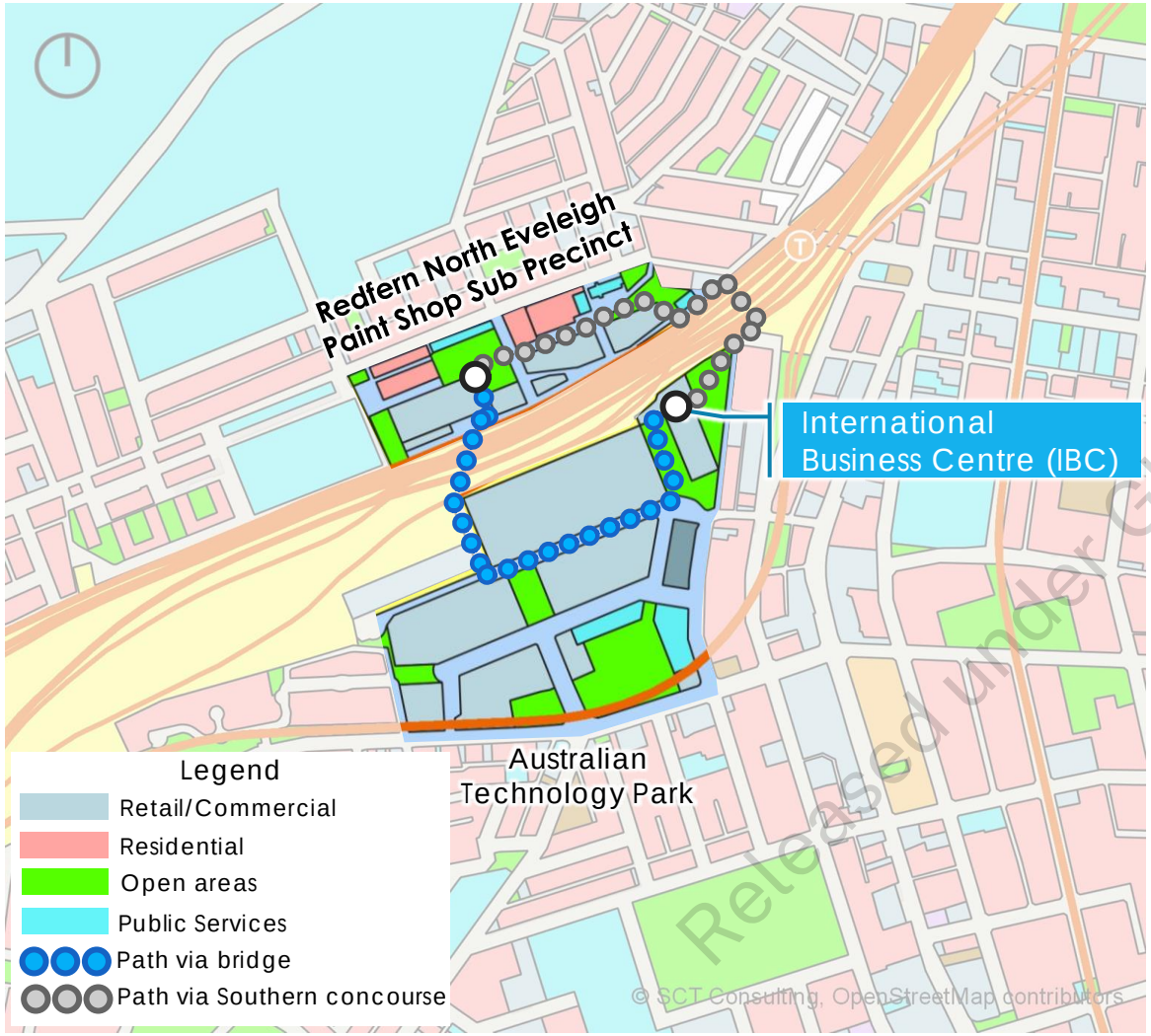
- Commercial/ office premises – 7,000 m2 GFA

- Number of employees – 388
- Travel time to RNE retail cluster
  - via southern concourse – 9 minutes 22 seconds
  - via proposed bridge – 9 minutes 22 seconds
- It is assumed that the path via the southern concourse will be unattractive even when the travel times are similar due to station pedestrian traffic and associated congestion.
- Number of daily trips via bridge – 14 to 27 trips

Key outcomes

Equal travel time via the proposed bridge and via the southern concourse
Number of daily trips via bridge – 14 to 27 trips

International Business Centre (IBC) to RNE retail cluster



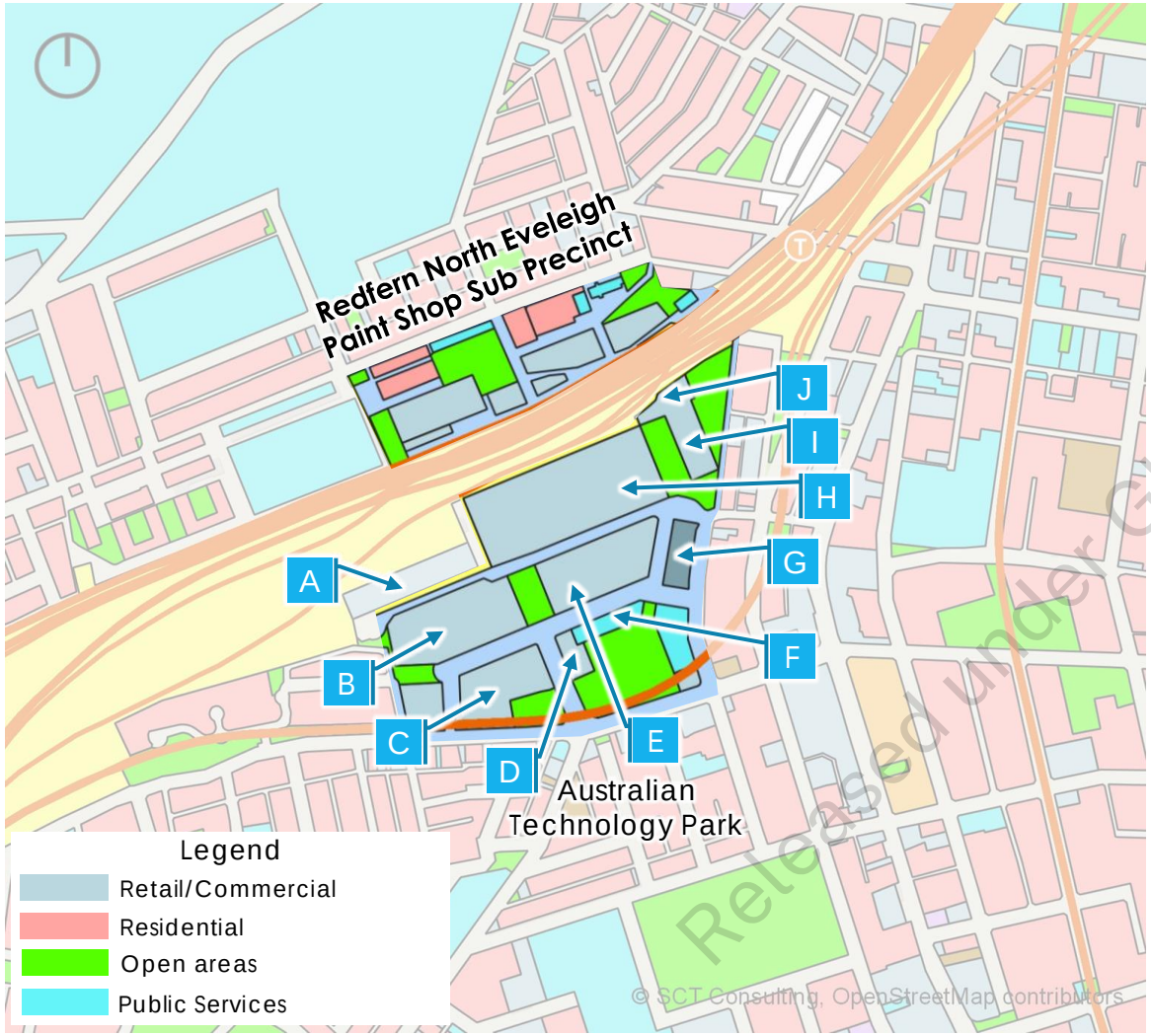
International Business Centre (IBC)

- Land use:
  - Commercial/ office premises – 950 m2 GFA
- Number of employees – 52
- Travel time to RNE retail cluster
  - via southern concourse – 8 minutes 32 seconds
  - via proposed bridge – 10 minutes 09 seconds
- No trips via the proposed bridge as the travel time via the southern concourse is lower
- Number of daily trips via southern concourse – 2 to 4 trips

Key outcomes

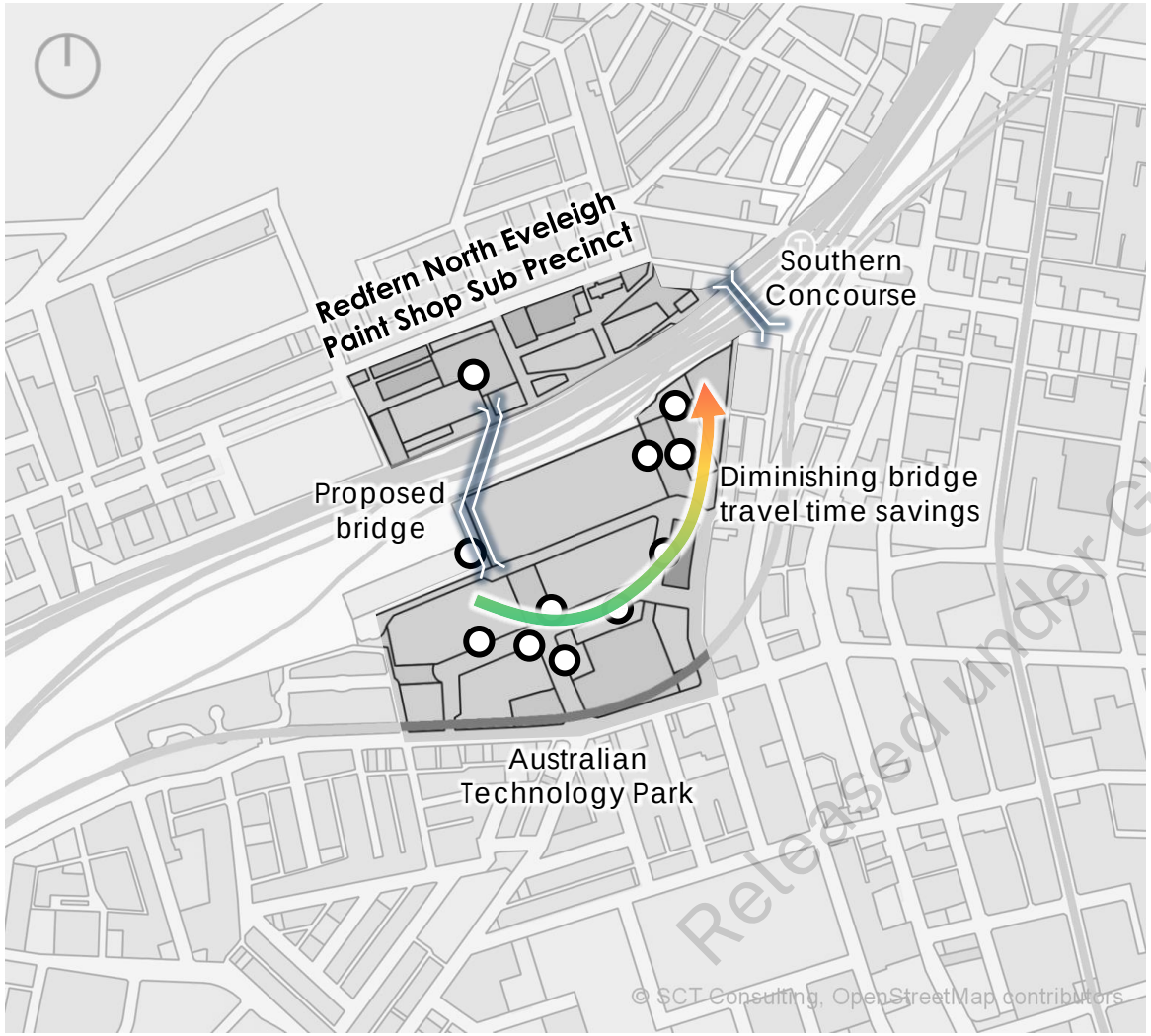
Travel time saving due to Southern concourse – 1 minute 37 seconds
No trips via the proposed bridge

Travel time from all buildings to RNE retail cluster



Key	Building	GFA (m2)	Number of Employees	Daily Trips via bridge	TT via southern concourse (mm:ss)	TT via proposed bridge (mm:ss)	TT savings due to proposed bridge
A	Large Erecting Shop (LES)	15,000	833	29-58	14:00	05:17	08:43
B	Media Centre Building	40,000	2,222	78-156	14:43	08:00	06:43
C	Commonwealth Bank (Axle)	46,832	2,570	90-180	14:11	07:33	06:37
D	Community Building	3,911	161	6-11	14:15	07:42	06:34
E	Commonwealth Bank (Foundry)	56,688	3,093	108-216	13:27	06:59	06:28
F	Biomedical Building	7,600	422	15-30	12:25	08:34	03:51
G	NICTA Building	11,200	622	22-44	10:46	09:33	01:12
H	Locomotive Workshop	25,000	1,388	49-97	09:49	09:12	00:38
I	National Innovation Centre (NIC)	7,000	388	14-27	09:22	09:22	-
J	International Business Centre (IBC)	950	52	-	08:32	10:09	-
	Total	214,181	11,751	409-819	-	-	-

Benefits due to proposed bridge



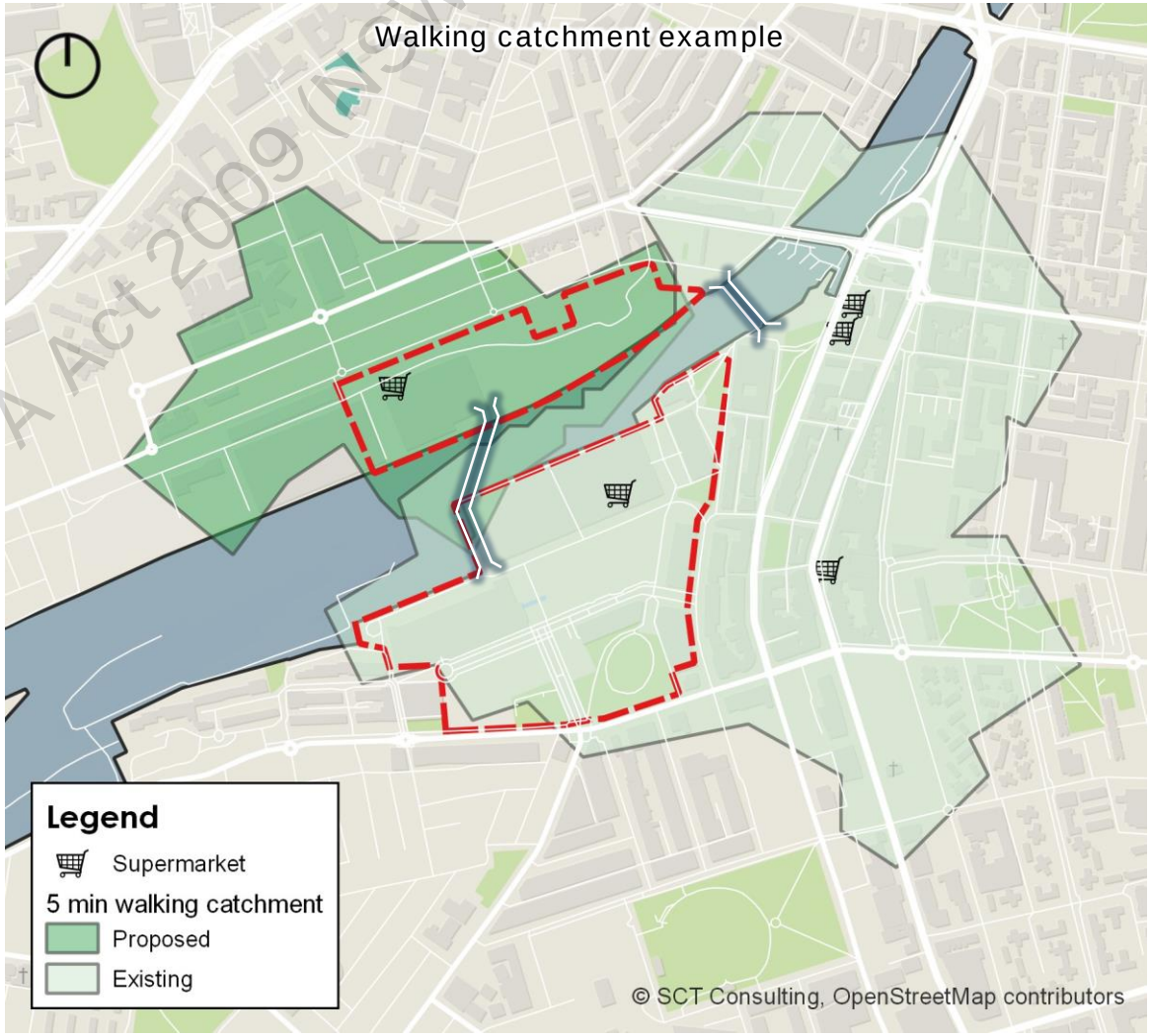
- Maximum travel time savings due to the proposed bridge were observed for the buildings near the proposed bridge.
- Commonwealth Bank buildings (Axle and Foundry), Media Centre Building and Large Erecting Shop(LES) get the highest travel time savings of up to seven minutes. Most employees (approximately 76%) work in one of these buildings.
- Southern Concourse at Redfern Train Station is closer to the buildings at the north-eastern end of the ATP. Hence, access to the Paint Shop sub-precinct retail cluster via the Southern Concourse is more attractive for trips originating from/destined to these buildings.
- Travel time benefits due to the proposed bridge diminish towards the north-eastern part of the ATP.

Key outcomes

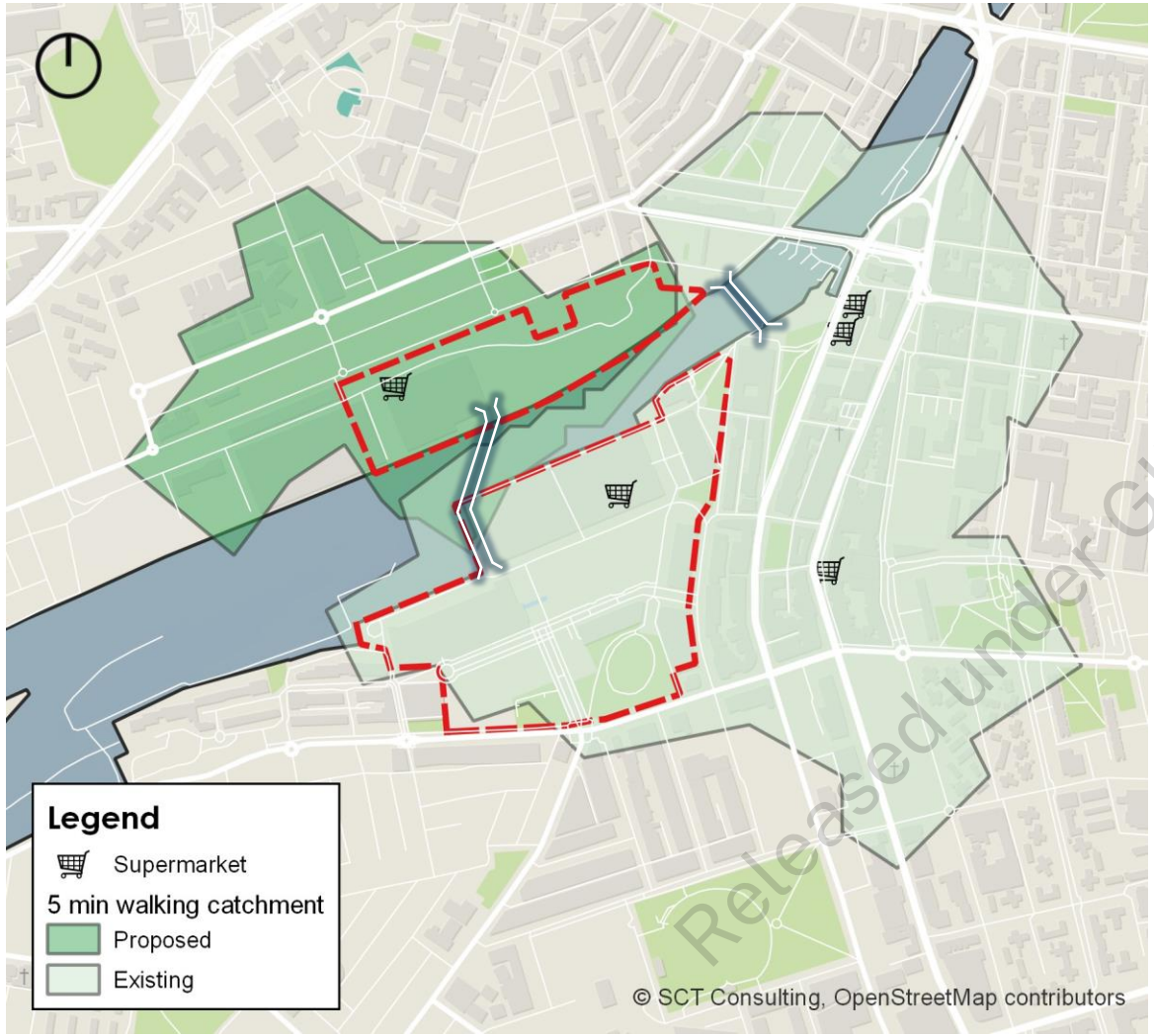
The highest travel time savings of up to 7 minutes are possible for the majority (76%) of the employees in the Australian Technology Park

Catchment analysis

- Key destinations were selected for the walking catchment analysis. Destinations included:
  - Cafes/ restaurants/ bars
  - Supermarkets
  - Medical centre/ pharmacy
  - Gym/ other retail
- Separate walking catchments were calculated for the existing destinations in and around ATP and proposed facilities in the RNE precinct. The attractiveness of the new retail cluster in the RNE precinct would be identified from the catchment area across the rail corridor.
- This has been used as a proxy to determine how likely the proportion of employees and/or residents are likely to cross the rail corridor via the proposed bridge to access these destinations
- For each trip, it is assumed that there is a return trip via the same route.
  - indicate walking catchment of the existing facilities
  - indicate the walking catchment of the proposed new facilities in RNE precinct

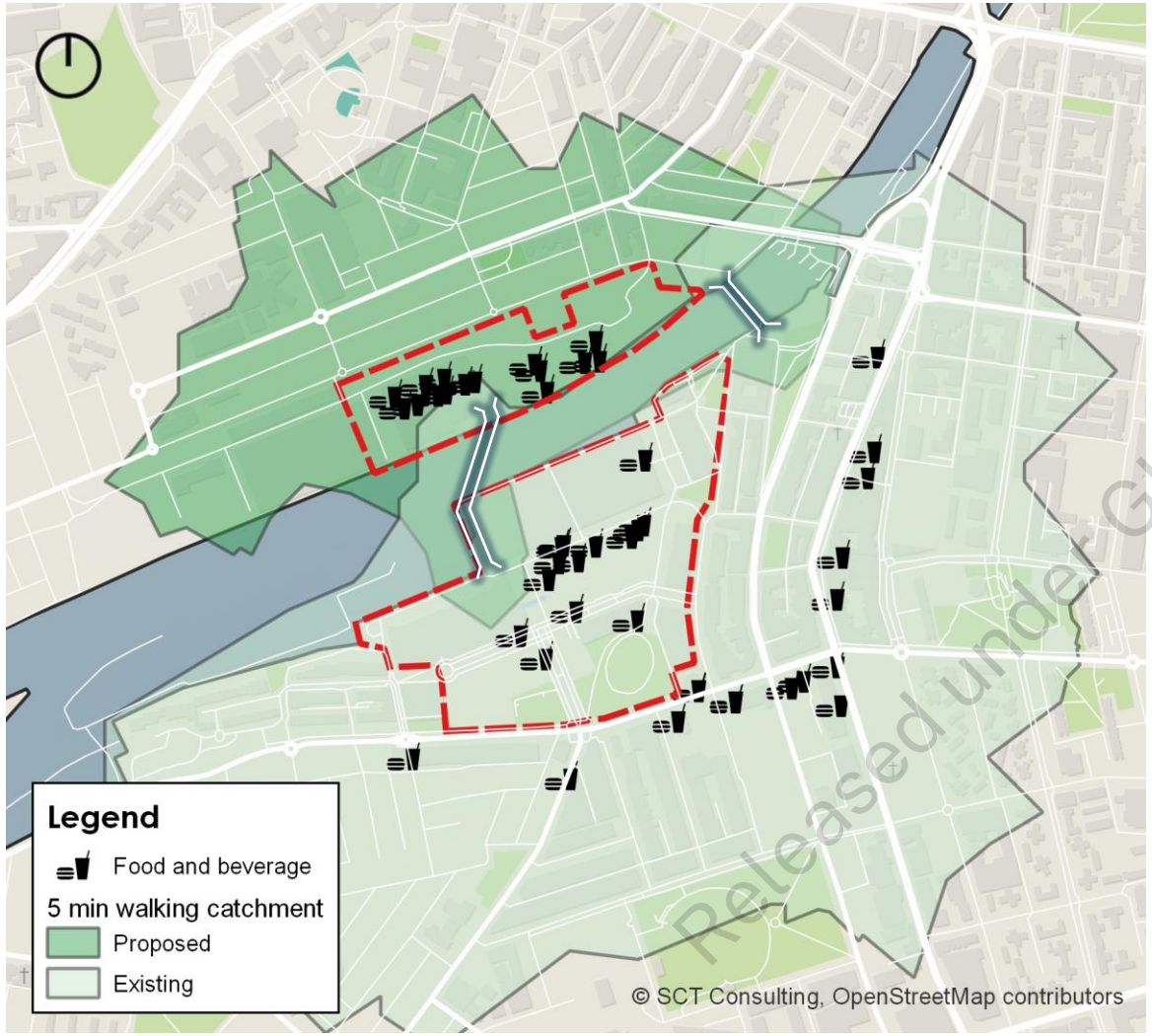


Key destinations and catchments – Supermarkets



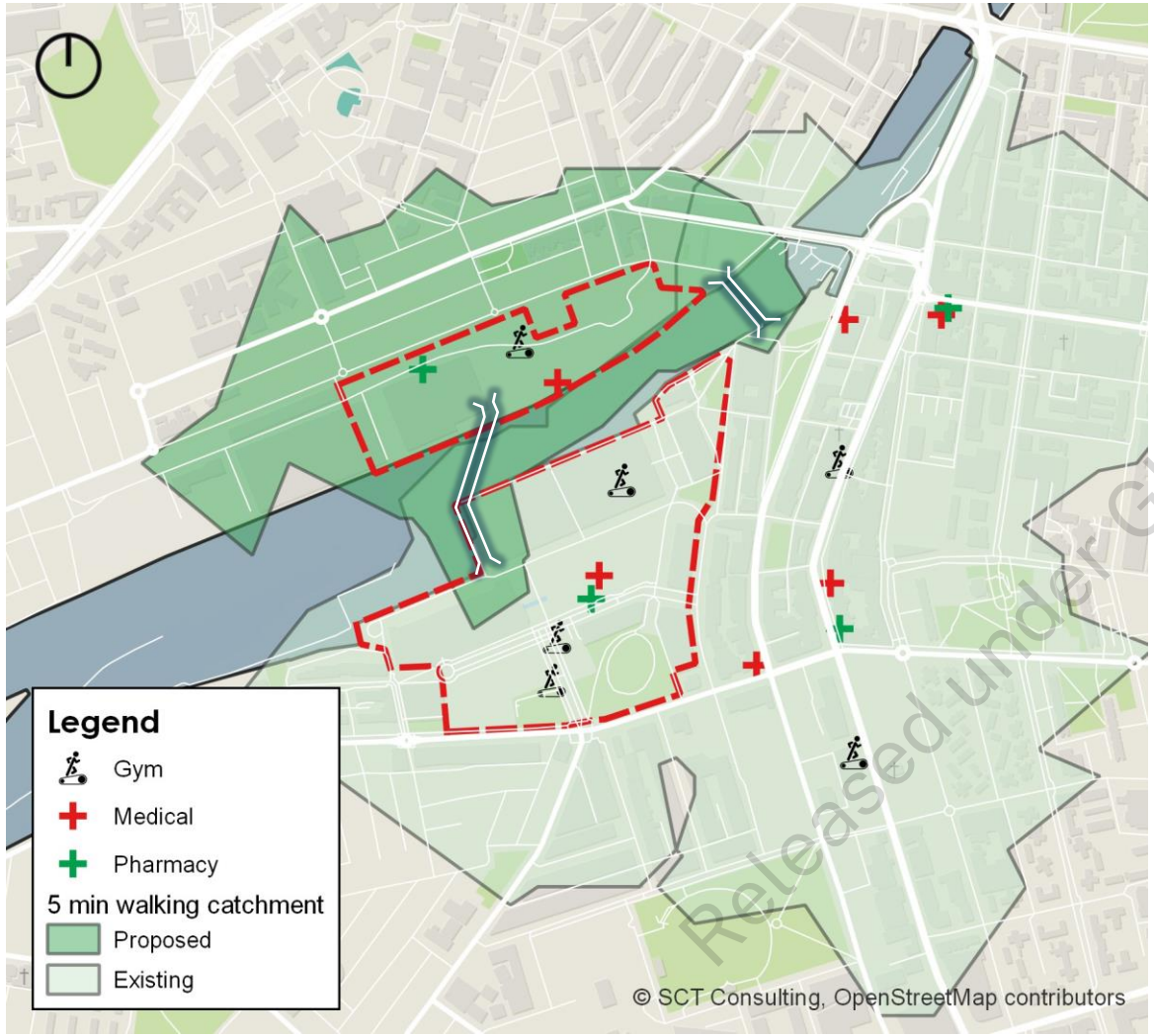
- Supermarkets are available in both ATP and Paint shop precinct
- It is unlikely to observe customers undertaking shopping trips between ATP and Paint Shop sub-precinct since an equal facility is available within the respective precincts.
- The exception would be if there is a customer preference regarding the supermarket chain/tenant. Though it is likely, this would represent a small proportion of trips and hence has not been considered.

Key destinations and catchments – Food and beverage



- Both ATP and RNE Paint shop precinct contain multiple food and beverage facilities. Therefore, most trips would be self-contained within the respective precincts.
- Based on the five-minute walking catchment of the new retail cluster RNE Paint shop precinct, the cluster is still within a reasonable walking distance of the four key commercial lots within ATP. Consequently, some customers may elect to cross the rail corridor to access a different selection of retail (and the associated open space of Fan of tracks).
- It is estimated that up to 10% of the total ATP demand (8,225 daily trips for all retail purposes) may access RNE retail and facilities via the proposed bridge on a typical day.

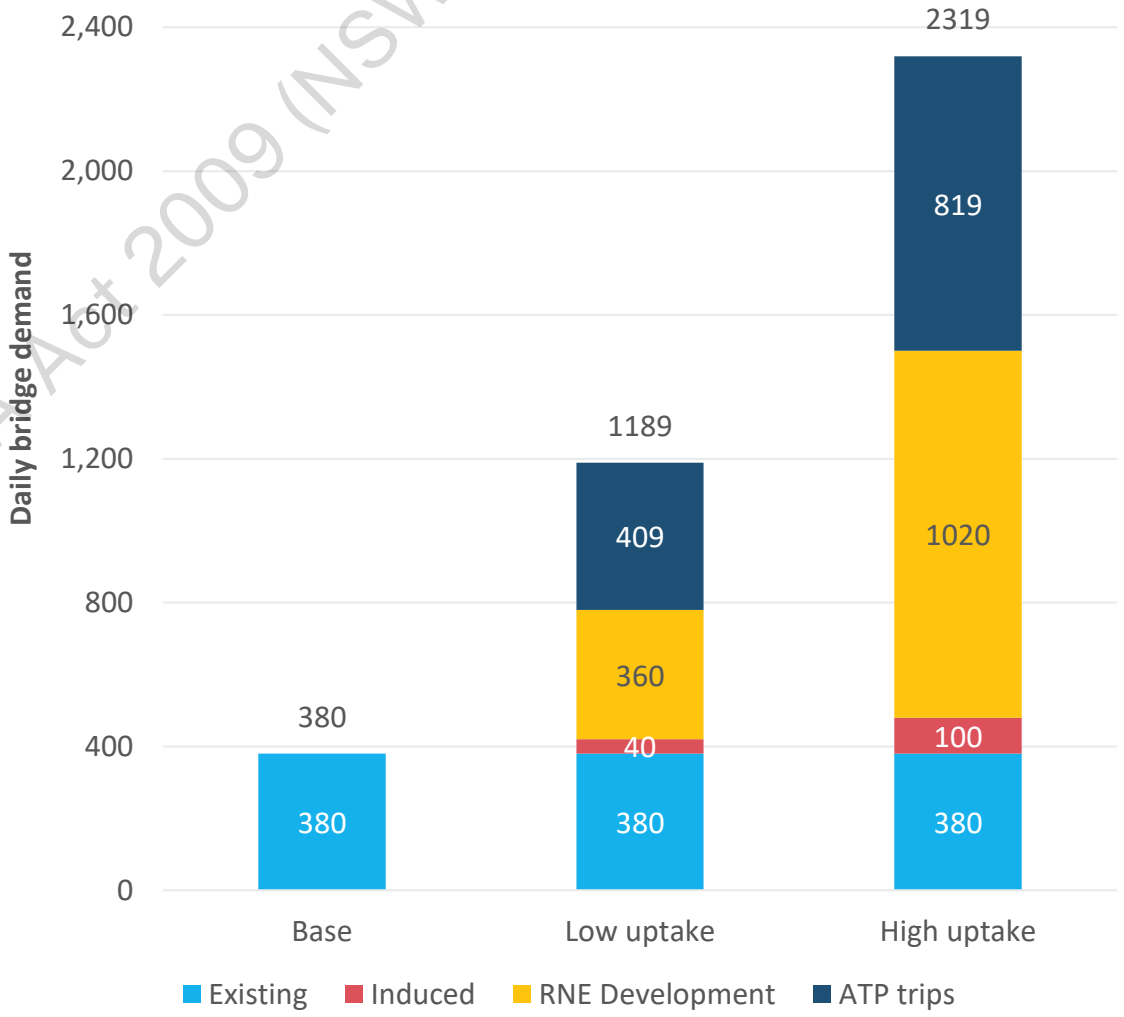
Key destinations and catchments – Other retail



- Other retail facilities such as a gym, pharmacy, and medical centre are available in ATP neighbourhood areas and the RNE precinct.
- The destinations of this type are mostly based on the individual's choice, and hence trips are likely between ATP and RNE precinct.
- ~5-10% of the total ATP demand (8,225 daily trips for all retail purposes) will likely use the proposed bridge.

Typical bridge usage from ATP

- ~400 – 820 additional trips from the ATP, using the proposed bridge, are likely due to retail, food and beverage facilities in the RNE paint shop precinct. Individuals within the ATP are unlikely to view the RNE retail as desirable given similar retail offerings within and surrounding the ATP.
- It is assumed that 10% of residents visit a retail facility on a given day – though these are all in RNE, hence not likely to cross to ATP.
- Overall, based on the retail sensitivity test, total daily trip numbers are forecast to increase to approximately 1,190 – 2,320 trips under either a low or high uptake scenario.



sctconsulting.com.au

SCT Consulting

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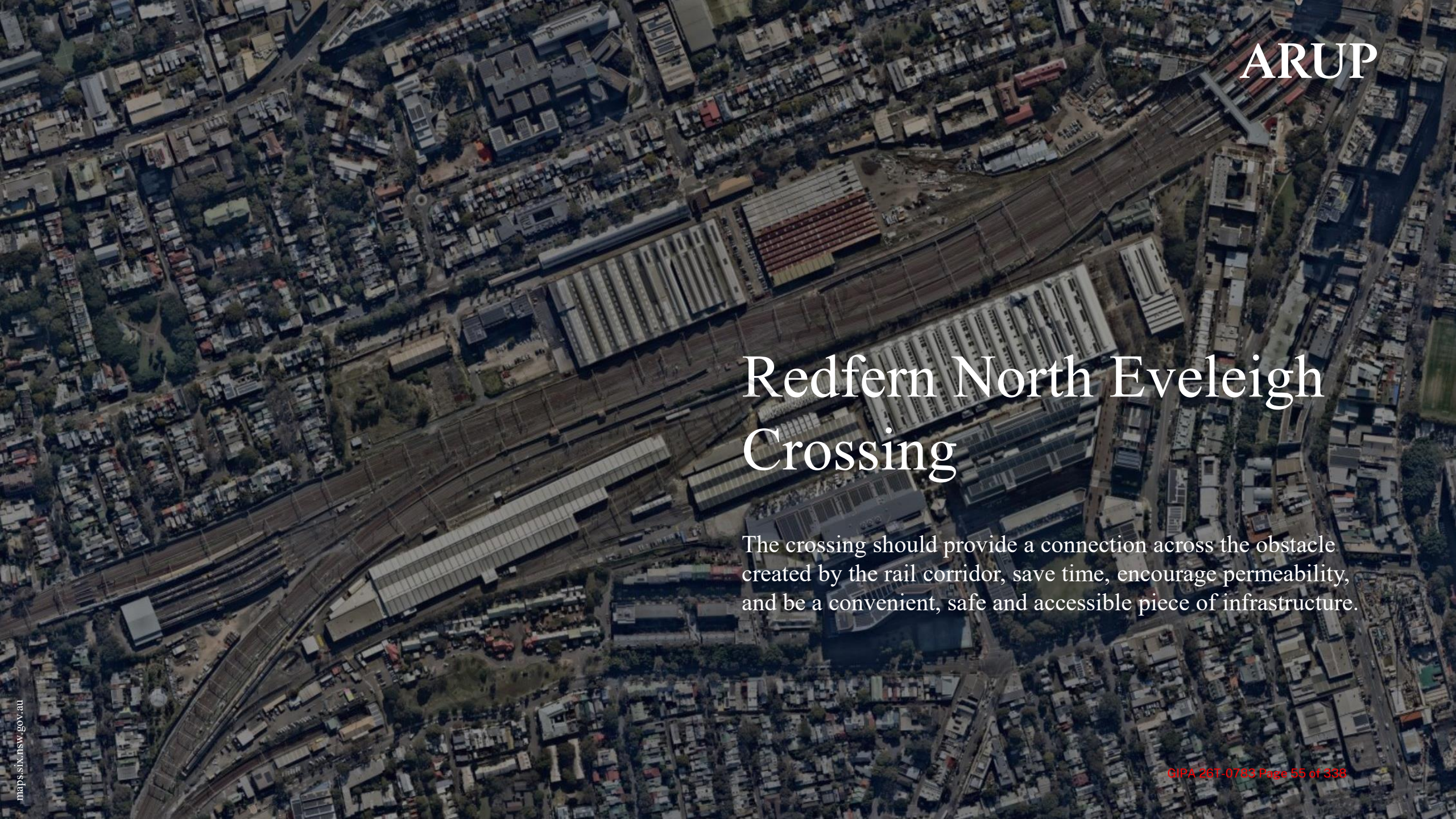
Redfern North Eveleigh Bridge

Feasibility Study

Transport for NSW



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Redfern North Eveleigh Crossing

The crossing should provide a connection across the obstacle created by the rail corridor, save time, encourage permeability, and be a convenient, safe and accessible piece of infrastructure.

maps.six.nsw.gov.au

Objectives

What characteristics should the crossing have?

- Connect the North and South Eveleigh communities
- Provide local permeability across the rail corridor
- Safe
- Comfortable
- Convenient
- Provide time savings for pedestrians and cyclists
- Accessible
- Sustainable
- Sympathetic to the industrial heritage of the area
- Connection to Country
- Value for Money

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Requirements & Constraints

SCT to provide

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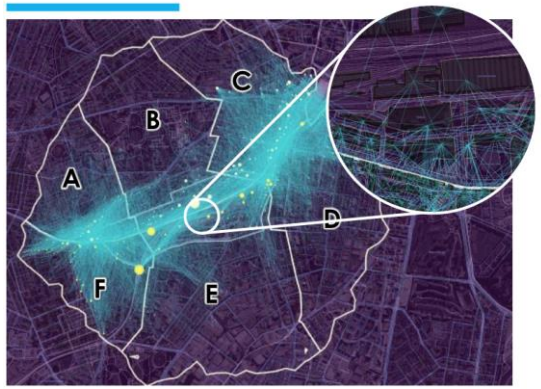
Future demand and travel time savings

Summarised from SCT Consulting, 2021, Bridge Catchment Analysis

Current demand

340-420 journeys per weekday,
53% are less than 1000m in length



Main beneficiaries of the additional bridge are cross-rail corridor journeys to/from:

- Urban residential
- Public services (University of Sydney)
- Commercial (North and South Eveleigh precincts).
- Light industrial and commercial (Waterloo and Green Square)

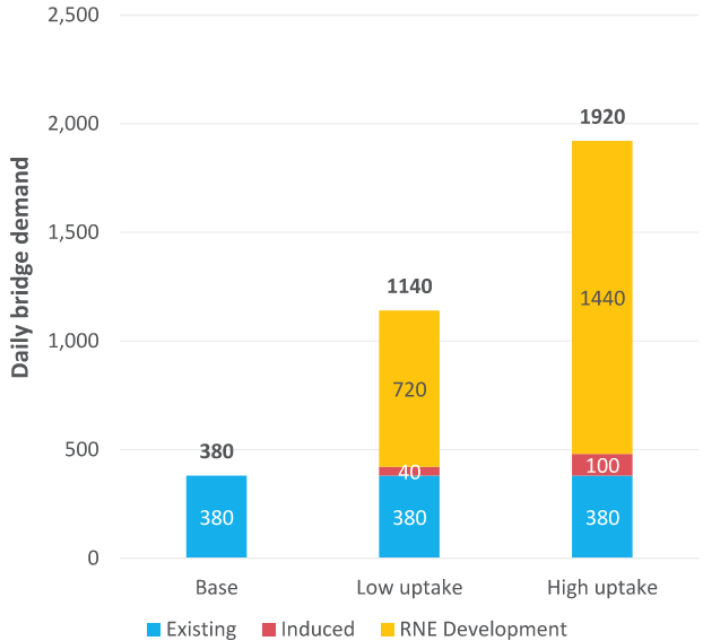
Travel time savings

3-6 minutes per trip

- The average travel time saving is 5-8 minutes (SCT Consulting, 2021).
- This needs to be further reduced to 3-6 minutes to account for time going up and down from the bridge.
- Savings become less pronounced for origins and destinations further away from the bridge.

Future demand

1140 – 1920 crossings per day



For comparison, George Street, between Albert Street and Phillip Street, Redfern has ~2000 journeys per day on both weekdays and weekends (City of Sydney Open Data Pedestrian Surveys, March 2022)

Constraints – Rail

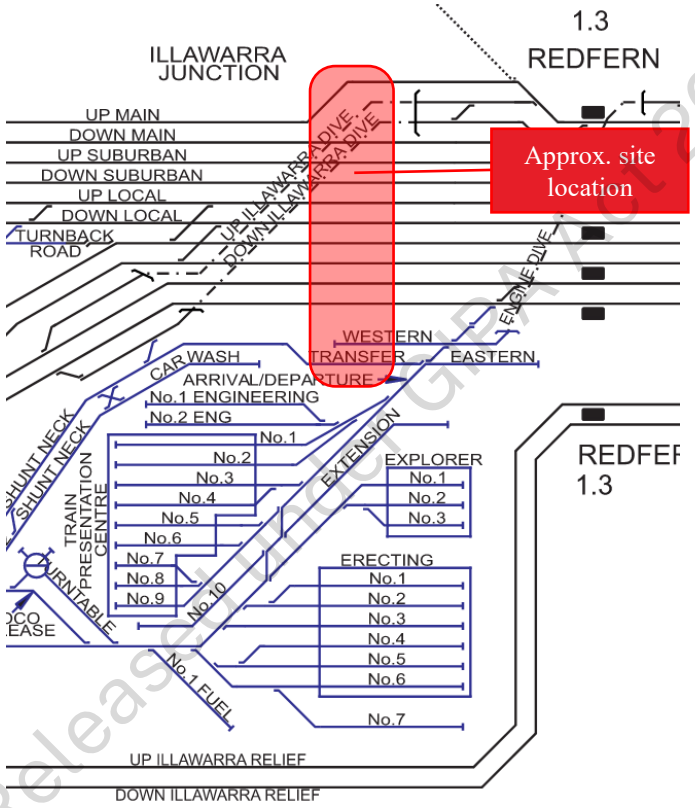
The length of the crossing results in permanent works within the Rail Corridor

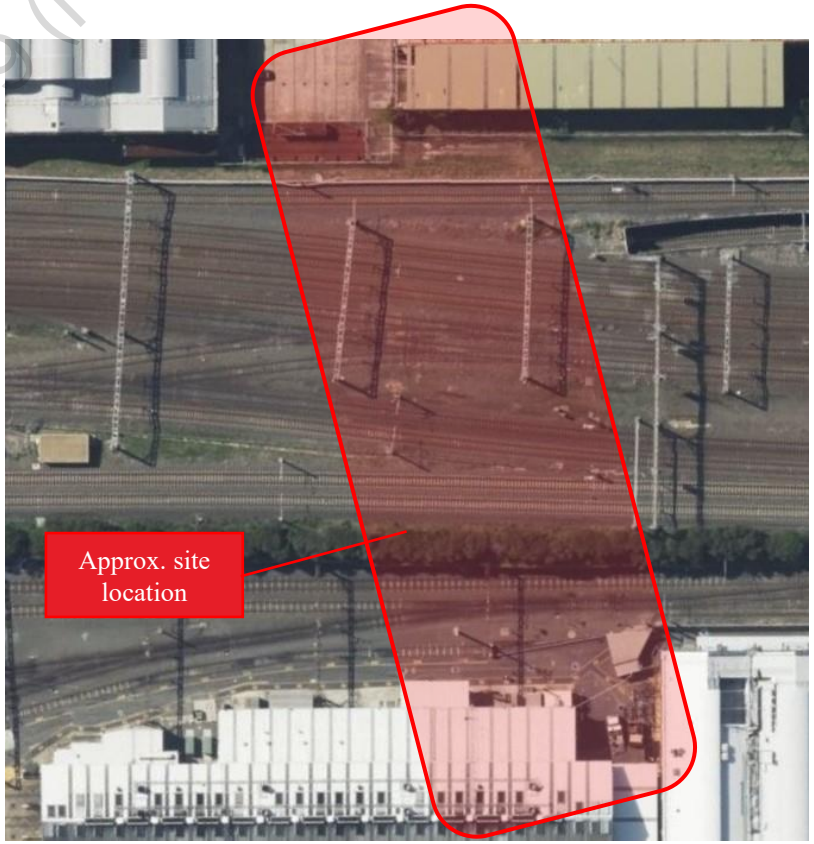
The rail corridor at this location is a key network artery that:

- Provides principal access to Central Station
- Is located within the Suburban and Intercity Train Maintenance Centre

Constraints in this area require the crossing:

- Construction activities align with the possession configurations.
- Utilises staged construction, with activities to be delivered in 48hr blocks.





Indicative crossing zone in red on the Metropolitan Network Diagram V3 TfNSW Config Diagram (2010)

slide not link to online nearmaps info on lengths and DSS info on services.

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Constraints – Rail

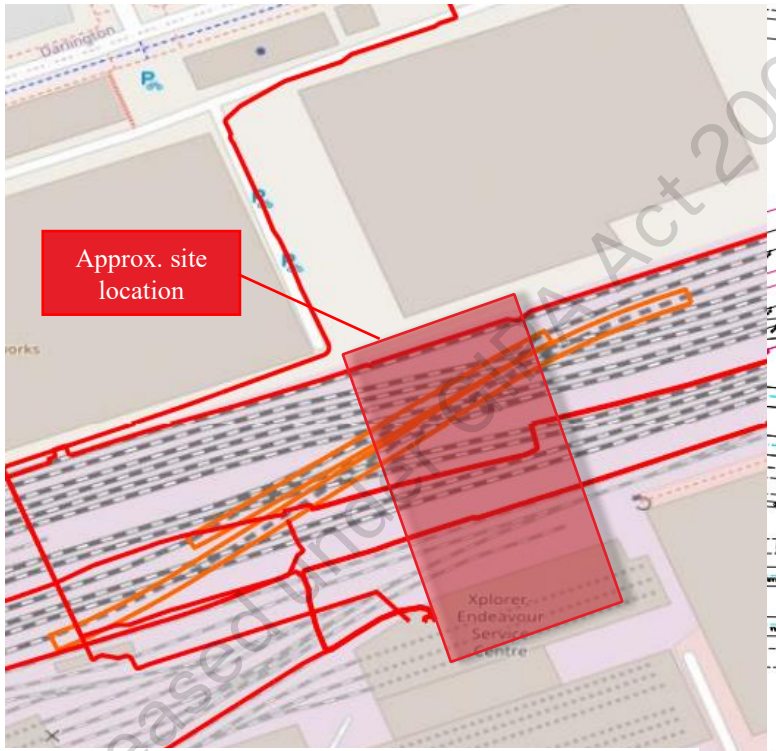
Significant built infrastructure exists within the study area

Active assets in the area include:

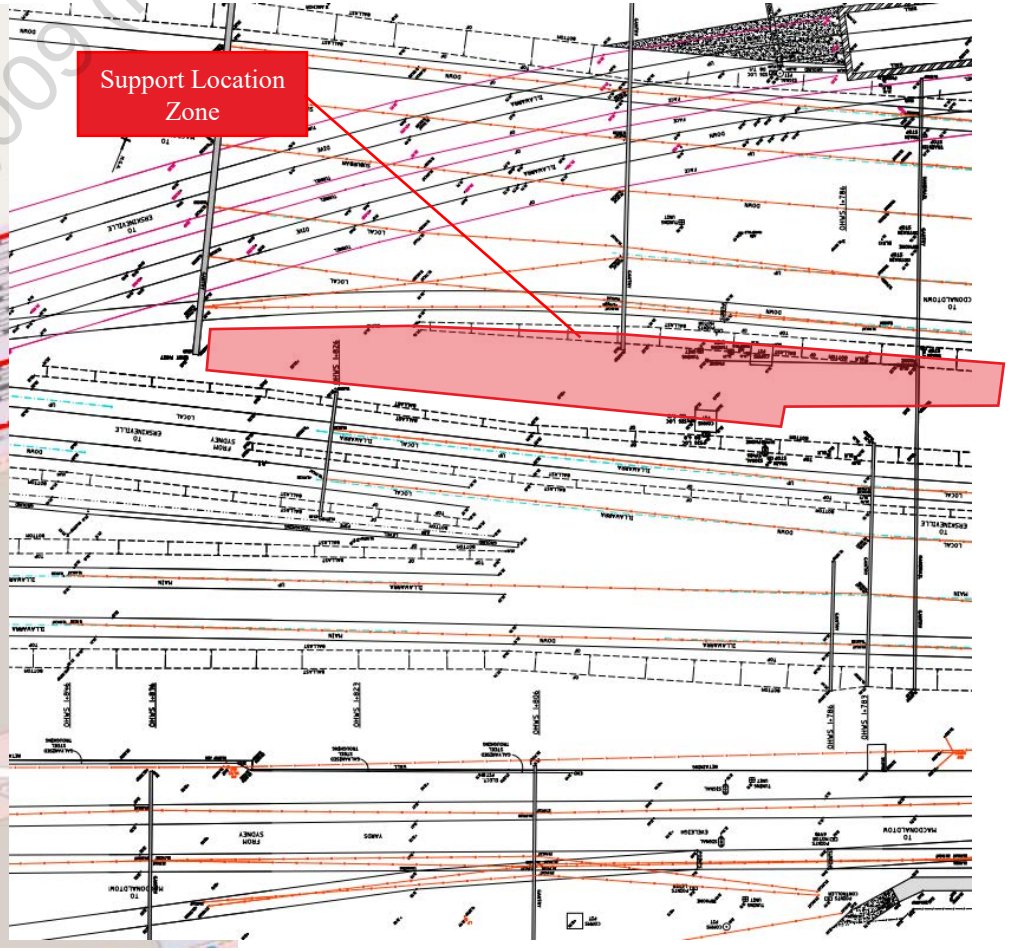
- HV cables
- Signaling & communication infrastructure
- Illawarra Dives (Tunnel)
- Redundant Workman's subway
- Overhead Wiring and Elevated Signal Gantries
- Potential for other underground services

Constraints in the area include:

- Works generally should not be within 5 metre radius of any electrical, communication assets, and within 25 metres of any other TfNSW tunnel.
- 9m vertical clearance over Rail Corridor



change area



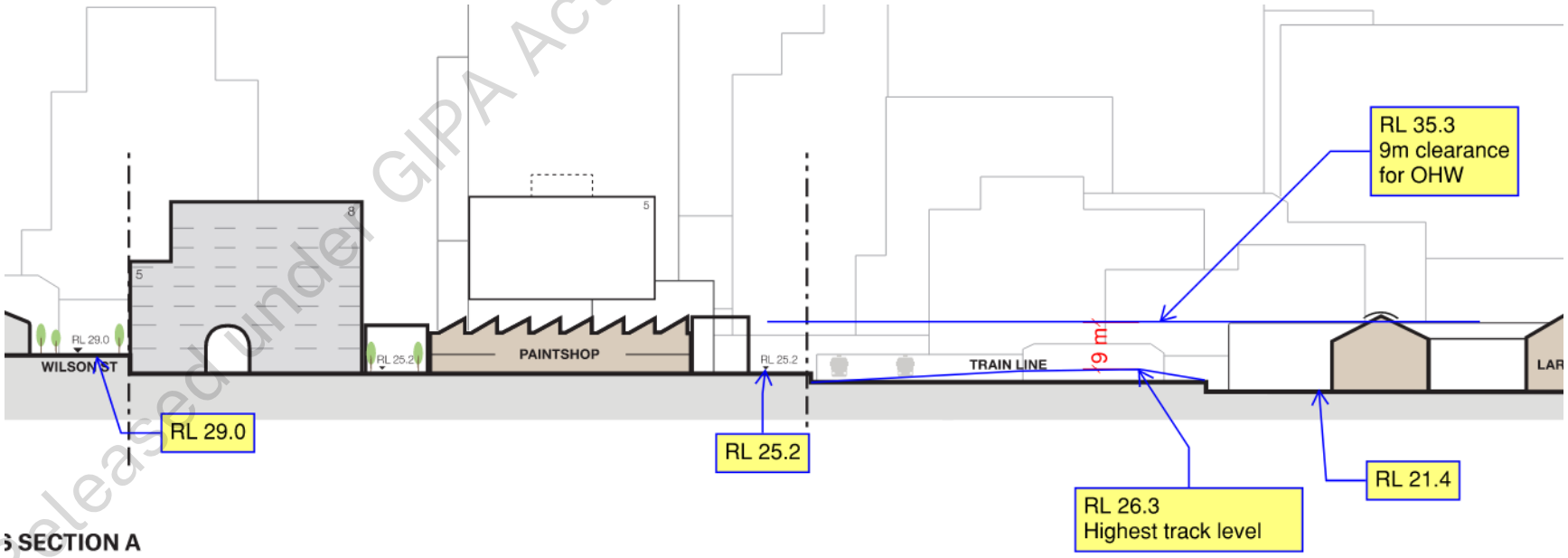
Sydney Train – Before You Dig Australia Location Information (2022)

Constraints - Topography

The site is on a declining landform, there is a significant elevation change along the crossing alignment

The Topography across the site, and necessary vertical clearances to the rail corridor, results in:

- 10.8m rise/fall from north landing to ground
- 7m rise/fall from north landing to Wilson Street
- 14.6m rise/fall from south landing to ground



Constraints - Heritage

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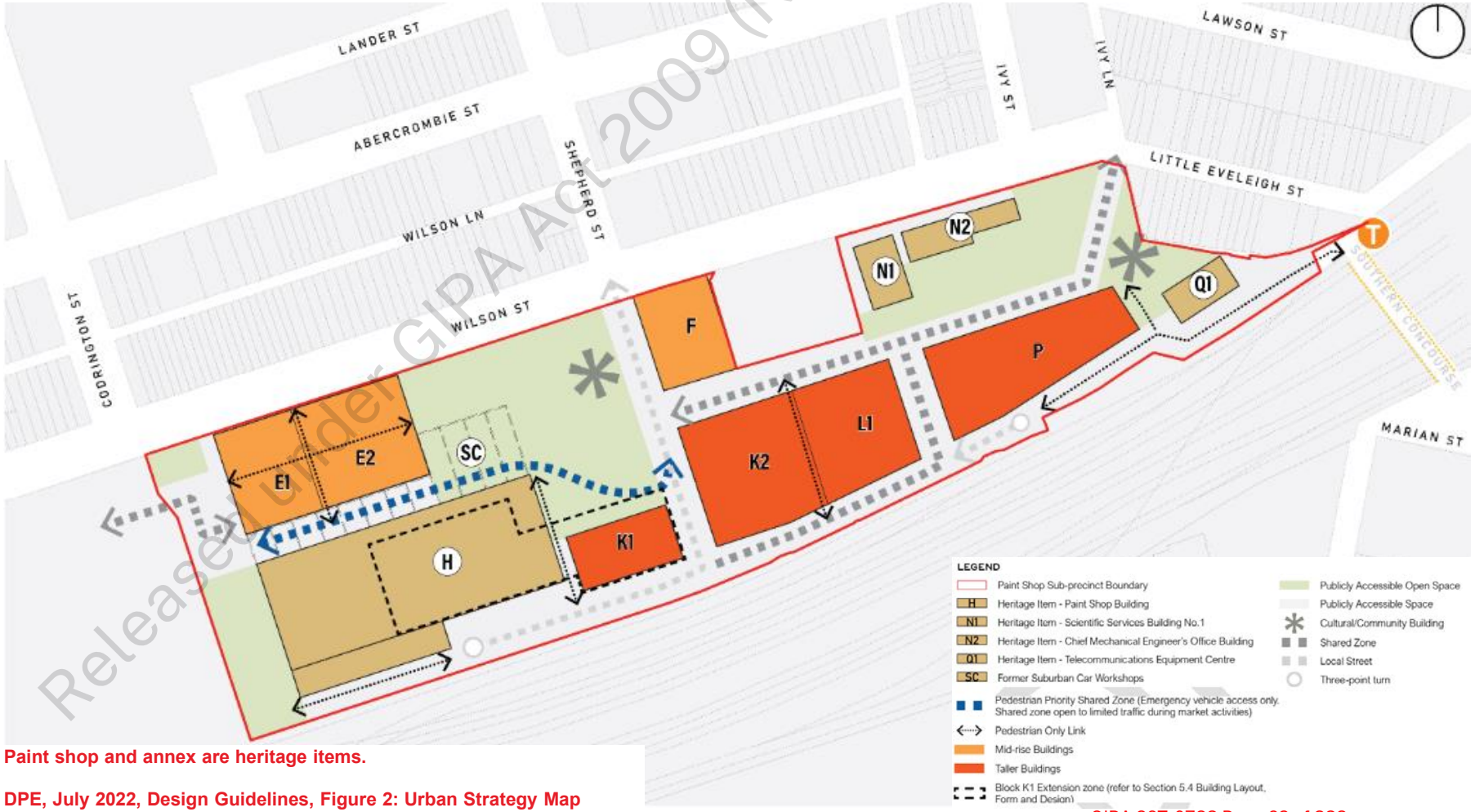
Crossing is located within, and interfaces with, heritage listed precincts

- Adjacent paint shop and annex is exceptional or high level of heritage significance.
- Traverser machine must be preserved, either at the northern or southern end of the Traverser carriageway.
- Ideally no structures obstructing the view from the heritage elements.



Paint shop and annex are heritage items.

DPE, July 2022, Design Guidelines, Figure 2: Urban Strategy Map

Constraints - Third Party Utilities

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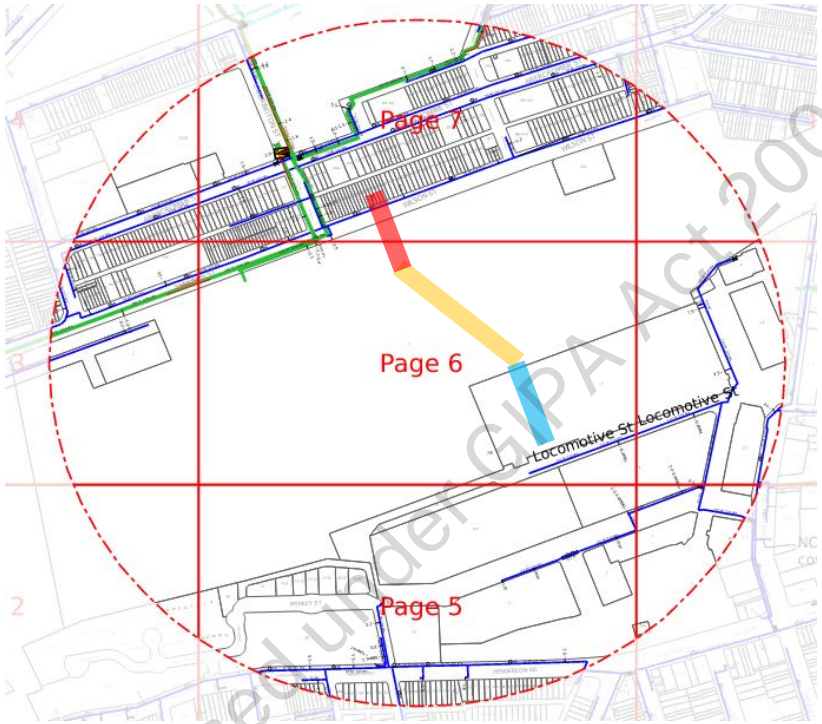
Existing utilities exist at both boundaries of the crossing

Currently identified assets include:

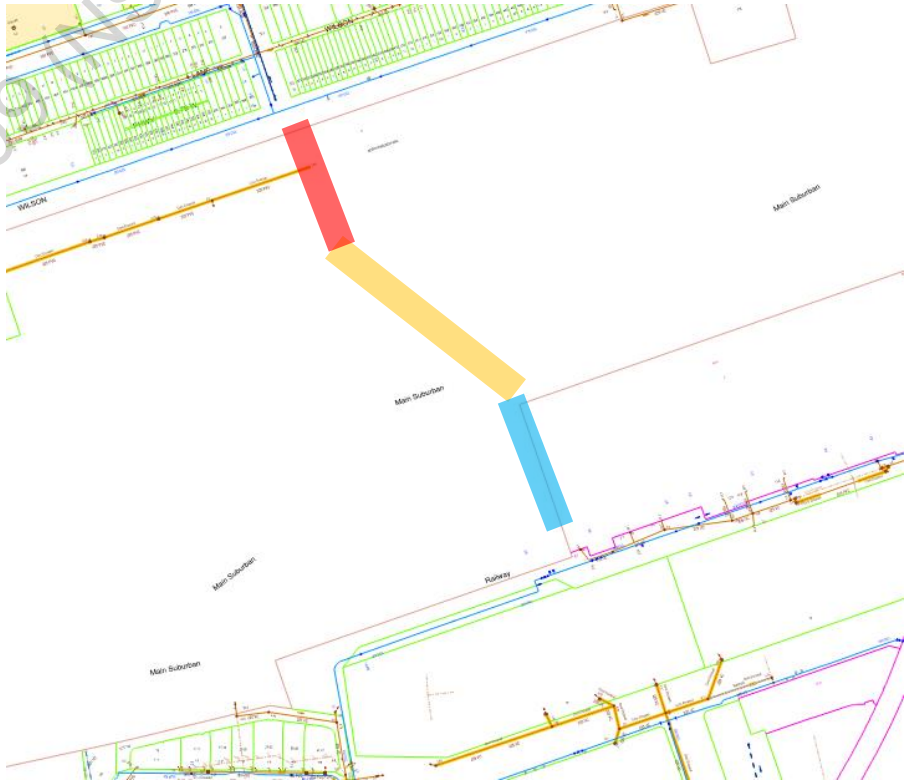
- Jemena
- Sydney Water
- Ausgrid
- City of Sydney
- NBN
- Potential for other underground services

Constraints include:

- Works may not be undertaken within the clearance set by the asset owner



Jemena DBYD



Sydney Water DBYD

Traverser

Potential Crossing location

Corridor between the Locomotive Workshop and the LES Building

210kPa Medium Pressure gas main

300kPa Medium Pressure gas main

400kPa Medium Pressure gas main

1050kPa High Pressure gas main

Sewer property connection point
With chainage to downstream maintenance hole.

Sewer concrete encased section

Sewer Rehabilitation

Sewer terminal maintenance shaft

Stormwater gully

Stormwater maintenance hole

Watermain – potable drinking water
With size type text.

Disconnected watermain potable drinking water
This means the watermain has been disused but remains in the ground.

Recycled watermain

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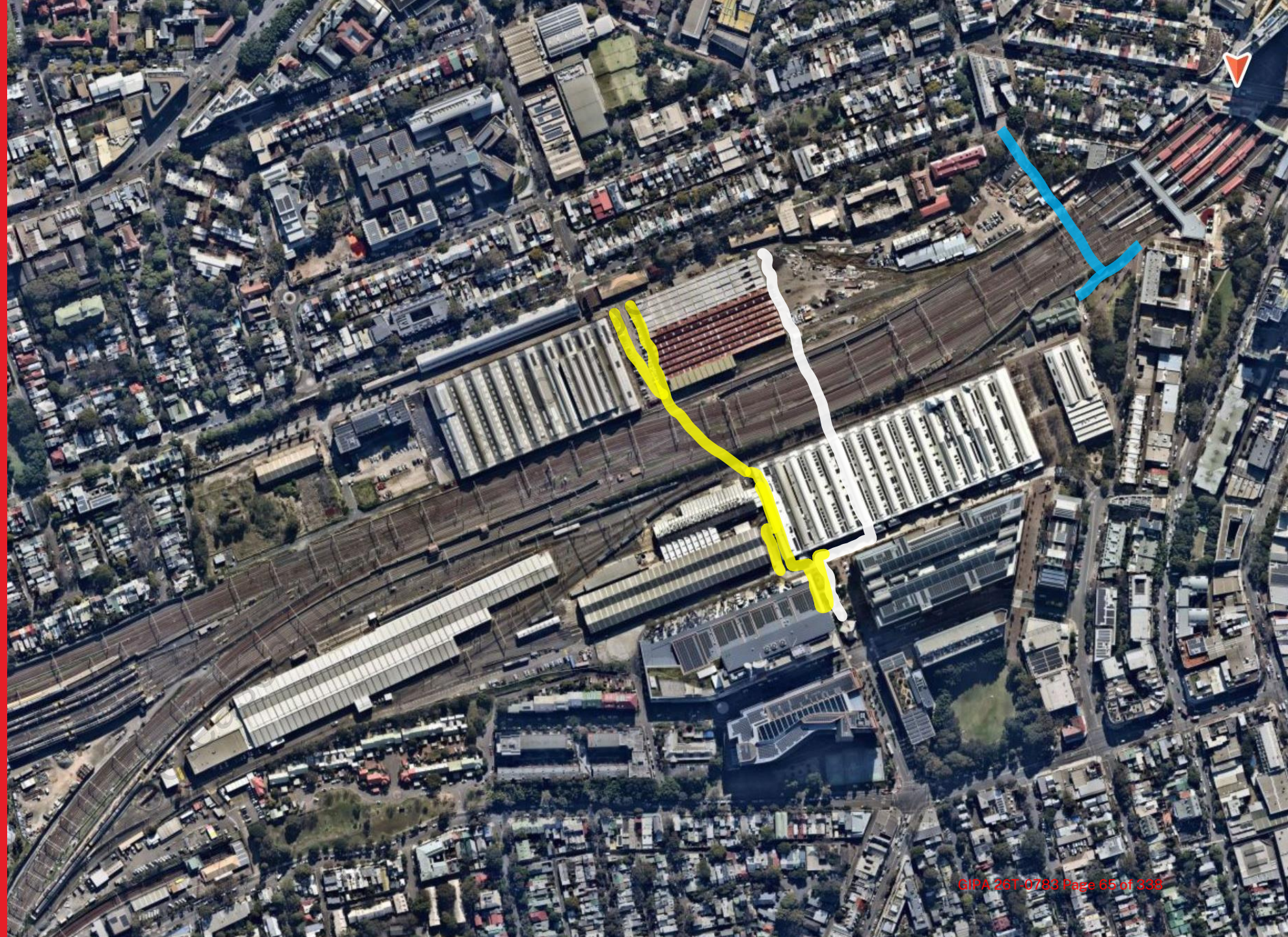
Review of Previous Studies

Study Areas & Alignments

Eveleigh Heritage Walk Report *for Redfern Waterloo Authority* [2008]

Carriageworks to Australian Technology Park – North-South Pedestrian Link *for UrbanGrowth NSW* [2017]

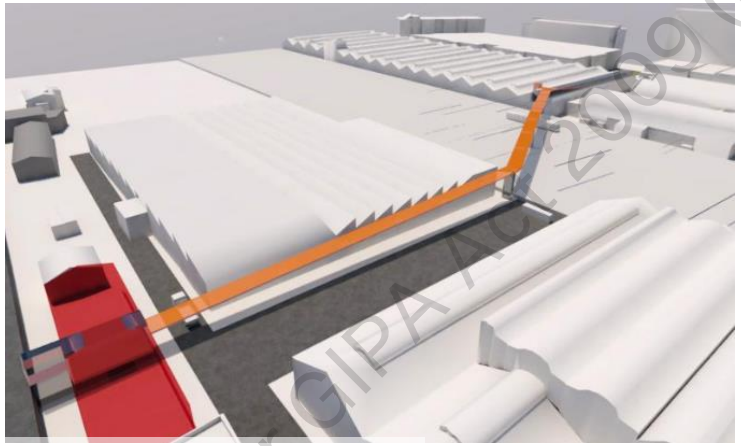


Previous studies

2008 and 2017 Studies for the Carriageworks to Australian Technology Park Pedestrian Link

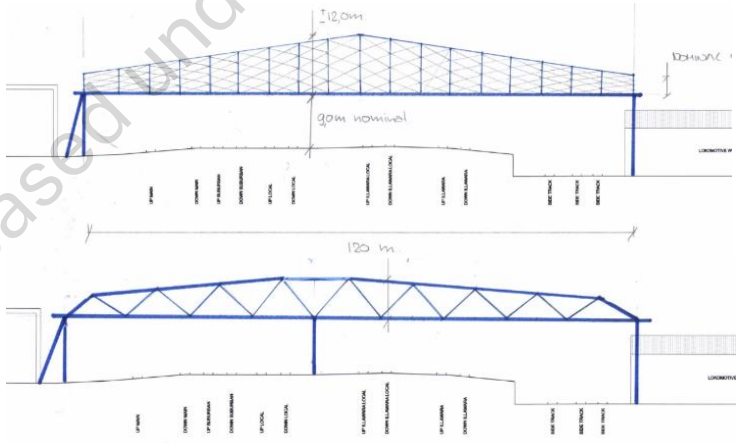
Arup were previously commissioned to review the site constraints including constructability and develop sketches of bridge concepts for preliminary costing.

- The 2008 study favoured eastern alignments over the western alignments as the bridge length could be minimized (undertaken pre new Redfern Station crossing)
- The 2017 study examined bridge crossing along the western alignment, including structural forms and end connections

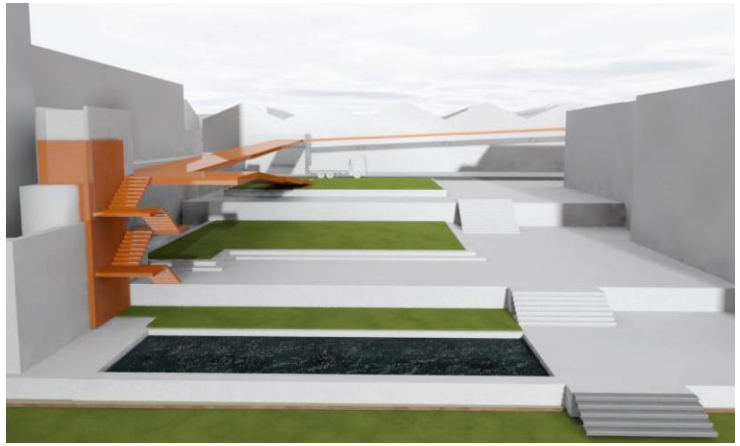


North landing to Wilson Street

South landing option in Locomotive Shed bay

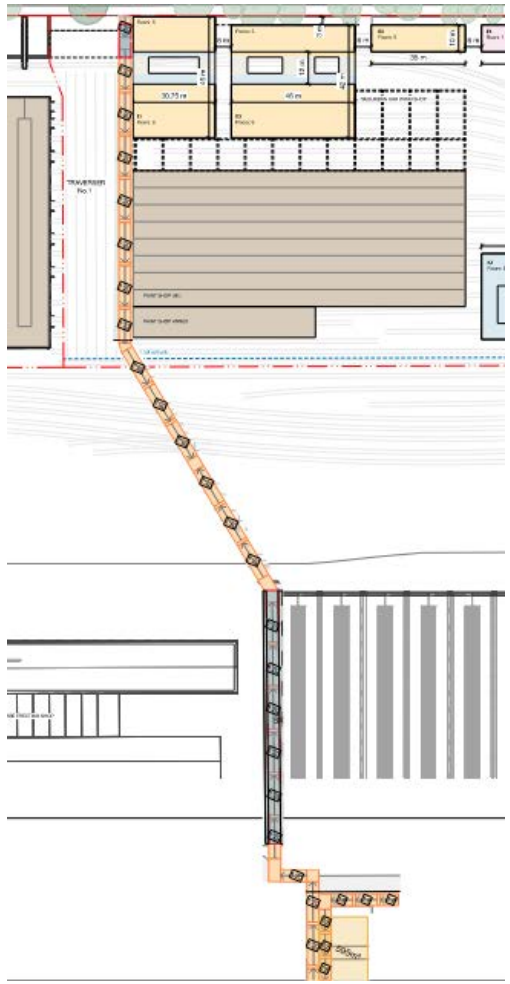


Truss options with pier, clear spans are ~50-120m

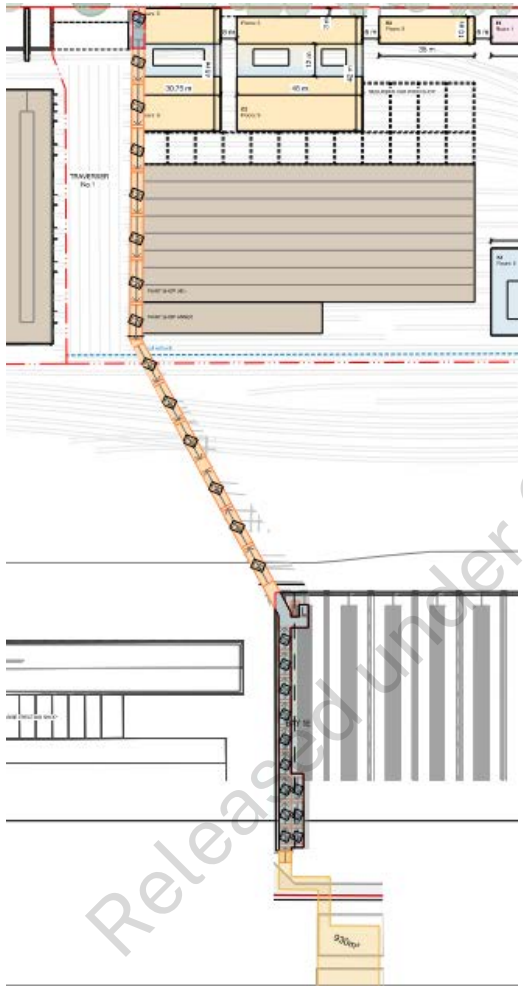


South landing option along village square (between Channel 7 and CBA)

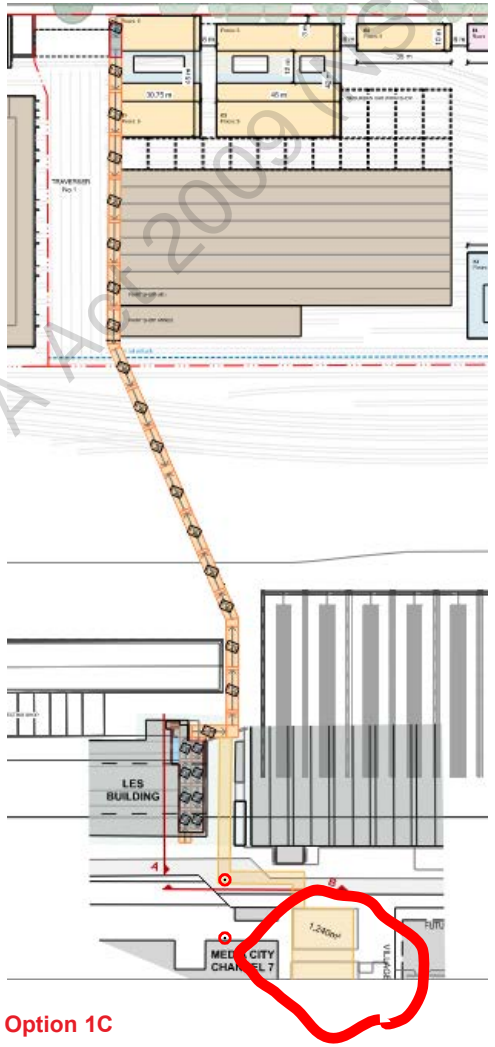
Previous studies



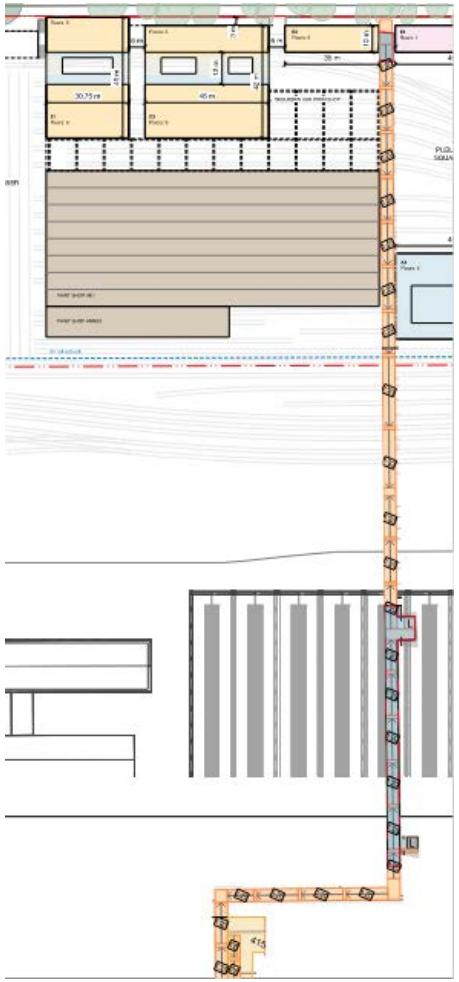
Option 1A



Option 1B



Option 1C



Option 4

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Crossing Options – Above ground crossing

move to previous work

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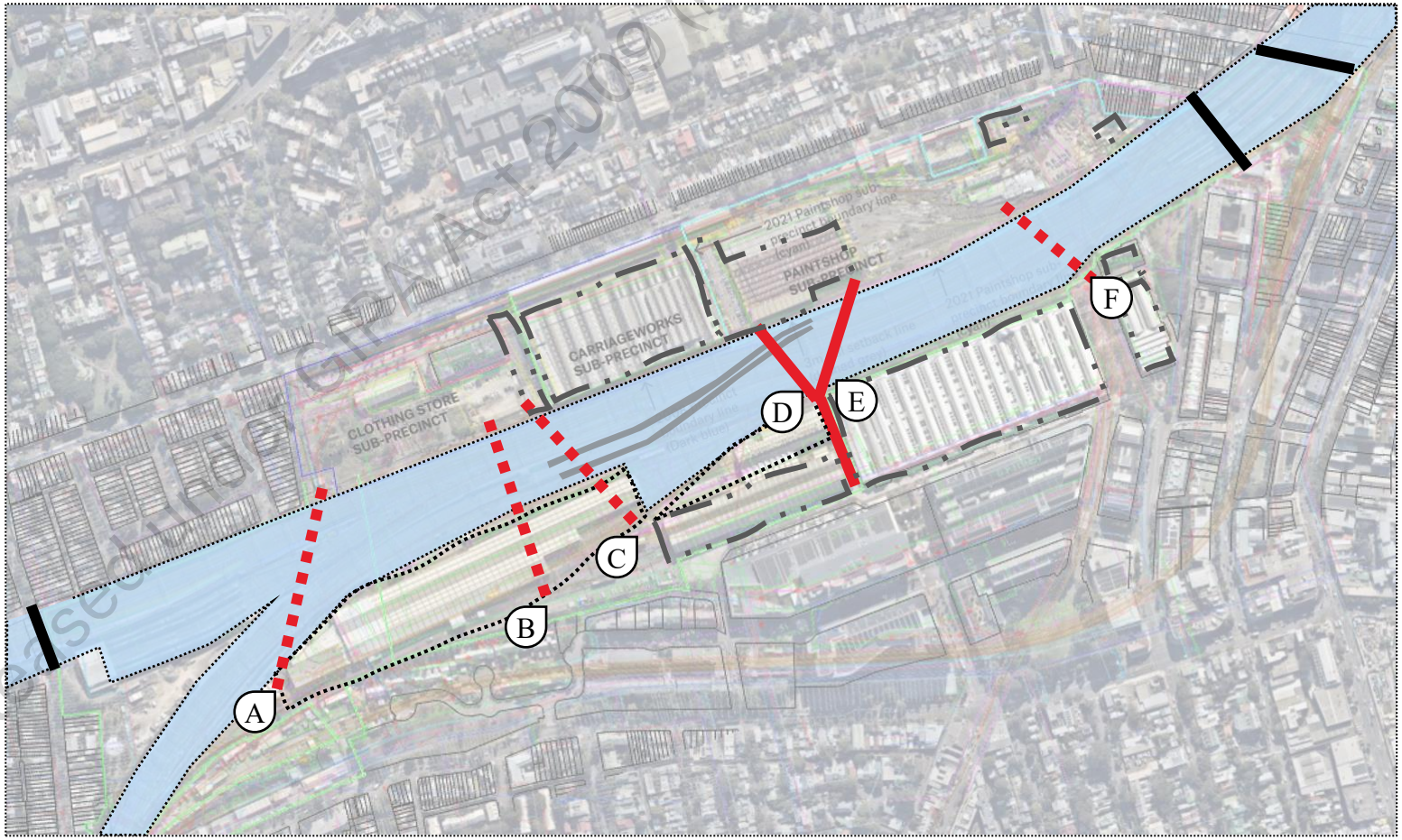
Above ground alignment options – Where should it go?

The Carriageworks to LES connection provides the best outcome for permeability. i.e. Alignments D and E.

- Study alignment
- Alternate alignments
- Existing connection
- Minimum 10m clearance height above rail corridor; HV cable, drainage at rail corridor
- Illawarra Dive (tunnel)
- Eveleigh Maintenance Centre
- Heritage

Alignment, and crossing type should,

- Comply with the rail corridor physical and operational constraints.
- Mitigate approvals from Sydney Trains for any design or construction activity.

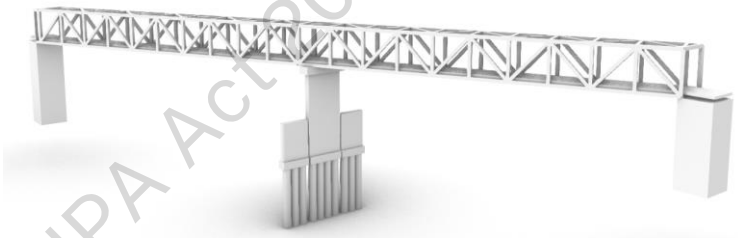
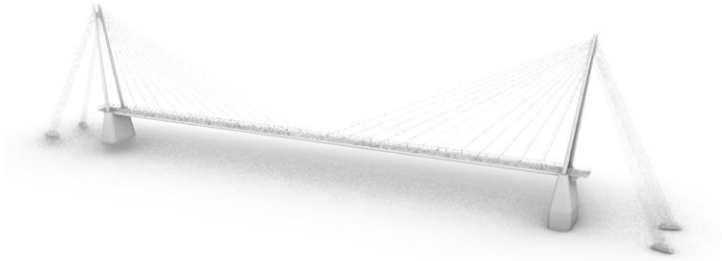


Bridge siting map

Structural Form – What form would a bridge take?

The truss was selected as an appropriate form for the feasibility study.

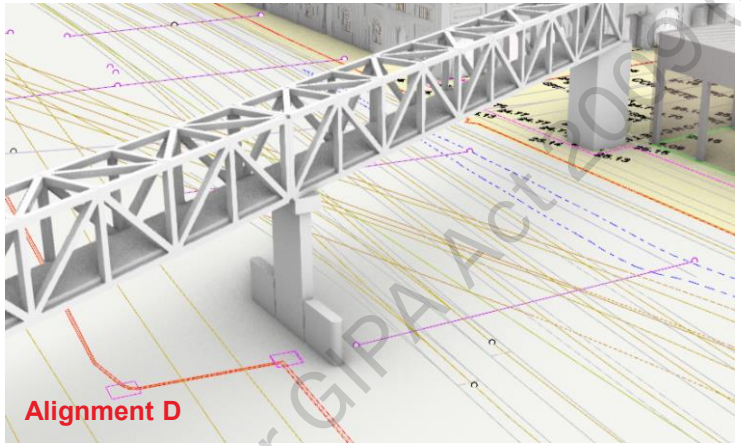
- Access should be through the structure to reduce the elevation required to clear rail assets.
- The structure cannot be 'raised' from the rail corridor but must be craned, launched or pivoted.
- Focus has been placed on testing a feasible solution and the truss has been selected for that purpose.
- Aesthetics and form will be an important consideration for heritage and Connection to Country.

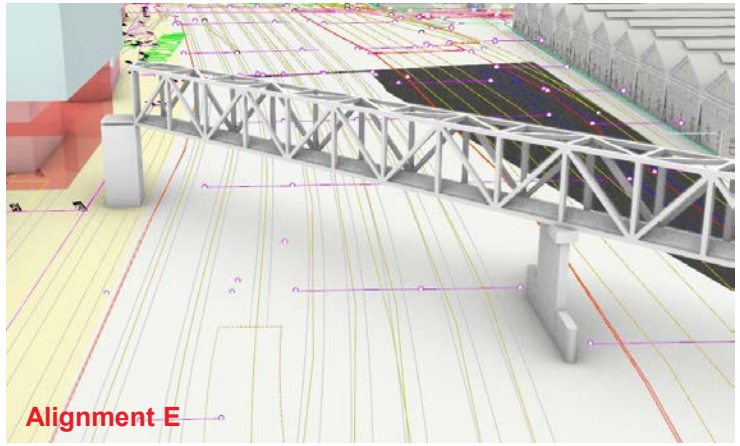
Example structural typologies		Height of spanning structure
Truss		5 – 6.5m
Tied arch		10 – 15m (from tie to highest point of the arch)
Cable-stayed		Pylon height ~25 – 30m

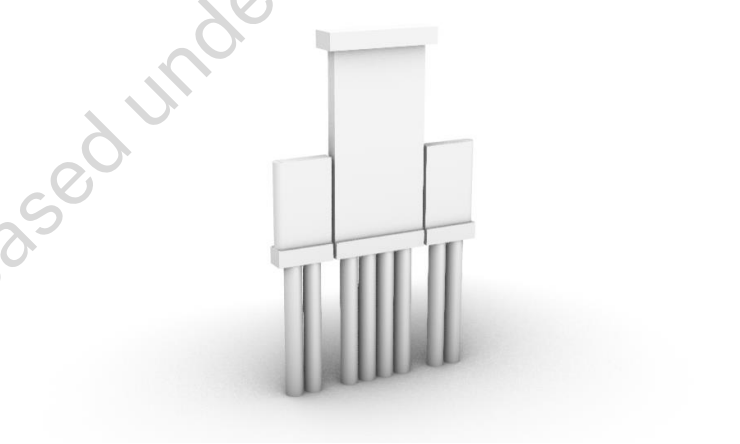
Bridge support in the rail corridor

A pier in the rail corridor is required and needs Sydney Trains approval.

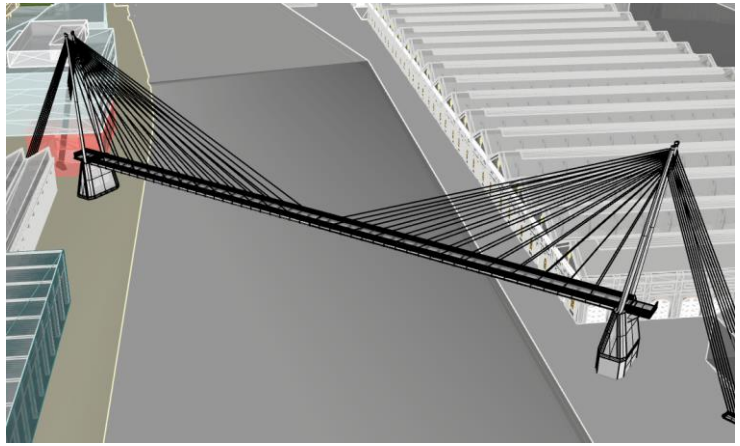
- A pier is required, otherwise the structure becomes very large
- Construction must occur during a rail shut down (i.e., possession)
- This section of the rail corridor is a key artery close to Central Station
- Design and construction requirements for the Sydney Trains corridor are very stringent and required their approval
- Approvals and possession pose a program and cost risk.
- Realistic duration of 4-5 years, excluding design and approvals (additional 1-2 years).







Piles, pile cap, deflection walls and pier



Cable supported bridge clashes with buildings

Bridge – Landings and Access

The south landing is complex and is the major constraint on the access design.

- An extended deck is required to span over the live maintenance facility.
- E-W pedestrian route interferes with emergency access from the Locomotive Sheds and is not along a desire line.
- Significant engagement and approvals would be required from Sydney Trains.

Extended deck over maintenance area

DDA ramp to Village Square (2017 study)

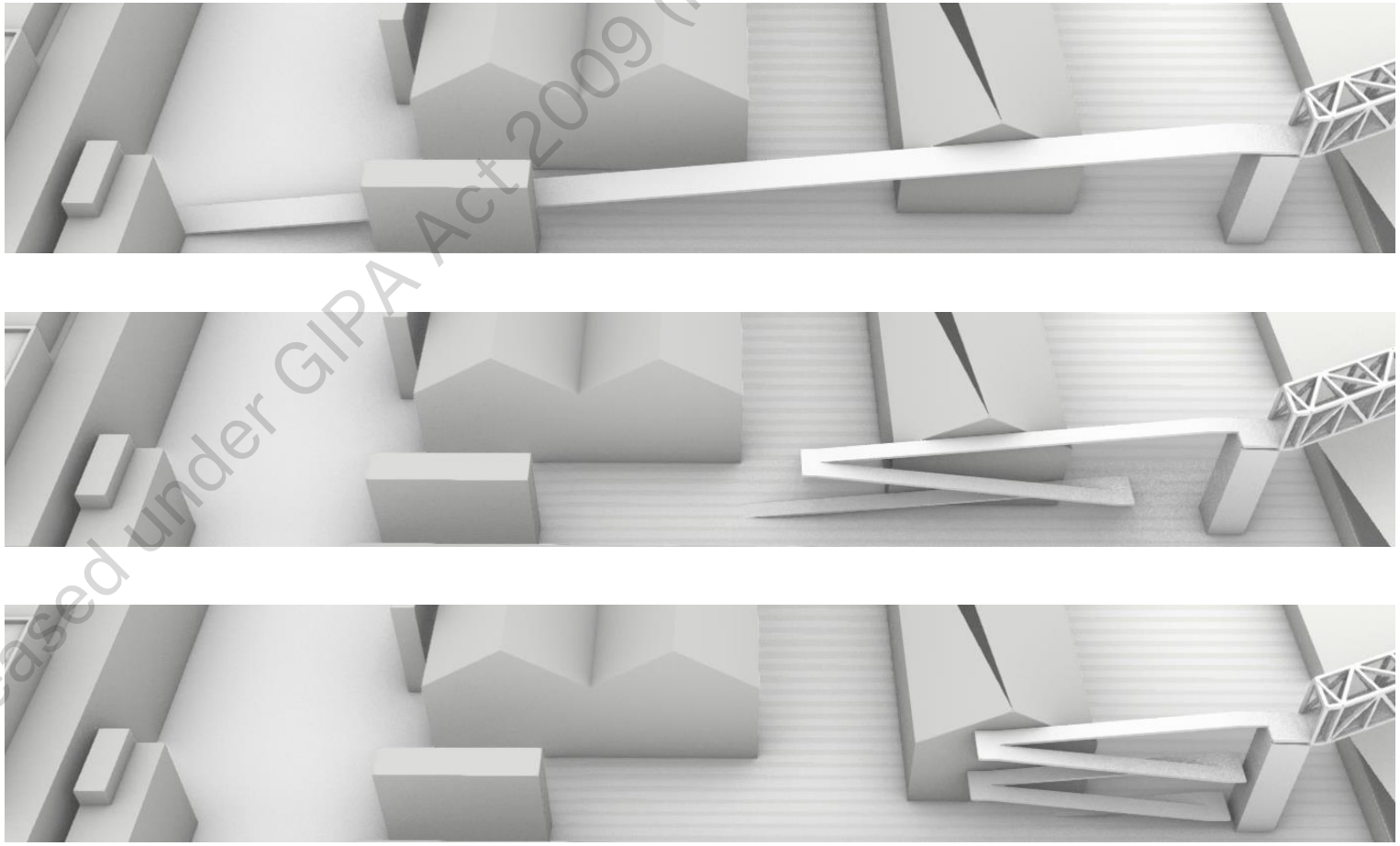
Rail area
Publicly accessible area
Abutment

Pedestrian access
Lift/stairs/deck

Southern ramps

A ramp is not appropriate for the south landing due to the space needed.

- The substantial changes in level mean a long run is needed.
- E.g. the steepest grade permissible (Grade 1 in 8 cyclist ramp) without rest zones results in a run to the base of the Channel 7 building.
- DDA compliant ramps (grade 1 in 20) would be longer still.
- A long ramp increases the walking time for pedestrians and the number of switchbacks for cyclists to navigate.
- Lift alternative, 2 likely to be required
- Similar typologies would be applied if ramps were used on the north.



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Crossing Options - Below ground options

Above ground alignment options – Where should it go?

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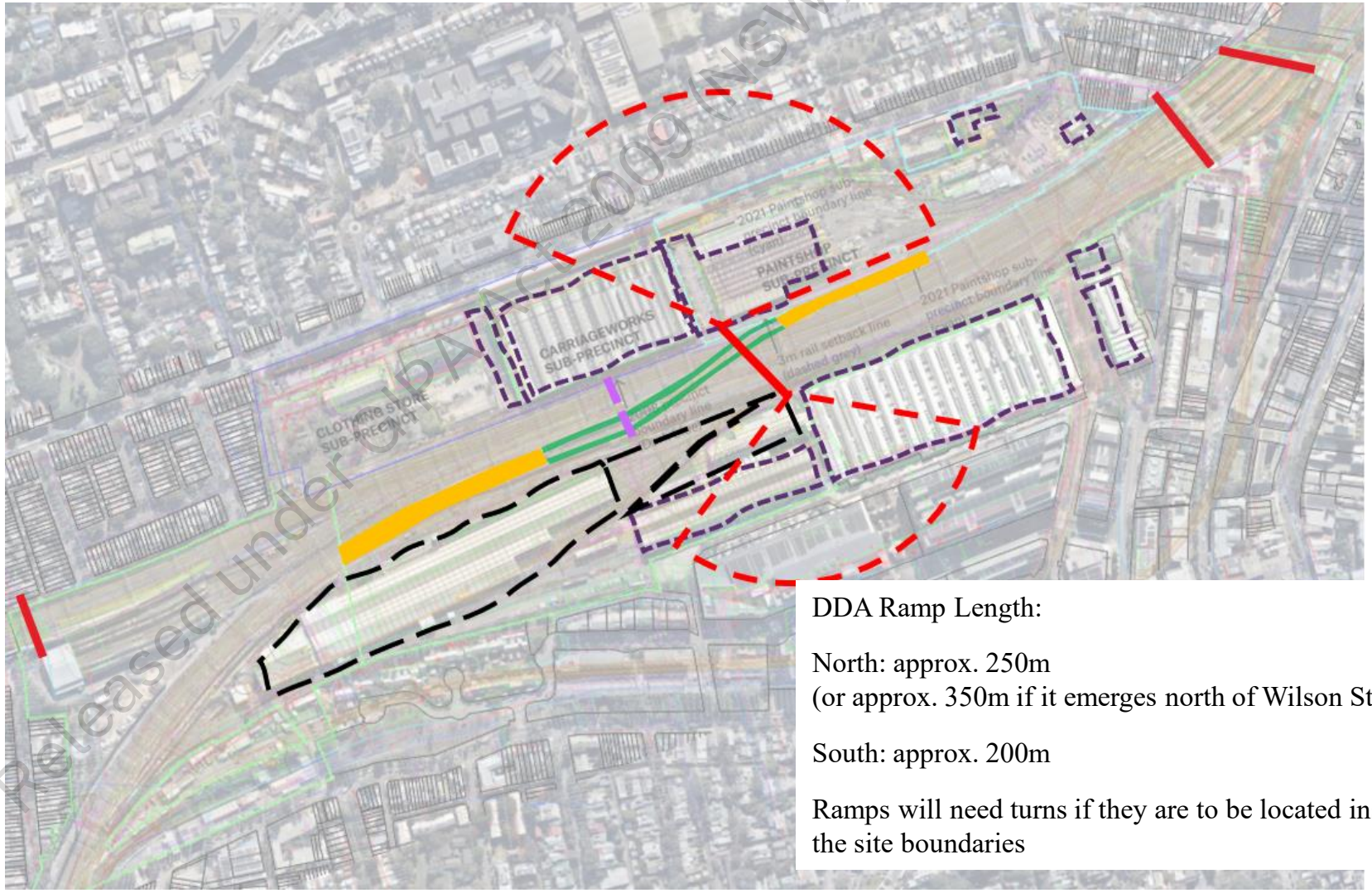
Existing Underground Structures

- Study alignment below rail corridor as per preferred bridge alignment (tunnel invert 12 to 15m below existing track level)
- DDA ramp length as radius (1 in 20 grade with landings) extending from tunnel invert
- Illawarra Dive
- Illawarra Tunnels (invert max 8m below existing track level
- Eveleigh maintenance tunnel
- Pedestrian crossings
- Eveleigh Maintenance Centre
- Heritage



DDA Ramp Length:

North: approx. 250m
(or approx. 350m if it emerges north of Wilson Street)

South: approx. 200m

Ramps will need turns if they are to be located inside the site boundaries

Tunnel Vertical Alignment

Site Topography and clearances are a major constraint to the access arrangements.

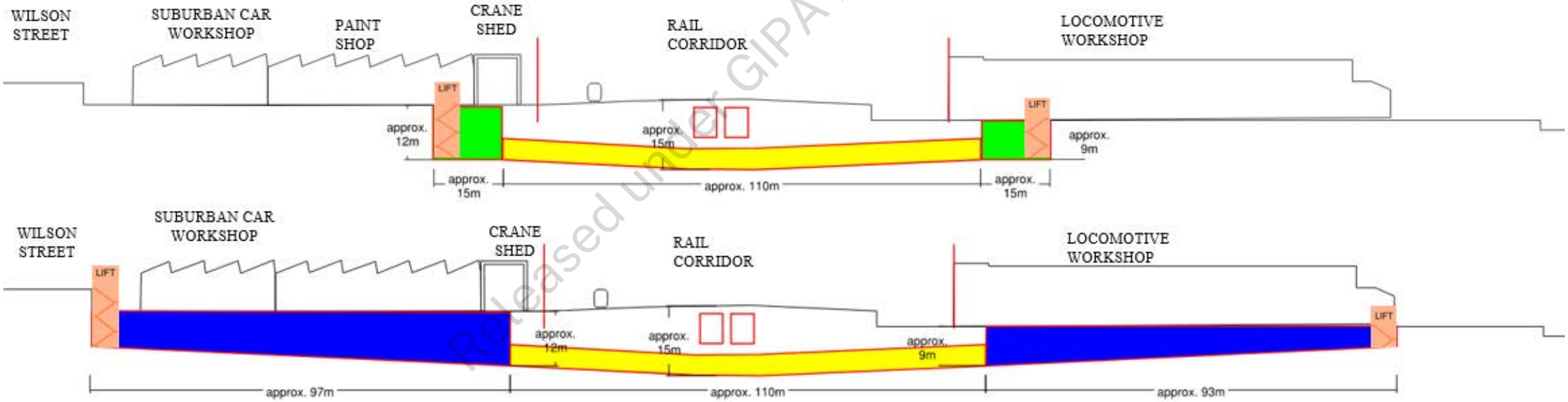
- The substantial level difference means that any ramps will be very long.
- Lifts and stairs are more appropriate at tunnel entries.
- There are limited to no locations to stage/launch tunnelling works

Existing Illawarra tunnels

Mined tunnel – approximate length 110 m

Cut and cover dive structures
North dive – approx. length 97m
South dive – approx. length 93m

Cut and cover access shaft – approximately 15m square



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Crossing Options - Alternatives

Alternatives – Urban cable cars

STRAP LINE/MESSAGE

Opportunities

- Minimise works within rail corridors
- Flexibility in the alignment (vertical and horizontal)
- RNE crossing could form part of a network

Risks

- Ongoing operating costs (inc. permanent staff)
- Operation can be weather dependant
- Low passenger throughput

Mi Telefrico urban cable car system, La Paz, Bolivia (Credit: Getty Images)

Yeosu Maritime Cable Car, Yeosu, South Korea (Credit: Visit Korea)

Alternatives – Personal Rapid Transit (PRT)

STRAP LINE/MESSAGE

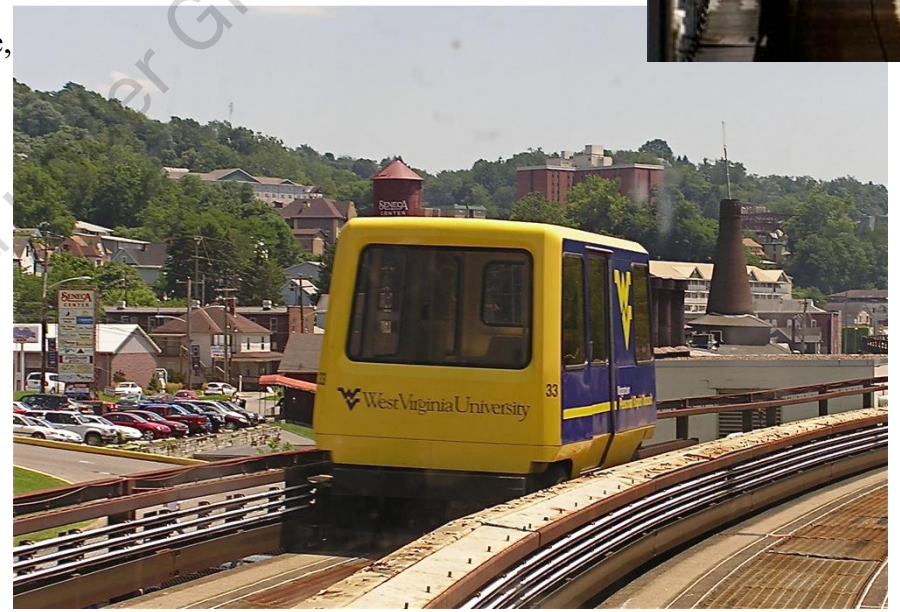
Opportunities

- Ability to climb gradients will minimise ramp lengths
- RNE crossing could form part of a network

Risks

- Ongoing operating costs (inc. permanent staff)
- The crossing of the Rail Corridor will still require a bridge, and associated works within the Rail Corridor
- Low passenger throughput

Heathrow T5 POD, London, UK (Credit: Getty Advanced Transit Association)



Morgantown Personal Rapid Transit, Morgantown, USA (Credit: Wikipedia)

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Alternatives – Monorail

STRAP LINE/MESSAGE

Opportunities

- Ability to climb gradients will minimise ramp lengths
- RNE crossing could form part of a network
- Reduced structure for the 'Track' when compared to Pedestrian bridge.

Risks

- Ongoing operating costs (inc. permanent staff)
- The crossing of the Rail Corridor will still require supports and associated works within the Rail Corridor
- Low passenger throughput

WeSPa Tsubakiyama Slopecar, Fukaura, Japan (Credit: Wikipedia)

H-Bahn, Dortmund, Germany (Credit: Wikipedia)

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Conclusion TO BE DISCUSSED WITH TfNSW

The Redfern North Eveleigh Bridge will be a very challenging and expensive bridge to build and does not provide outstanding time savings or convenience for users.

Next steps:

Internal TfNSW benefits and value assessment.

Business case preparation and funding submission (subject to passing value and benefits assessment).

If the bridge is built:

There will be a high cost and long program due to physical and operational constraints.

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Conclusion TO BE DISCUSSED WITH TfNSW

A detailed benefits assessment and business case is required.

Connect the North and South Eveleigh communities	✓
Provide local permeability across the rail corridor	✓
Safe	✓
Comfortable	?
Convenient	?
Provide time savings for pedestrians and cyclists	?

Accessible	✓
Sustainable	!
Sympathetic to the industrial heritage of the area	!
Connection to Country	✓
Value for Money	!

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Redfern North Eveleigh Crossing

The crossing should provide a connection across the obstacle created by the rail corridor, save time, encourage permeability, and be a convenient, safe and accessible piece of infrastructure.

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Objective

Objectives

What characteristics should the crossing have?

- Connect the North and South Eveleigh communities
- Provide local permeability across the rail corridor
- Safe
- Comfortable
- Convenient
- Provide time savings for pedestrians and cyclists
- Accessible
- Sustainable
- Sympathetic to the industrial heritage of the area
- Connection to Country
- Value for Money
- Facilitate an Innovation and Collaboration precinct

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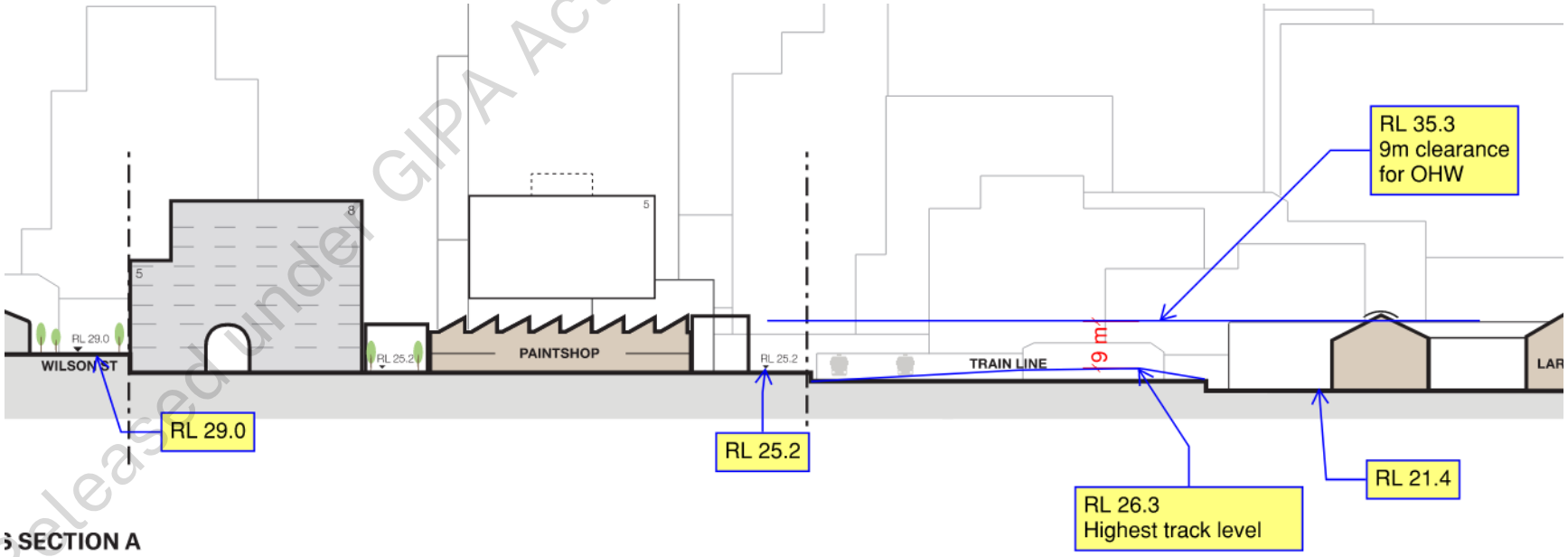
Site Attributes

Constraints - Topography

The site is on a declining landform, there is a significant elevation change along the crossing alignment

The Topography across the site, and necessary vertical clearances to the rail corridor, results in:

- 10.8m rise/fall from north landing to ground
- 7m rise/fall from north landing to Wilson Street
- 14.6m rise/fall from south landing to ground



Constraints – Rail

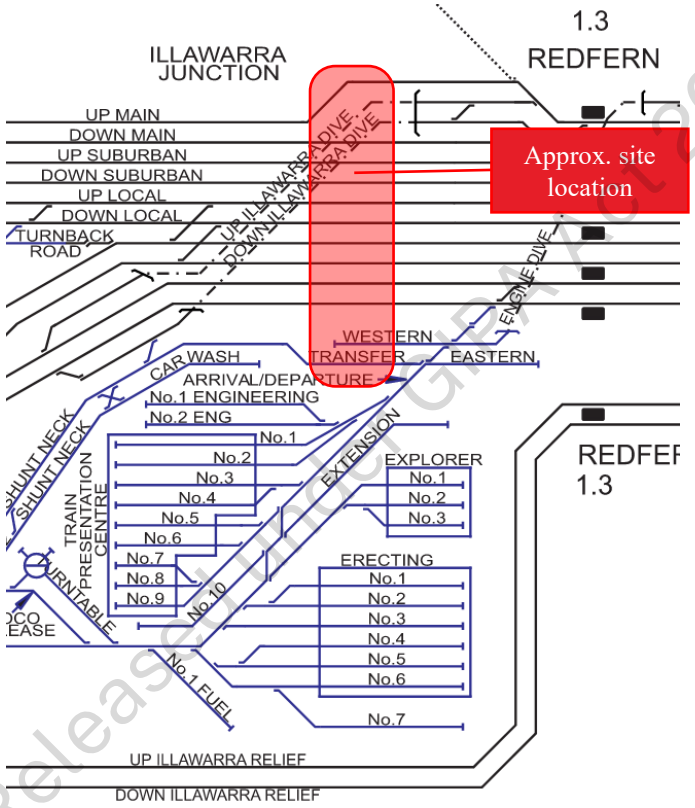
The length of the crossing results in permanent works within the Rail Corridor

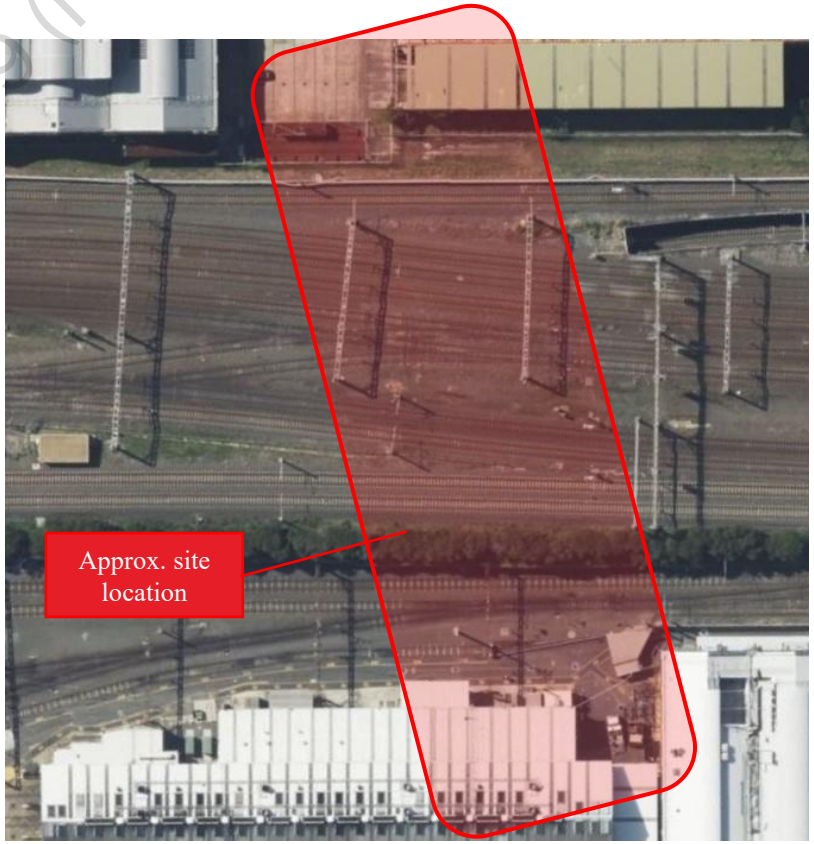
The rail corridor at this location is a key network artery that:

- Provides principal access to Central Station
- Is located within the Suburban and Intercity Train Maintenance Centre

Constraints in this area require the crossing:

- Construction activities align with the possession configurations.
- Utilises staged construction, with activities to be delivered in 48hr blocks.





Indicative crossing zone in red on the Metropolitan Network Diagram V3 TfNSW Config Diagram (2010)

Constraints – Rail

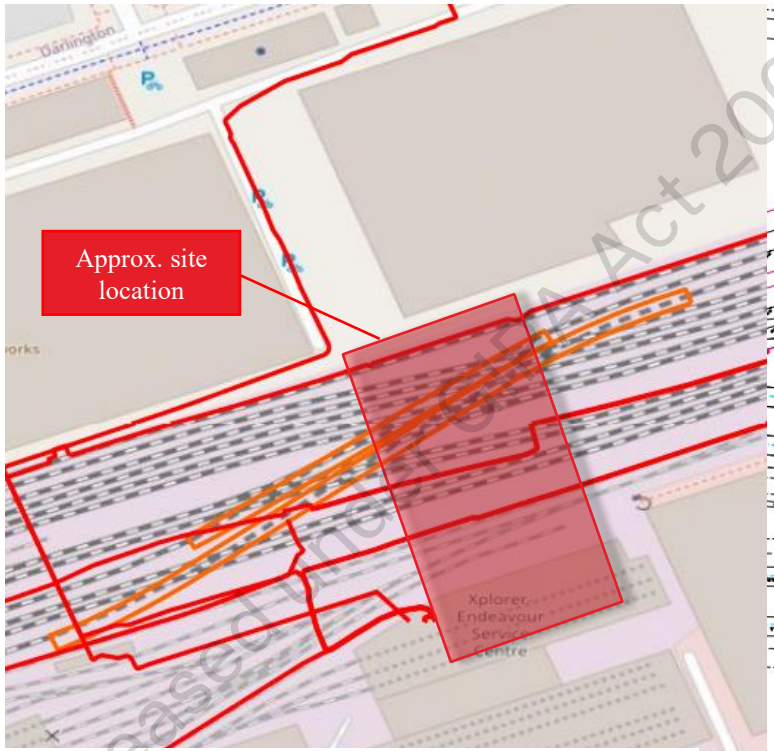
Significant built infrastructure exists within the study area

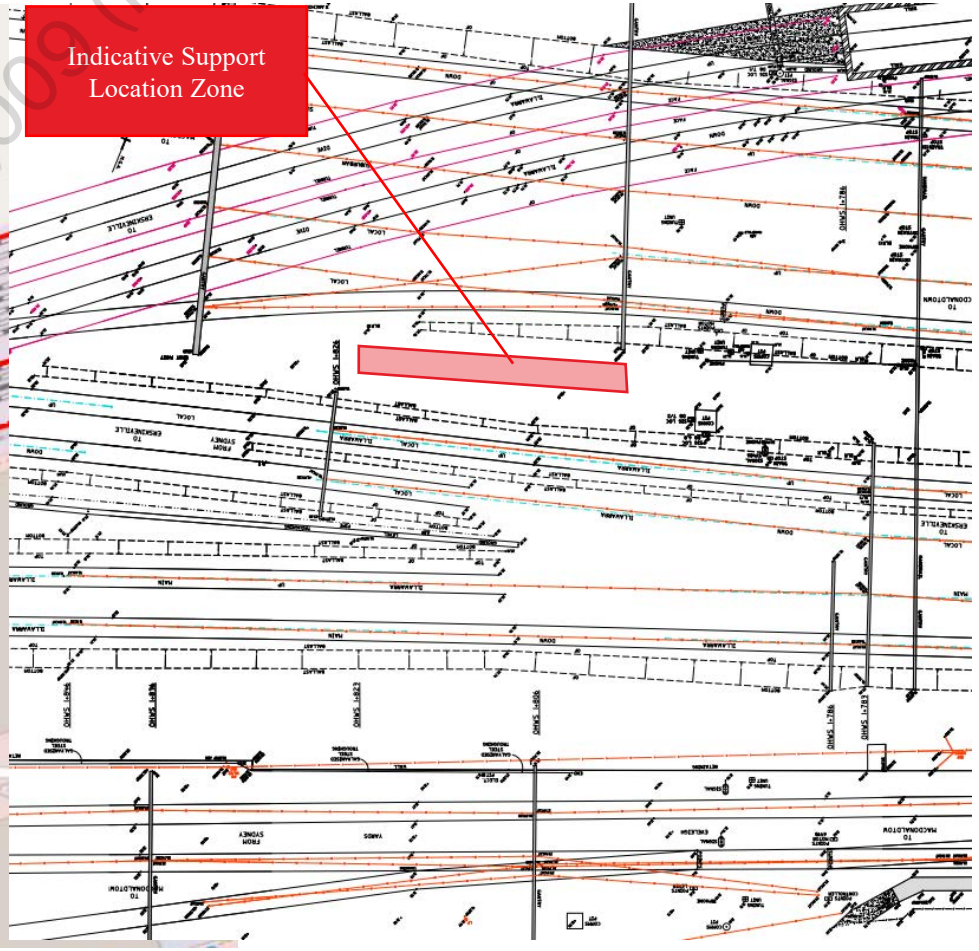
Active assets in the area include:

- HV cables
- Signaling & communication infrastructure
- Illawarra Dives (Tunnel)
- Redundant Workman's subway
- Overhead Wiring and Elevated Signal Gantries
- Potential for other underground services

Constraints in the area include:

- Works generally should not be within 5 metre radius of any electrical, communication assets, and within 25 metres of any other TfNSW tunnel.
- 9m vertical clearance over Rail Corridor





Sydney Train – Before You Dig Australia Location Information (2022)

Constraints - Third Party Utilities

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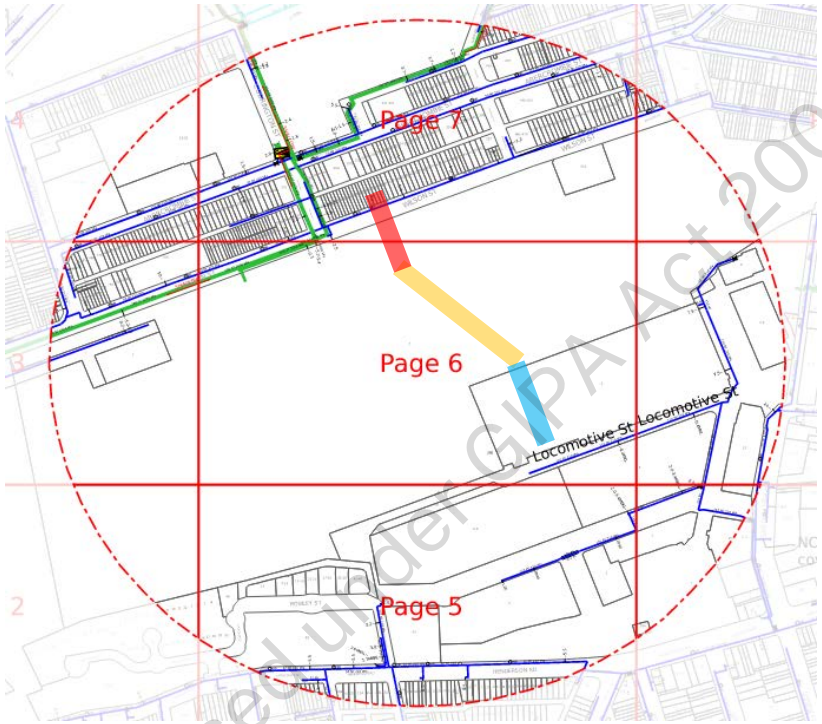
Existing utilities exist at both boundaries of the crossing

Currently identified assets include:

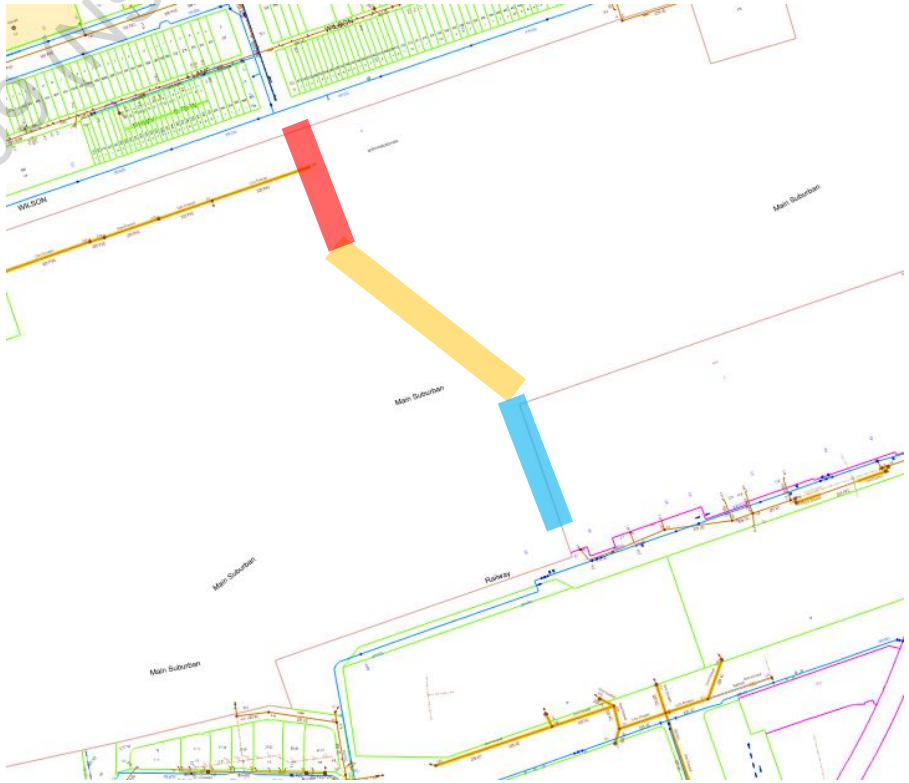
- Jemena
- Sydney Water
- Ausgrid
- City of Sydney
- NBN
- Potential for other underground services

Constraints include:

- Works may not be undertaken within the clearance set by the asset owner



Jemena DBYD



Sydney Water DBYD

Traverser

Potential Crossing location

Corridor between the Locomotive Workshop and the LES Building

210kPa Medium Pressure gas main

300kPa Medium Pressure gas main

400kPa Medium Pressure gas main

1050kPa High Pressure gas main

Sewer property connection point
With chainage to downstream maintenance hole.

Sewer concrete encased section

Sewer Rehabilitation

Sewer terminal maintenance shaft

Stormwater gully

Stormwater maintenance hole

Watermain – potable drinking water
With size type text.

Disconnected watermain potable drinking water
This means the watermain has been disused but remains in the ground.

Recycled watermain

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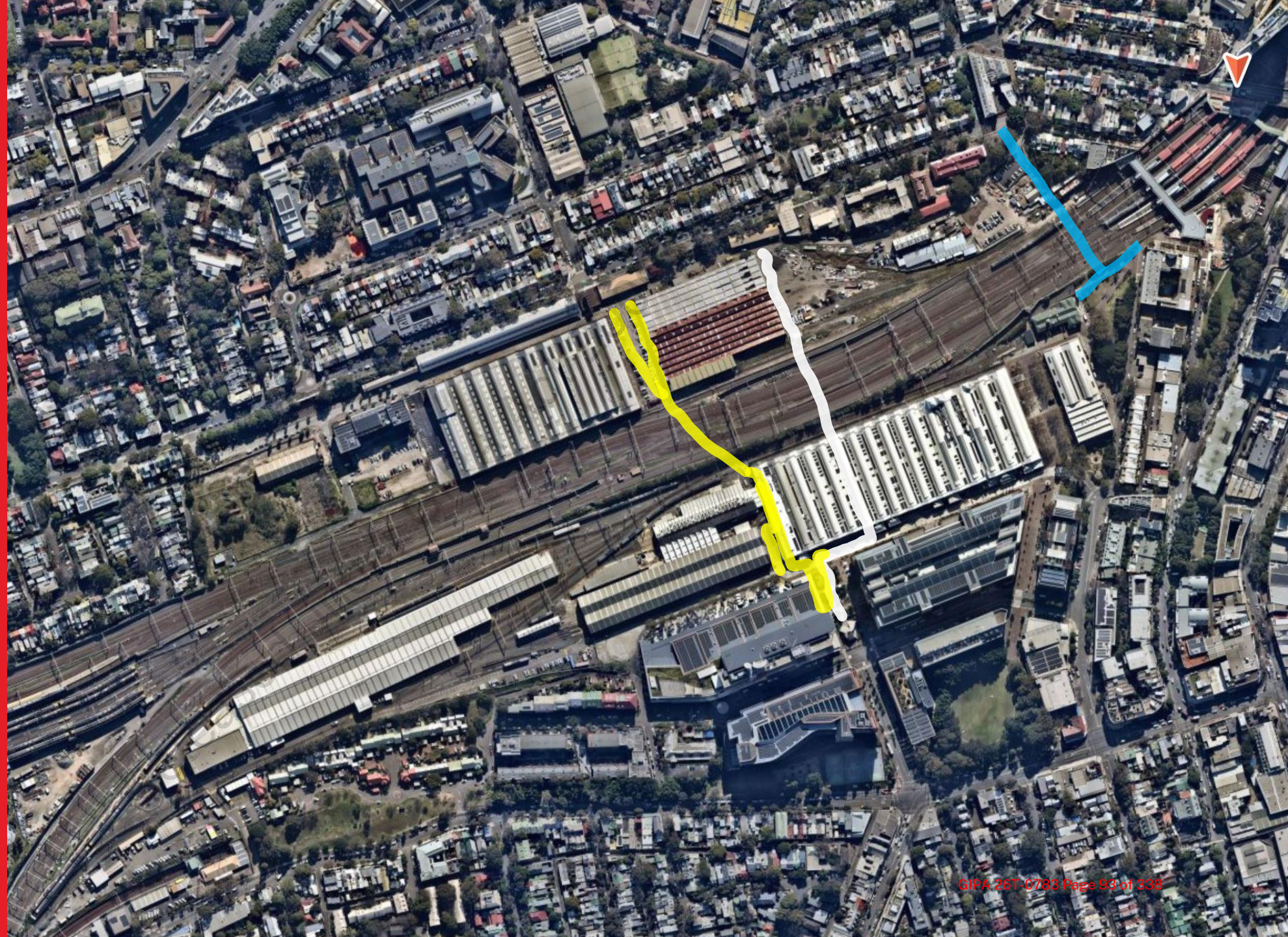
Review of Previous Studies

Study Areas & Alignments

Eveleigh Heritage Walk Report *for Redfern Waterloo Authority* [2008]

Carriageworks to Australian Technology Park – North-South Pedestrian Link *for UrbanGrowth NSW* [2017]

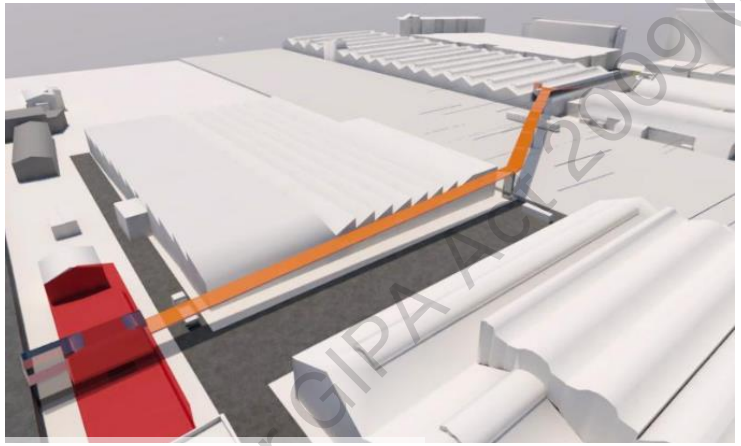


Previous studies

2008 and 2017 Studies for the Carriageworks to Australian Technology Park Pedestrian Link

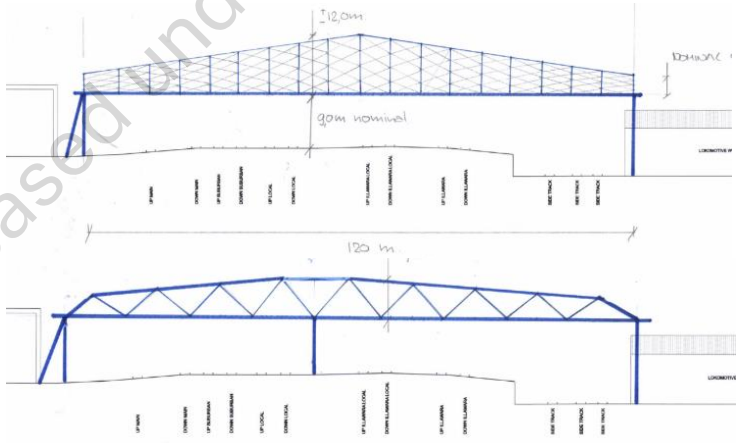
Arup were previously commissioned to review the site constraints including constructability and develop sketches of bridge concepts for preliminary costing.

- The 2008 study favoured eastern alignments over the western alignments as the bridge length could be minimized (undertaken pre new Redfern Station crossing)
- The 2017 study examined bridge crossing along the western alignment, including structural forms and end connections

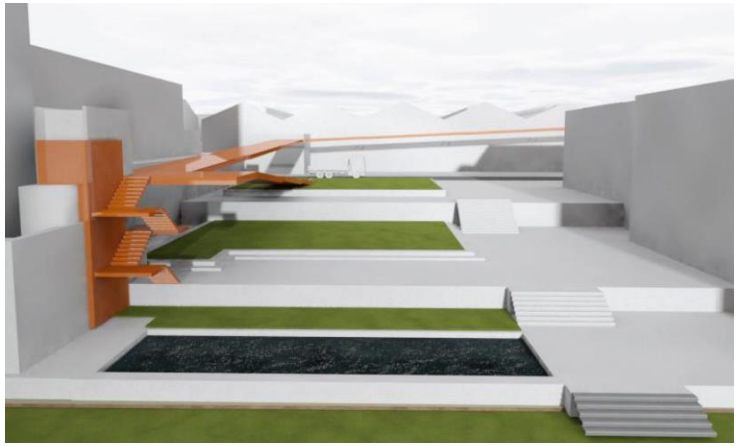


North landing to Wilson Street

South landing option in Locomotive Shed bay

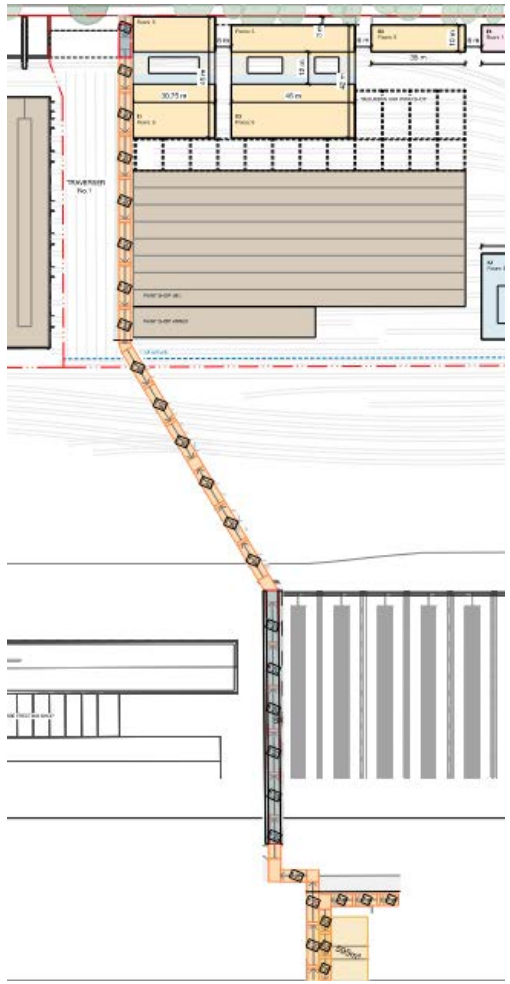


Truss options with pier, clear spans are ~50-120m

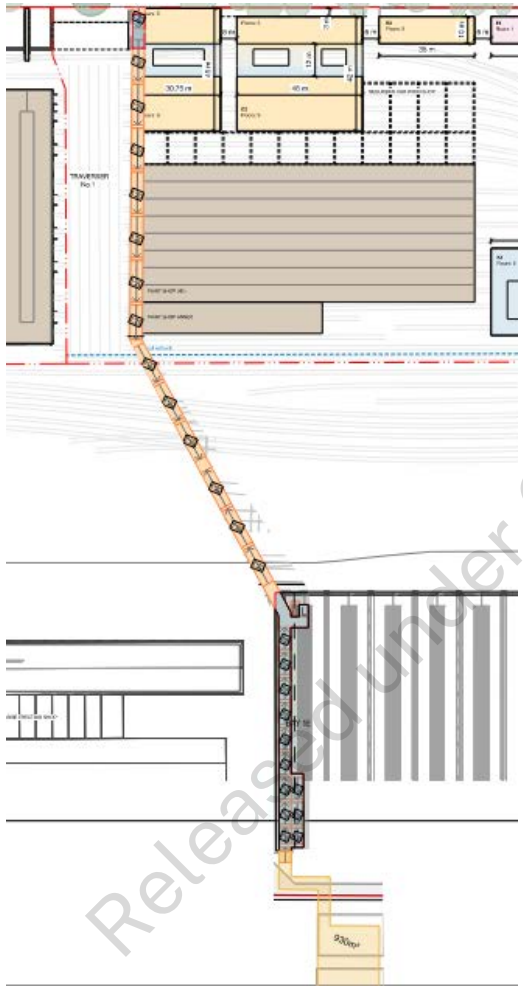


South landing option along village square (between Channel 7 and CBA)

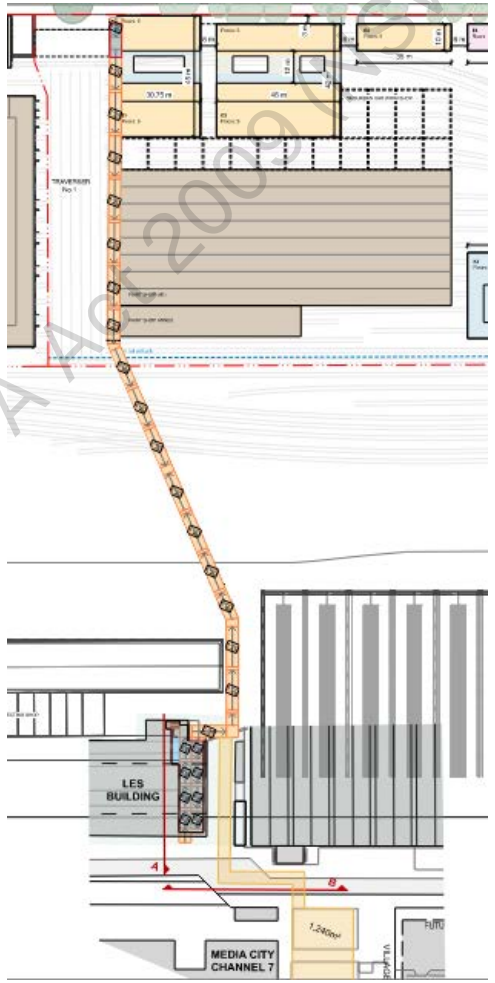
Previous studies



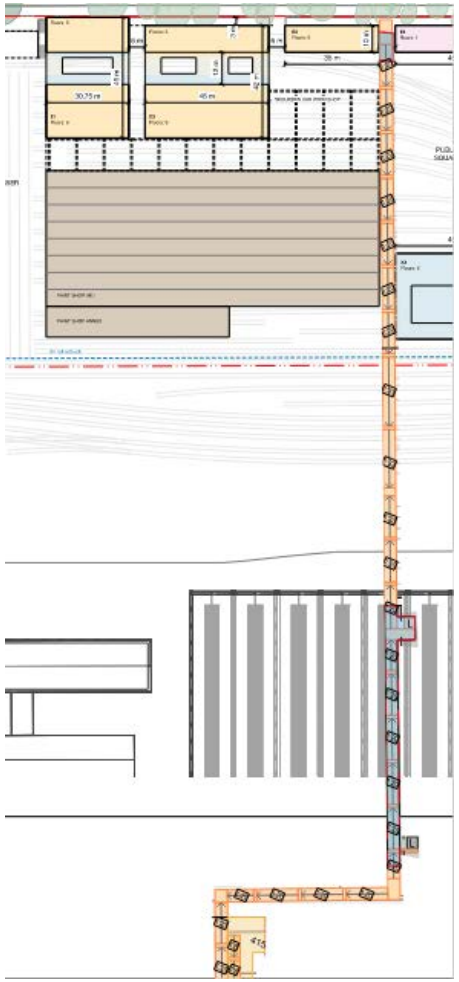
Option 1A



Option 1B



Option 1C



Option 4

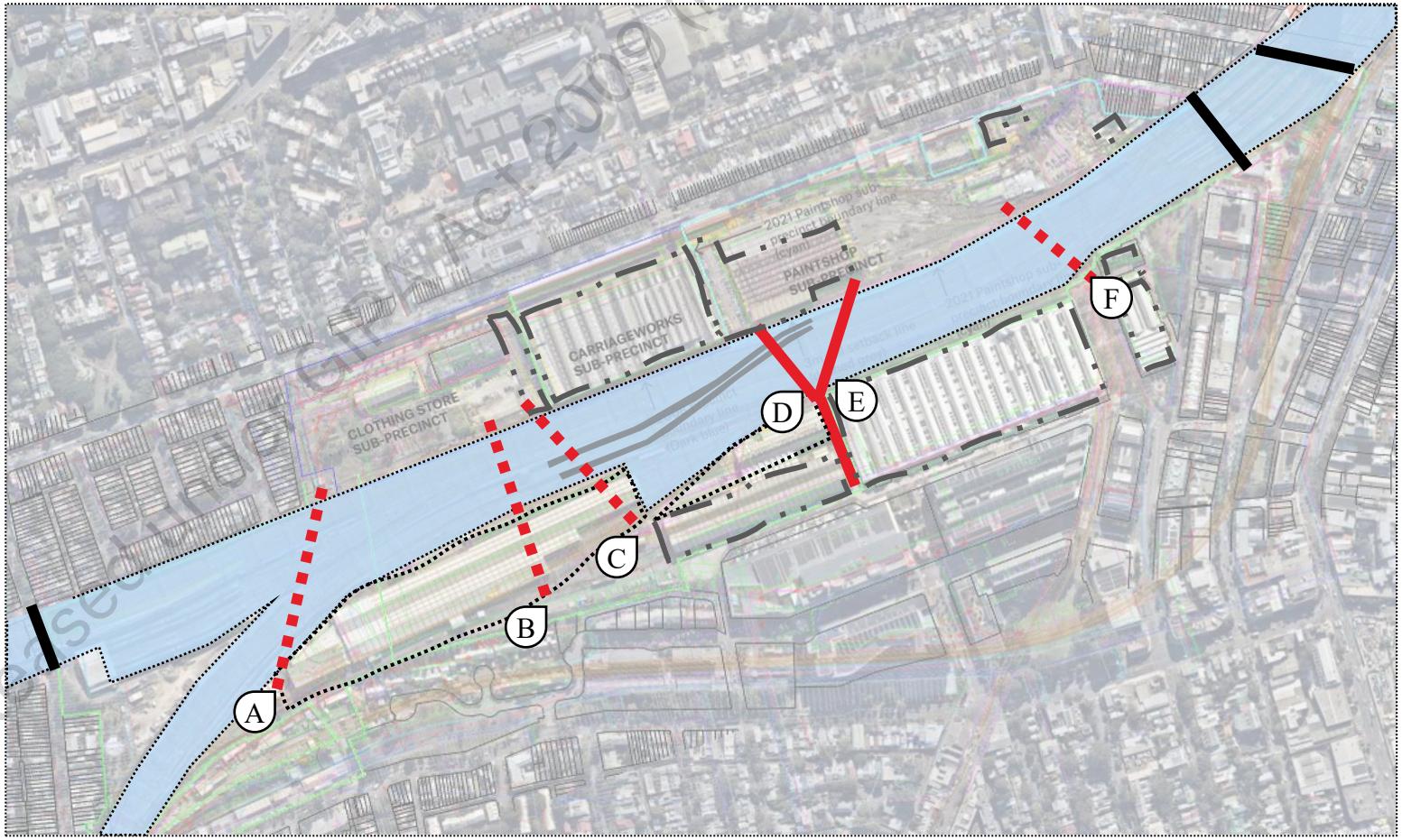
Above ground alignment options – Where should it go?

The Carriageworks to LES connection provides the best outcome for permeability. i.e. Alignments D and E.

- Study alignment
- Alternate alignments
- Existing connection
- Minimum 10m clearance height above rail corridor; HV cable, drainage at rail corridor
- Illawarra Dive (tunnel)
- Eveleigh Maintenance Centre
- Heritage

Alignment, and crossing type should,

- Comply with the rail corridor physical and operational constraints.
- Mitigate approvals from Sydney Trains for any design or construction activity.



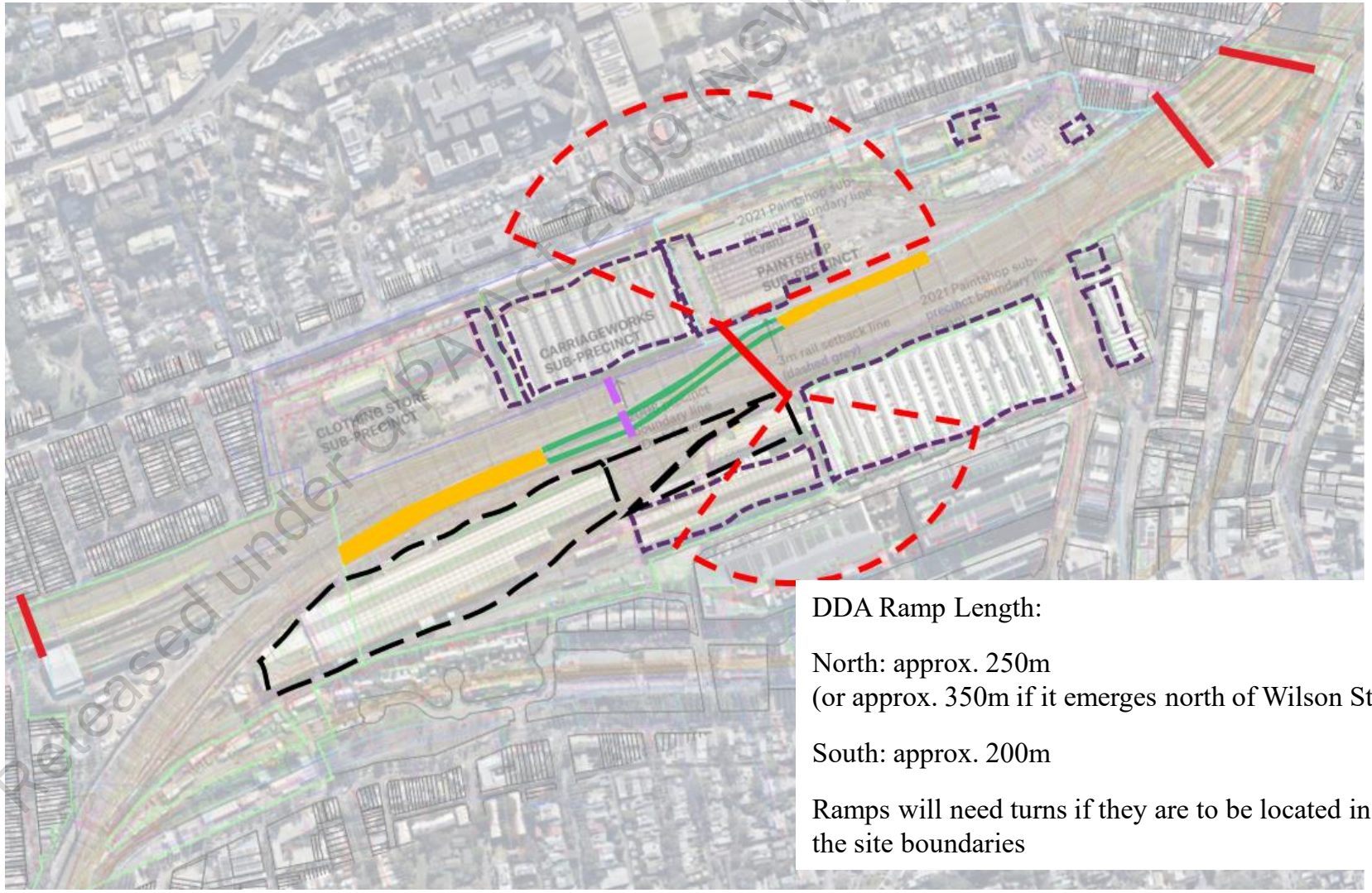
Bridge siting map

Above ground alignment options – Where should it go?

ARUP

Existing Underground Structures

- Study alignment below rail corridor as per preferred bridge alignment (tunnel invert 12 to 15m below existing track level)
- DDA ramp length as radius (1 in 20 grade with landings) extending from tunnel invert
- Illawarra Dive
- Illawarra Tunnels (invert max 8m below existing track level
- Eveleigh maintenance tunnel
- Pedestrian crossings
- Eveleigh Maintenance Centre
- Heritage



DDA Ramp Length:

North: approx. 250m
(or approx. 350m if it emerges north of Wilson Street)

South: approx. 200m

Ramps will need turns if they are to be located inside the site boundaries

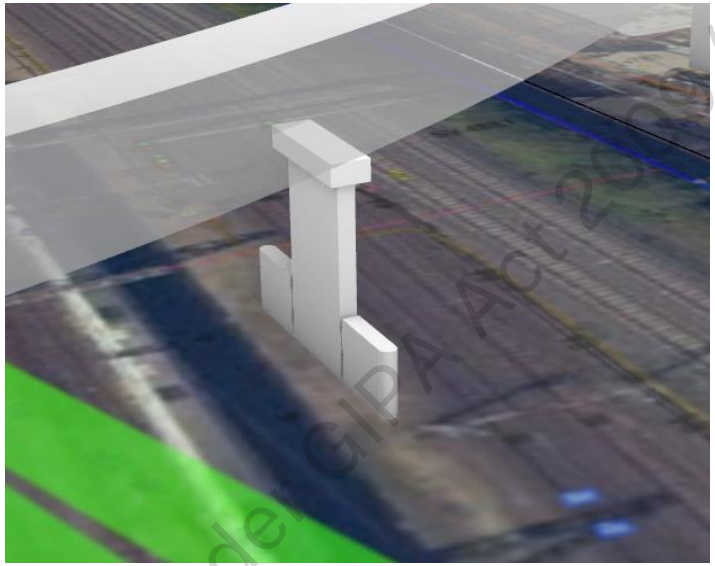
ARUP

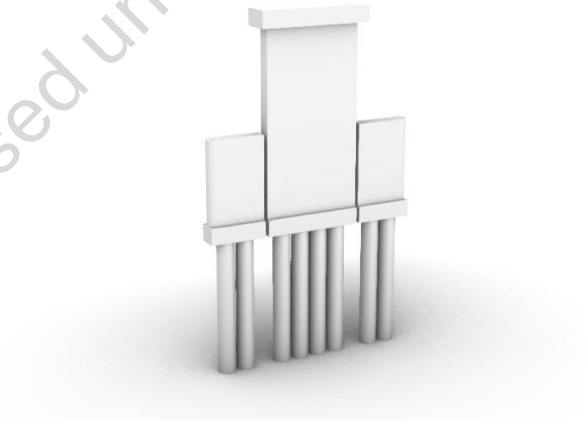
Crossing Options – Above ground crossing

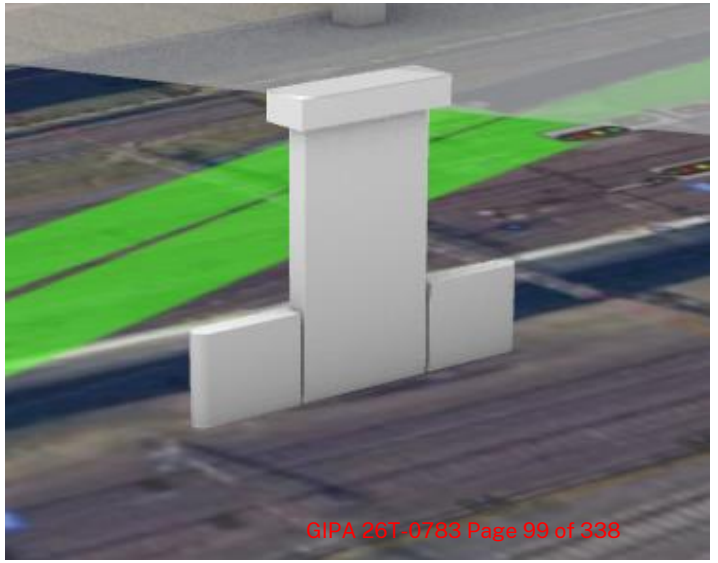
Bridge – Central Support

A pier in the rail corridor is required and needs Sydney Trains approval.

- A pier is required, otherwise the structure becomes very large.
- Eastern crossing precluded as pier location is severely constrained.
- Construction must occur during a rail shut down (i.e., possession)
- This section of the rail corridor is a key artery close to Central Station
- Design and construction requirements for the Sydney Trains corridor are very stringent and required their approval
- Approvals and possession pose a program and cost risk.
- Pier has been positioned to clear existing HV and Signalling services within the rail corridor.







Bridge – Elevator & Stairs

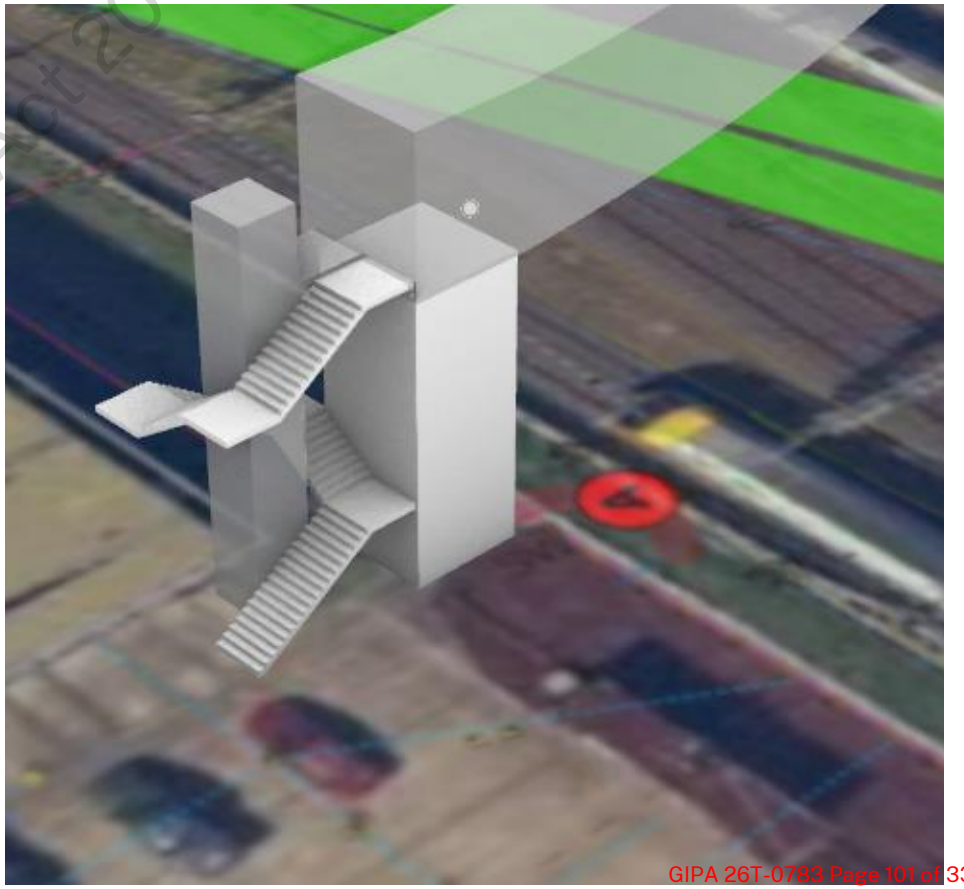
North & South - Constrained locations

- Main spans approx. dimensions - 45m (Nth), 55m (Sth)
- Southern Approach approx. lengths - 50m, 47m, 35m
- Northern stair tower approx. height – 10.5m (~4 stories)
- Southern abutment approx. height - 15m (~5 stories)
- Southern stair piers & tower approx. height – 10m, 10m & 7m

Bridge – Elevator & Stairs

Northern Elevator and Stair located in constrained site

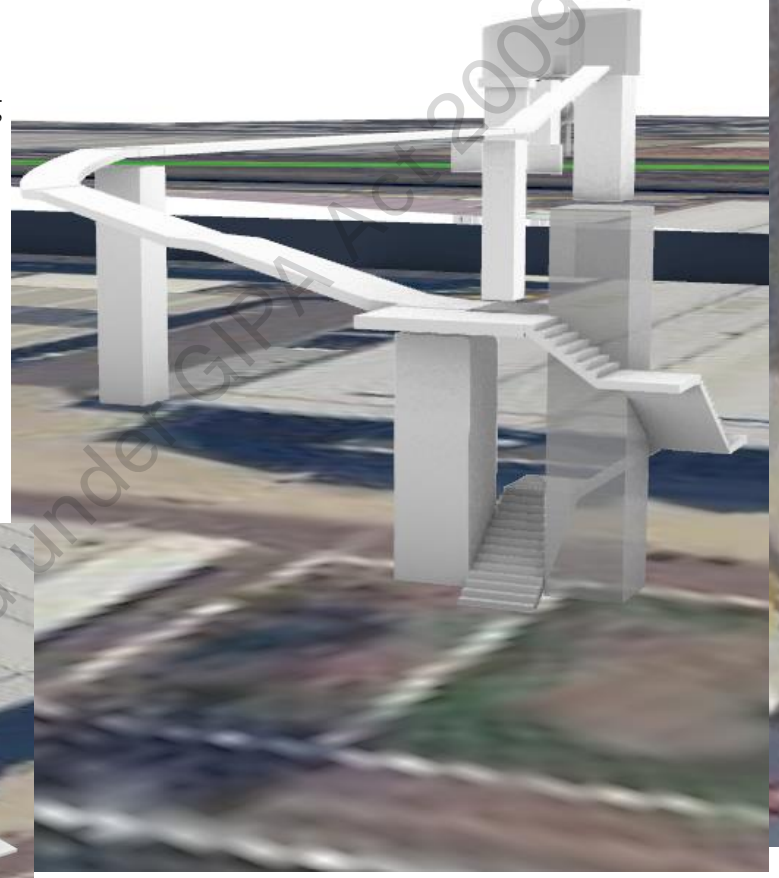
- Abutment, stairs and elevator are to be positioned clear of
  - Heritage Listed Traverser (where it is currently parked)
  - Heritage Listed Paint Shop Annex (with no demolition of the Annex)
  - Local Drainage (including connection at Traverser)



Bridge – Elevator & Stairs

Southern Elevator and Stairs located off Locomotive Street

- Stairs and landings located in Davy Street Park
- An extended deck is required to span over the live maintenance facility which requires 24hr access. Access is also to be maintained to facilities including Large Erecting Shop
- Significant engagement and approvals would be required from Sydney Trains.
- Opportunity grade ramp down (subject to approval) to minimise stair tower height
- Public (pedestrian & vehicular) access to be maintained to Locomotive Street



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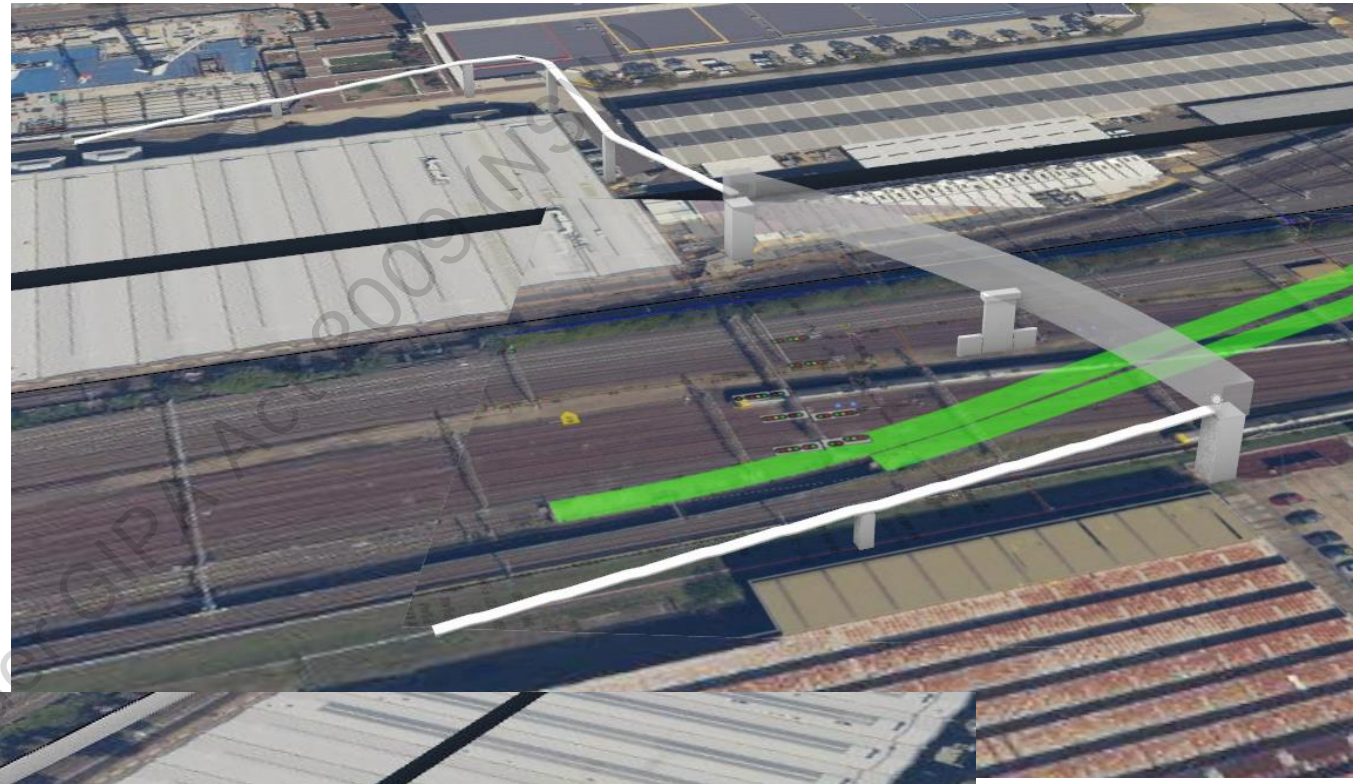
Bridge – Ramps

Ramp connections to innovation precincts

- Main spans unchanged
- Northern Approach approx. lengths 55m, 55m
- Southern Approach approx. lengths - 50m, 47m, 25m, 40m, 40m



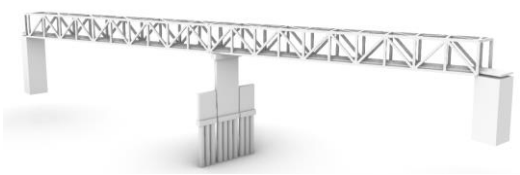
Superstructure – General Forms

The images presented are generic bridge forms to suggest the typologies of possible bridges.

Throughout the iterative design process, the design principles for the site would be integrated with structurally feasible solutions.

It should be noted that all bridge forms must satisfy minimum clearance of 9m above railway track to avoid clashing with the existing OHW and signal gantries.

A **truss form** was identified as the least obtrusive form and was taken forward for the purpose of this study. Weathering steel could be used for the construction, which would also eliminate maintenance requirements for painting.

	Truss	Tied Arch	Cable-Stayed
			
Height of spanning structure	5 – 6.5m tall	10 – 15m tall (from tying chord to highest point at arch)	Pylon height ~25 – 30m
Span length	50 – 65m	50 – 65m	100 – 130m
Other requirements	Central pier required	Central pier required	Need space for the back stay (image shown is a comparatively compact arrangement) Needs very tall pylons of ~ 25-30m high
	Considered further Form is sympathetic to industrial character of the surrounds.		

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Crossing Options - Below ground options

Tunnel Vertical Alignment

Site Topography and clearances are a major constraint to the access arrangements.

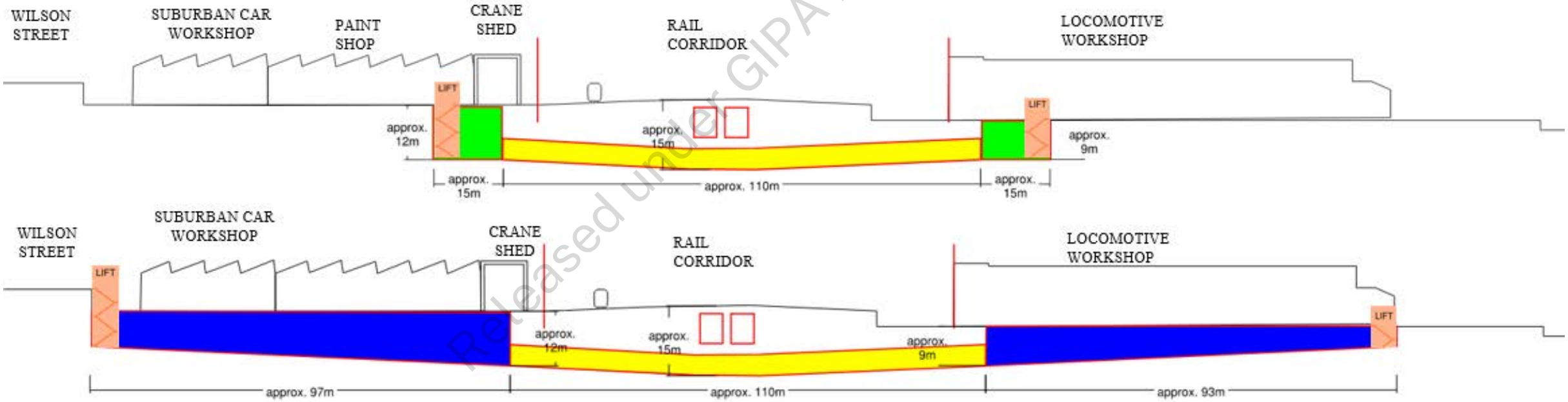
- The substantial level difference means that any ramps will be very long.
- Lifts and stairs are more appropriate at tunnel entries.
- There are limited to no locations to stage/launch tunnelling works

Existing Illawarra tunnels

Mined tunnel – approximate length 110 m

Cut and cover dive structures
North dive – approx. length 97m
South dive – approx. length 93m

Cut and cover access shaft – approximately 15m square



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Crossing Options - Alternatives

Crossing Options - Alternatives

Non-fixed link crossings available include Urban Cable Cars, Personal Rapid Transits/Monorails, Shuttle Buses, eScooters

Opportunities

- Minimise works within rail corridors (minimal infrastructure for Shuttle Bus/eScooters
- Flexibility in the alignment (vertical and horizontal)
- RNE crossing could form part of a network

Risks

- Ongoing operating costs (inc. permanent staff)
- Operation can be weather dependant
- Bridge still required for Rail Corridor (PRT & Monorail
- Low passenger throughput,
  - >2000pph (Urban Cable Car)
  - <1000pph (PRT) 5000+pph (Monorail)
- Require delivery/operating entity,
- eScooter public safety (collisions/accidents).

On Demand Shuttle, Sydney (Credit: KeolisDowner)

Mi Telefrico urban cable car system, La Paz, Bolivia (Credit: Getty Images)

(Credit: City of Hobart)

WeSPa Tsubakiyama Slopecar, Fukaura, Japan (Credit: Wikipedia)

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Conclusions and other issues to consider

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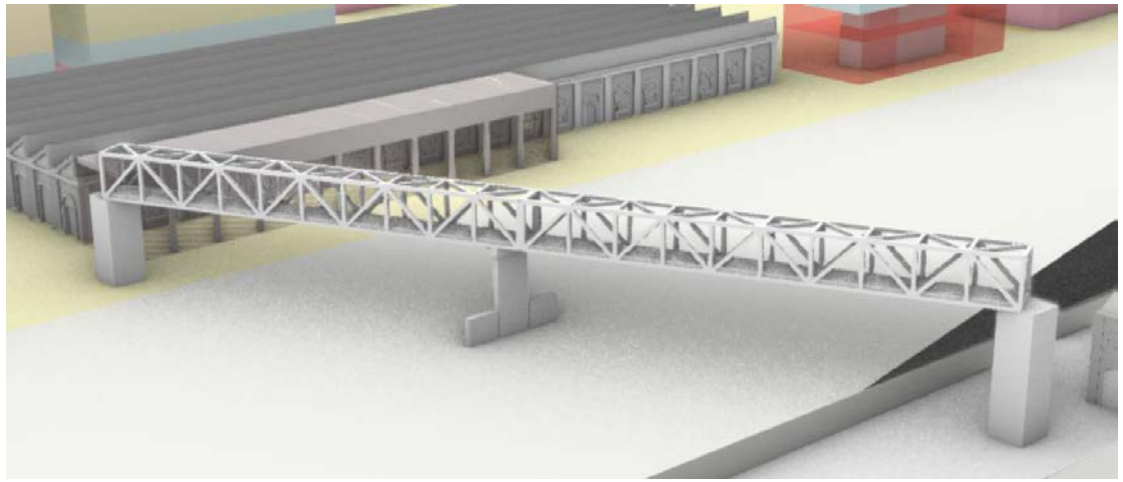
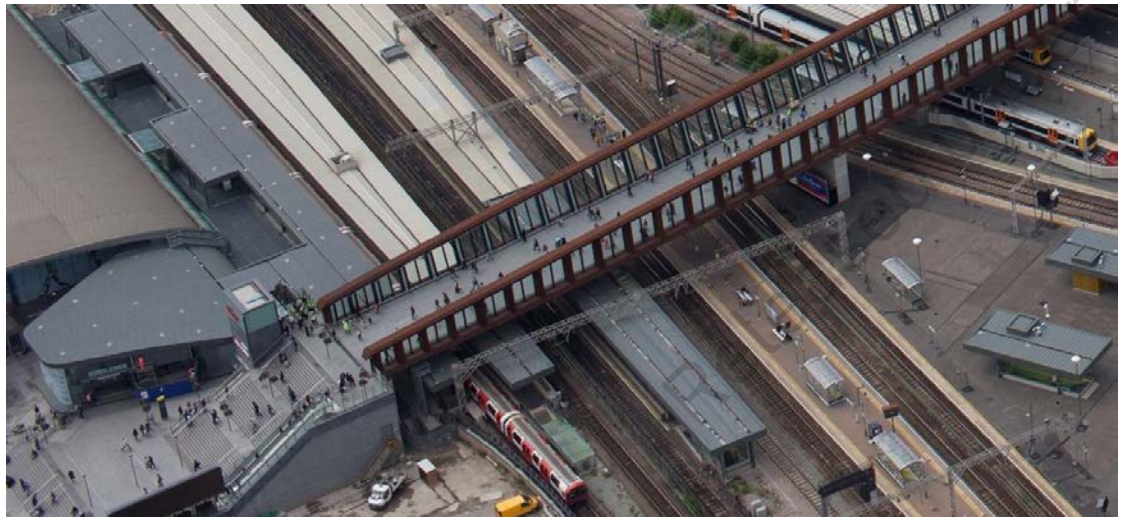
Benchmark Comparisons – Bridge Forms



2022 RNE STUDY

Breakfast Creek Green Bridge, Brisbane (exp 2024) (Credit: Brisbane City Council)



Stratford Town Centre Link (2010) London (Credit: 5th Studio)

Kangaroo Point Bridge, Brisbane (exp 2023) (Credit: Brisbane City Council)

Benchmark Comparisons – Bridge Forms

	2022 STUDY	Stratford Town Centre Link	Breakfast Creek Green	Kangaroo Point
Type and location	Multi-span Through Truss. Crossing railway corridor	Continuous Through Truss. Crossing railway corridor (& station)	Single Span Arch. Crossing river	Cable stay with approach spans. Crossing river
Approx. dimensions	~110 x 5.5m	~130 x 12m	80 x 5m	470 x 6.8m
RNE site applicability		Constructed in constrained urban environment Launched to minimise lifting/cranage needs	Potential to span corridor. Would require temporary construction piers within Rail Corridor	Bridge stayed from central pier. Requires significant pier/pile cap in the middle of rail corridor.

Conclusion

A detailed benefits assessment and business case is required.

Connect the North and South Eveleigh communities	✓
Provide local permeability across the rail corridor	✓
Safe	✓
Comfortable	?
Convenient	?
Provide time savings for pedestrians and cyclists	?

Accessible	✓
Sustainable	!
Sympathetic to the industrial heritage of the area	!
Connection to Country	✓
Value for Money	!
Facilitate an Innovation and Collaboration precinct	✓

ARUP

6 August 2023

Mr Mark Reynolds
Senior Development Manager, Redfern-Eveleigh
Infrastructure and Place
Transport for NSW
E: mark.reynolds2@transport.nsw.gov.au

Dear Mark

RE: Pedestrian Bridge Heritage Assessment, ERW.

I am writing in response to your request for a review of the potential heritage impacts associated with the proposed 'Pedestrian Bridge Alignment D', which to date, is understood to be the only current viable alignment to allow for pedestrian access between North Eveleigh and South Eveleigh, as outlined in Figure 1, below.

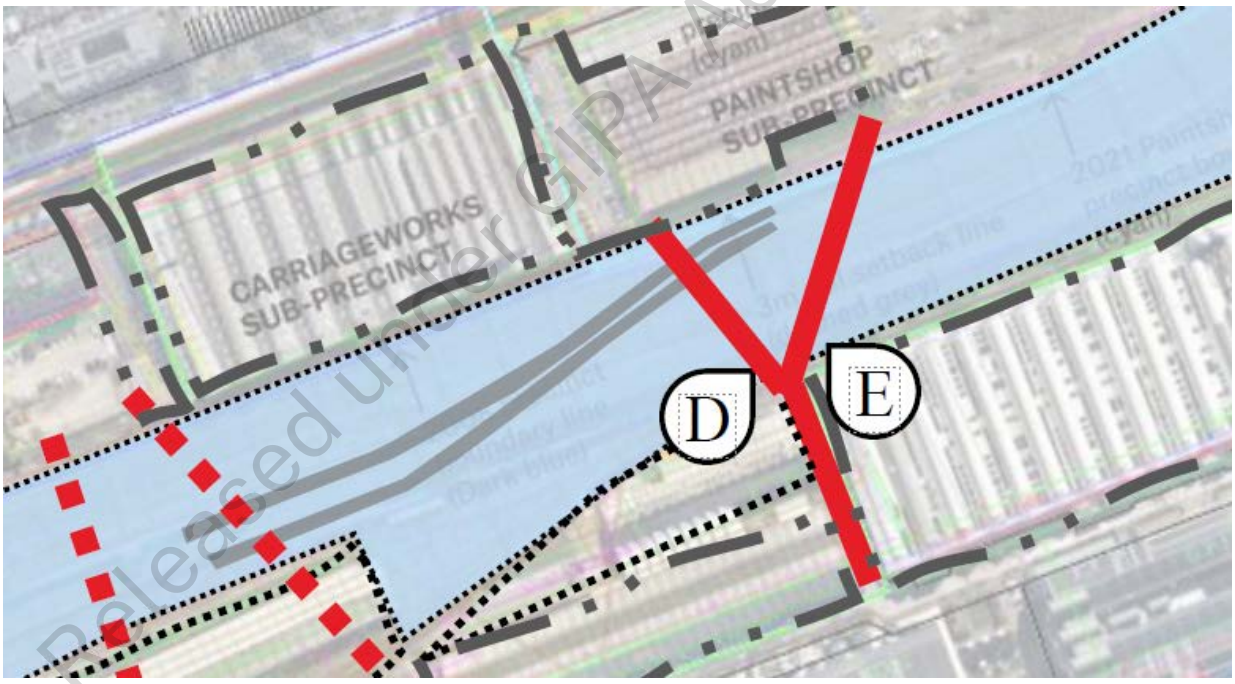


Figure1.0: Proposed Alignment of the Pedestrian Bridge between North & South Eveleigh, noting that Option E has been identified as not viable. (Image Source TfNSW).

It is understood that Option E, shown in Figure 1.0, above, has been discounted as an alignment option as Arup have identified that, after checking the inground services there is no mid rail corridor space available for the required pier support.

Background & Site Context

The following site context and background information has been extracted from existing Curio heritage reports for ease of reference and to provide the overarching context only. It is not intended to represent a comprehensive history of the site.

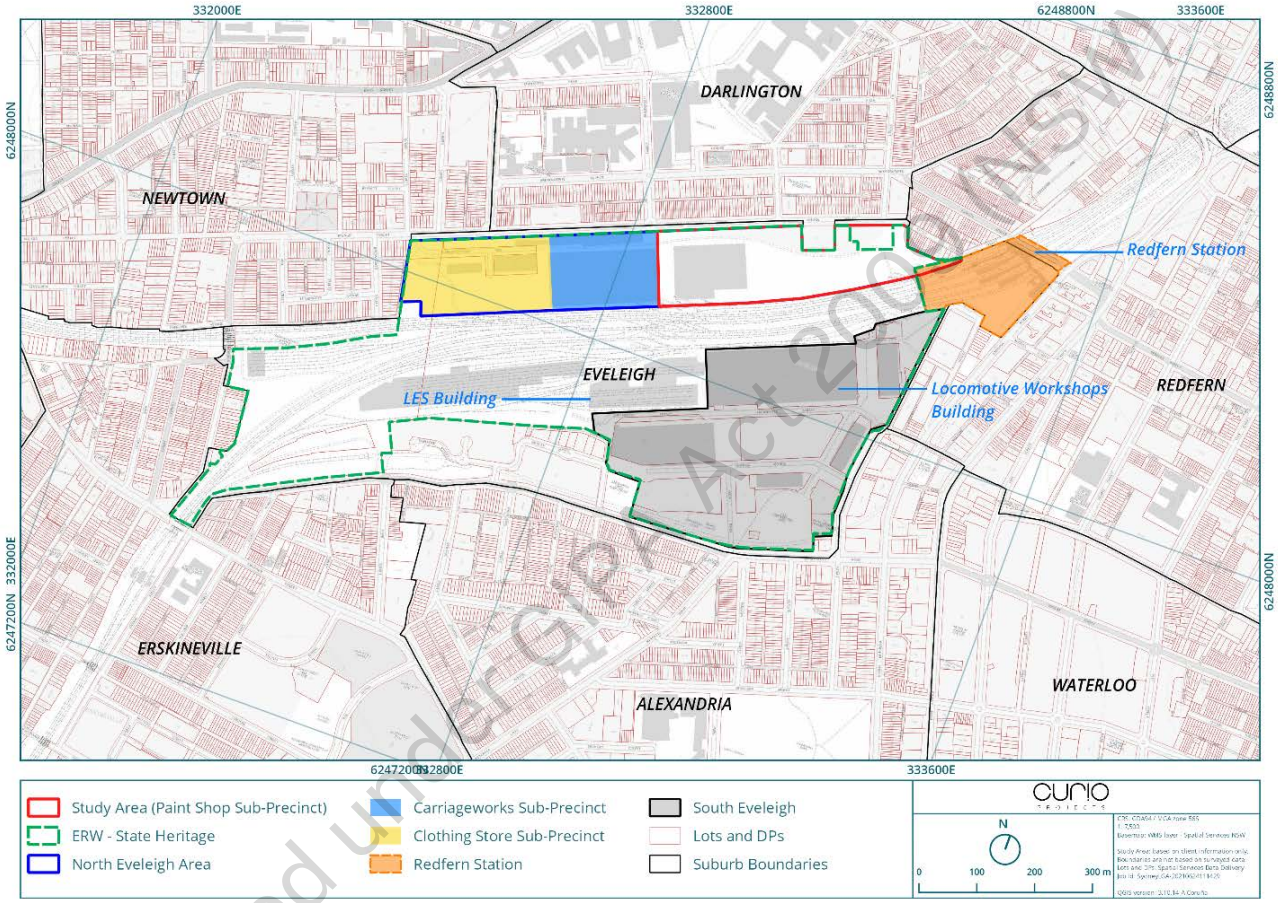


Figure 1.1: Overarching context of North Eveleigh and Sub-Precincts (Source: Curio 2021)

Figure 1.2 Aerial photograph of the general zone of impact for the proposed Pedestrian Overbridge Alignment Option D highlighted in yellow. (Source:GoogleEarth Maps[1] accessed on 6.08.2023, with Curio amendments).

Eveleigh Railway Workshops (ERW)

The construction and opening of Sydney's first railway line in 1855 from Sydney to Parramatta was followed by rapid demand for, and growth of, rail infrastructure and transport in the second half of the nineteenth century. It soon became apparent that the small group of rail workshops at the original Sydney Terminal yards would no longer be sufficient to sustain the maintenance and operational needs of the NSW's burgeoning rail fleet, and that establishment of a new and expanded government-owned maintenance facility was required. Planning for the ERW commenced in 1875, followed by the resumption of the Chisholm Estate in 1878, excavation and land leveling in preparation for construction of the workshop facilities in the early 1880s, and construction of the main workshop buildings commencing in 1885.

The ERW opened sequentially throughout 1887 as buildings were completed: first with the opening of the Locomotive Workshops on the southern side of the railway line, (Bays 1-4 opening first closely followed by Bays 5-15), and later in the same year the opening of Bays 16-25 of the Carriage Workshops on the northern side of the railway line (Figure 1.1 and Figure 1.8).

The operation of the ERW was divided into two main sections: the Locomotive Workshops (south) and the Carriage Workshops (north). The rationale behind the split of the complex to either side of the rail line was to allow both the Locomotive and Carriage Workshop facilities to interact

[1] https://earth.google.com/web/search/Carriageworks,+Wilson+Street,+Eveleigh+NSW/@-33.89517038,151.1945697,32.66166877a,336.81330455d,35y,151.3180346h,44.99667874t,0r/data=CigiJgokCaVEAjBsfjJAESCm7_drfjLAGfqs14Xam0dAIRN7V9DN2knA

independently with the central rail line avoiding any interference with rail traffic, while still allowing sufficient communication between the two workshops as part of an integrated whole.[2]

Redfern Station

The first 'Eveleigh Station' was constructed by NSW Railways in 1876, named after the nearby Eveleigh House, and was located 200 metres to the west of the current Redfern Station (i.e., approximately consistent with the location of Platform 1 of Redfern Station today). The second Eveleigh Station (the current Redfern Station) was built in 1886-87 and officially re-named Redfern Station in 1906.

The station was extended multiple times from 1891 until 1925 with the addition of new platforms and the construction of a footbridge at the southern end of the platform allowing access to the Eveleigh workshops from the station for workers. The footbridge was key in connecting both North and South Eveleigh and created a pedestrian thoroughfare for Eveleigh workers walking between the workshops and the Station as part of their daily commute to work (Figure 1.3).

The functional connection between ERW and Redfern Station significantly influenced the development and growth of Redfern Station throughout the years of function of the ERW. These influences remain most visible today at the southern end of Platform 1 (overlapping function between the Platform 1 Office, Elston's Sidings, and the Carriage Workshops), and in the general growth of the station that was required to manage and adapt to its primary use throughout the late 19th and 20th centuries by the ERW workforce (Figures 1.4-1.7)

Figure 1.3: Southern footbridge across railway at Redfern Station, connecting North and South Eveleigh (Source: State Rail Authority Archives, State Archives NSW, NRS21573_2_PR000642_c)

[2] OCP Architects 2017a

Figure 1.4: View from Cornwallis Street across rail line to the south eastern end of Carriage Works. South Eveleigh Work Managers Office and Water Tower in foreground, undated (Source: OCP CMP 2002)

Figure 1.5 Footbridge viewed from Redfern Station looking towards the Locomotive Workshops. Image title School children arriving and leaving Redfern Station – Royal Tour, 25.02.1952, (Source: State Archives NSW NRS-22469-1-1-H540162).

Figure 1.6 1983 Photocard of the footbridge taken from the North East looking towards MacDonaldtown, Locomotive Workshops to the left.

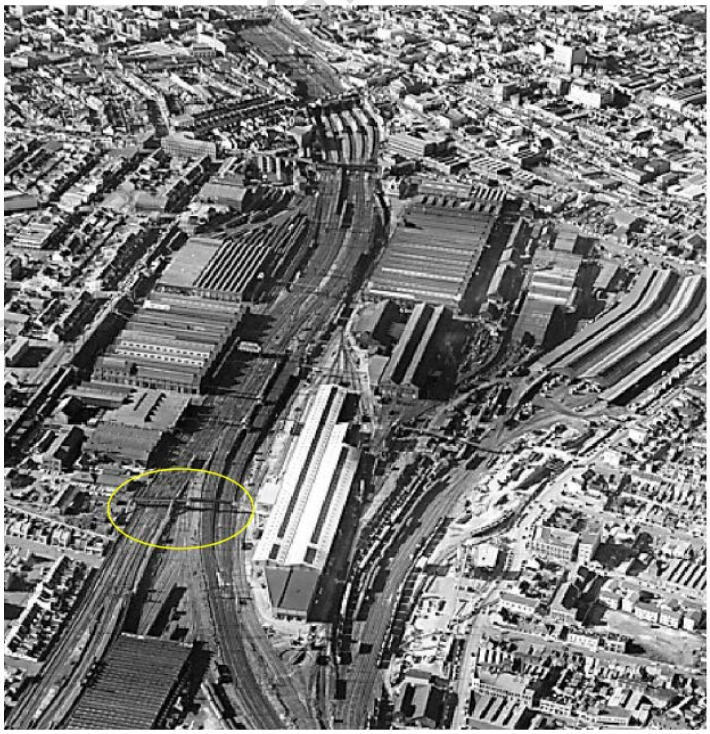


Figure 1.7 Aerial View showing the footbridge and traffic crossings, with Carriageworks located to the right Locomotive Workshops to the left, with the pedestrian footbridge circled in yellow. (Source: Mitchell Library, State Library of New South Wales (1012320)).

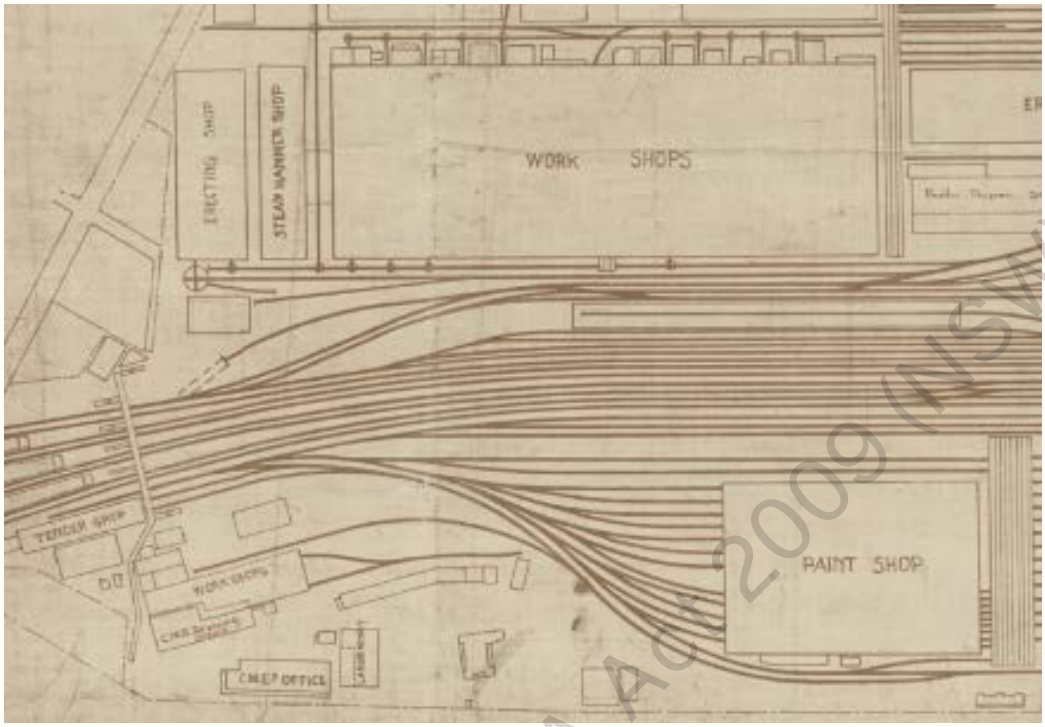


Figure 1.8 : Detail from NSWR Plan of Eveleigh Yard, Dated 8.9.1924 (Source: SLNSW Z/SP/E12/3, https://collection.sl.nsw.gov.au/digital/PpDwGz3V0WRVl)

Traverser No.1

The first traversers within the North Eveleigh Carriage Workshops site were installed in Bays 17 and 23 of the Carriage Workshops building. These original steam-driven ground traversers were removed from the Carriage Workshops Building in 1901 and 1902, replaced by new external electrical traversers installed at either end of the Carriage Workshops building.[3]

The Traverser at the eastern end of the Carriage Workshops came to be referred to as Traverser No.1, running on six rail lines between the Paint Shop and Carriage Workshop buildings (Figure 1.8) The six rails of the Traverser extend on a north- south orientation between the two buildings, along which the traverser moved whilst transporting carriages to their allocated spots for work. In 1969, the current traverser was installed which remains in situ adjacent to the rail corridor along the southern boundary of the Precinct.

The 2002 CMP describes Traverser No.1 as:

> *Traverser No. 1 runs on six rails between the Paint Shop and the Carriage Shops. The rear axle drives six wheels at the front. The traverser motor is a Crompton Parkinson, 400-440 volts, which operates at 950 revs and is 50 horsepower. A dog clutch can engage either the drive system or a capstan, which is mounted on the centre line of the traverser. The capstan can be used for towing train carriages to the traverser via*

[3] Godden 1990: 71

cable, which runs from the capstan around pedestal wheels, set immediately in front of it. The pedestal wheels are frozen.

There are two cabins mounted on the traverser, one on either side of the centre line. The operator's cabin is to the east and a small storeroom is mounted to the west. The central section between the two cabins is roofed with corrugated iron on a timber and steel frame. The traverser is operable, and it appears to be in poor condition structurally. The traverser was altered when relocated from Yennora. Wings each side are supported on their inner face by being attached directly to the main section and on its outer face there are four small unflanged wheels, two wheels on either side of the two rails.

The traverser runs on three overhead wires and is connected to these via three trolley poles with wheels. It is possible to disconnect the wiring, simply by winding short lengths of rope which would disconnect the wheel of the pantograph from the overhead wires.[4]

'The traversers played an essential role in moving vehicles into and out of the work bays in the main building and the Paint Shop. Carriages were moved on and off the traverser using tractors, steam engines and powered capstans with ropes.[5]'

Bogies would be stored adjacent to the western façade of the Paint Shop next to the traverser and short rails are still found in this location (Figures 1.13-1.15).[6] Rail motors would also be stored adjacent to Traverser No.1.

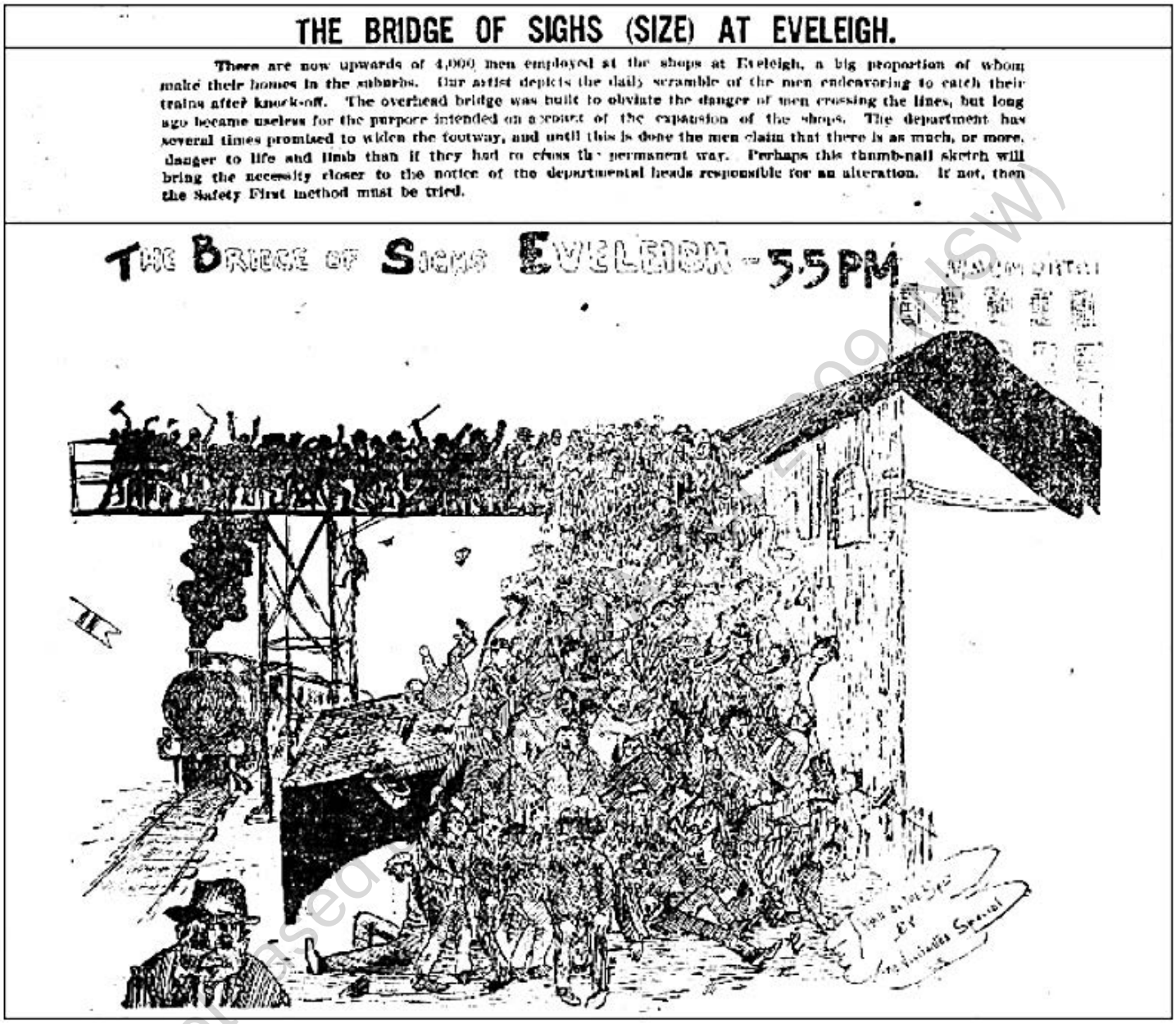
The open space between the Paint Shop and the Carriage Workshop buildings, where Traverser No.1 is located, was also likely a common location for meeting or gatherings of large groups of people. For example, "the corned beef rush during the 1917 railway strike" as seen in Figure shows a queue of workers lined up in front of the Traverser No.1 control box, possibly striking workers receiving food handouts from the union.[7]

The trolley itself was replaced by a more modern one which was relocated from Yennora in 1971 which ran on 600w DC power including two overhead wires. Traverser No.1 is still in near operational condition between the Paint Shop and Carriage Workshop buildings.

[4] OCP CMP Vol 1, 2002: 237
[5] OCP 2002a, Vol. 1: 110
[6] ibid.
[7] ibid: 96

Figure 1.9: Traverser No.1 at the Eveleigh Carriageworks c.1937 carrying a 400 class Rail Motor (Source: SRAO)

Figure 1.10: Photograph taken outside of Traverser No.1 during "the corned beef rush during the 1917 railway strike" (Source: ML Videodisk "At Work and Play", the Sam Hood Collection)



THE BRIDGE OF SIGHS (SIZE) AT EVELEIGH.

There are now upwards of 4,000 men employed at the shops at Eveleigh, a big proportion of whom make their homes in the suburbs. Our artist depicts the daily scramble of the men endeavoring to catch their trains after knock-off. The overhead bridge was built to obviate the danger of men crossing the lines, but long ago became useless for the purpose intended on account of the expansion of the shops. The department has several times promised to widen the footway, and until this is done the men claim that there is as much, or more, danger to life and limb than if they had to cross the permanent way. Perhaps this thumb-nail sketch will bring the necessity closer to the notice of the departmental heads responsible for an alteration. If not, then the Safety First method must be tried.

Figure 1.11 Co-operator (Sydney NSW 1910-1917), Thursday 16 March 1916, page 1.

Figure 1.13 :Southern view of Traverser No.1 between the Paint Shop and Carriageworks with the Channel 7 building in the background (Source: Curio 2021)

Figure 1.14: Southern view of Traverser No.1 (Source: Curio 2021)

Figure 1.15: Western view of Traverser No.1 with Carriage Workshops in the background (Source: Curio 2021)

Views to and from South Eveleigh (View 2)

The view lines and vistas from Traverser No.1 to South Eveleigh still showcase a strong and significant visual connection between both precincts which was established in the beginning of the ERW history.

From the southern extent of the Chief Mechanical Engineer's building, there is a significant heritage view line across the Paint Shop Sub-Precinct towards South Eveleigh. This view was critical to the function and management of the overall ERW complex, as it is from this vantage that the Chief Mechanical Engineer could monitor and have a key view across the entire ERW precinct.

From the northern extent of Traverser No.1, the LES and Media City building across the railway line to the south are in view (Figure 1.16 and Figure 1.18). The closer a person moves to the southern extent of Traverser No.1, more of the Eveleigh Locomotive Workshops building becomes visible (Figure 1.17). The full extent of the Locomotive Workshops is visible across the main rail corridor from the vantage point at the southern boundary of the Traverser corridor.

Another significant view line from the site to South Eveleigh is located from the western edge of the Trackfast Depot on the Wilson Street level looking south towards the Locomotive Workshops and newly built Commonwealth buildings.

Figure 1.16: Southern view of Traverser No.1, Carriage Workshop and Paint Shop with a view line to South Eveleigh (Source: Curio Projects)

Figure 1.17: South Eastern view from the southern end of Traverser No.1 with South Eveleigh and the Locomotive Workshops in the background (Source: Curio Projects)

Figure 1.18: Southern View from Traverser No.1 with the Carriage Lifting Crane in the foreground and the LES building and Channel 7 building visible in South Eveleigh (Source: Curio Projects 2021)

Views within North Eveleigh Precinct (View 4)

The visual connection of the Paint Shop Sub-Precinct to the rest of the North Eveleigh Precinct highlights the relationship between each area (Figure 1.20)

The western perimeters of the Paint Shop Sub-Precinct, which abuts the Carriageworks Sub-Precinct (Figure 1.16 and Figure 1.20**Error! Reference source not found.**) includes a key view west between t he Carriage Workshop and Blacksmith Workshop down Carriageworks Way to the Clothing Store Sub-Precinct (Figure 1.19). This view line would have been important during the running of the ERW for communication between workers across the main workshops and stores in the precinct.

Figure 1.19 Looking west down Carriageworks Way towards the the Clothing Store Sub-Precinct (Source: Curio Projects 2021)

The Carriage and Wagon Superintendents office was located where the Carpenters Plumbers and Food Distribution building is currently located on site just north of the Former Suburban Car Workshops and west of the Compressor House. From this office, the Carriage and Wagon superintendent would have had the best view east, south and west. West towards the Clothing Store Sub-Precinct, south towards the Paint Shop, Traverser No1, and the Carriage Workshop, and east towards the Telecommunications Equipment Centre, Fan of Tracks and other key elements contributing to the function of the ERW.

Figure 1.20: Southern view of Traverser No.1 and South Eveleigh in the background (Source: Curio 2021)

Figure 1.21 Southern view towards Traverser No.1 and the railway line on the abutting the southern boundary of the subject site (Source: Curio 2021)

Figure 1.22: South eastern view along the southern boundary of the subject site south of the Paint Shop and Carriage Lifting Crane (Source: Curio 2021)

HIS Conclusions Regarding The Traverser – Masterplan

The Curio HIS which accompanied the recently approved Masterplan concluded that:

Positive outcomes of the masterplan with respect to physical impacts to heritage fabric include the retention and adaptive re-use of key items of exceptional and high heritage significance including the Paint Shop (including southern annexe and in situ carriage lifting crane), former Suburban Car Workshop/Paint Shop Extension (partial retention), Chief Mechanical Engineers Building, Scientific Services Building No. 1, and Telecommunications Equipment Centre. Other heritage features and fabric proposed for in situ retention (final details subject to future detailed design) include the traverser corridor and Traverser No. 1, sections of the brick retaining wall, fan of tracks (partial retention), remnant footings of former pedestrian footbridge, and sections of the Skipping Girl fence.[8]

[8]Curio Projects, RNE Precinct Renewal—Paint Shop Sub-Precinct | Non-Aboriginal Heritage Study (FINAL DRAFT), December 2021

Assessment of Proposed Pedestrian Bridge Overbridge Alignment Option D

It is understood that the underside of the pedestrian overbridge structure needs to be 9 metres clear of the rail tracks. Therefore, to create the 9 metre clearance required, the Southern stair tower will need to be approximately 15 metres in height (~5 stories), and the Northern stair tower will need to be approximately 9 metres in height (~3 stories). The two options for Alignment Option D are:

- a pedestrian overbridge with ramp, and
- a pedestrian overbridge with stairs and lifts, no ramp.

Impacts to Traverser No. 1

Both concepts will require the removal of Traverser No. 1 to enable the installation of the North Eveleigh piers and pedestrian bridge entry point from North Eveleigh. This would be a major physical, visual and relational impact on the Eveleigh Railway Workshops (ERW) for the following reasons:

1. The recently approved masterplan was designed to ensure that the physical fabric of the traverser was conserved, interpreted and maintained insitu with sight lines protected, given it's significance in terms of it's pivotal role within the ERW precinct and it's rarity, in terms of being only 1 of 2 traversers left insitu within the ERW site that can demonstrate the former functionality of the site and the important role of the traverser as a key functional element for the transportation and relocating of locomotives on site in this exact location.

   In particular, despite the poor current condition of the fabric of the traverser, the ongoing physical and visual relationship between the railway line, South Eveleigh, Traverser No.1, the Paintshop and Carriageworks was considered significant enough to require retention within any redevelopment of the site as part of the masterplanning process. This was supported by both the historical research, the significance assessments in the Conservation Management Plan and heritage studies prepared for the site, and ground-truthed in the multiple stakeholder consultation meetings with Heritage NSW, the NSW Government Architect's State Design Review Panel, Redwatch and other associated stakeholder groups.

2. Options for emergency access routes, greening of the space between the Paintshop and Carriageworks, and/or any type of built form within the location of the traverser itself and/or within the Paintshop-Traverser-Carriageworks central corridor were discounted on the basis that the impacts to both the heritage fabric and views and vistas would lead to an unacceptable and irreversible heritage impact.

3. Recently the displaced Traverser from South Eveleigh was de-acquisitioned (July 2023) and removed from the ERW S170 register of moveable heritage assets after 6 years of protected negotiations with Heritage NSW, TfNSW and Heritage Transport for NSW. The asset was removed from its insitu location between the Large Erecting Shed and the Locomotive Workshop in the 1990s by the NSW State Government to allow for the redevelopment of the site into ATP. It was retained within Bay 10 of the Locomotive Workshops for several years after its displacement and was unable to be relocated anywhere meaningful on site, as its core significance related to location, function and fabric. Several reports were

commissioned to examine its significance and it was concluded that the loss of the functionality and insitu location of the traverser was the core reason for the loss of its significance. Coupled with this, was the agreed position that the remaining Traversers at North Eveleigh, including Traverser No. 1 were more significant due to their insitu retention in their original locations and that their retention was of upmost importance.

Therefore, in all options presented, the removal and/or relocation of Traverser No. 1 to allow for the construction of the North Eveleigh bridge piers and entry is considered to be a major and heritage impact that is unlikely to gain any support from key stakeholders, including Heritage NSW, DPE and the NSW Government Architect's State Design Review Panel.

Option D – with ramps

The proposed alignment of the pedestrian overbridge with an option for access via ramps will require extensive intervention, both physical and visual across both North and South Eveleigh, as highlighted in Figure 1.23 below.

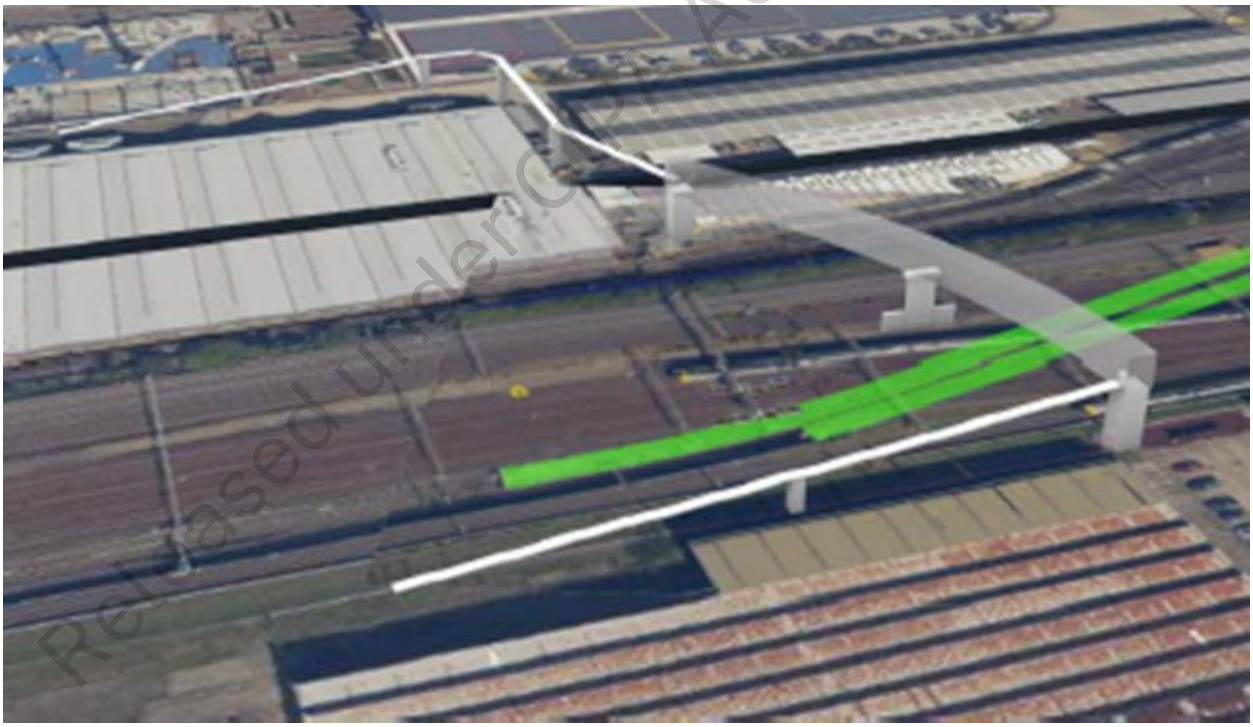


Figure 1.23 Concept of Pedestrian Overbridge Alignment Option D (Source: TfNSW)

This impact whilst having a major detrimental visual impact when viewed from all aspects of the rail corridor, North Eveleigh and South Eveleigh is most detrimental when assessed from the South Eveleigh landing locations. The key visual impacts associated with the required piers and ramp itself would have an irreversible effect on the visual sightlines along Locomotive Street as it runs past the Locomotive Workshops and Large Erecting Shed. The impact on the small green park itself, from a

heritage perspective is negligible, due to the fact that the park is modern and has no historical associations with the use of the site. It would be extremely difficult to mitigate the visual effect of the ramp using materiality and design, given the required bulk and form in order to achieve the.

In addition, whilst pedestrian overbridges were a highly significant part of the functional relationship between North and South Eveleigh, the proposed alignment of Option D with ramps would impact the key historic sightlines along Locomotive Street.

In conclusion from a heritage perspective, the installation of the pedestrian overbridge with entry/exit ramps for cycling and pedestrian access would have:

- a major irreversible physical and visual impact on the location, readability and understanding of one of the last remaining traversers on site, Traverser No. 1 at North Eveleigh;
- a major irreversible physical, and visual impact the significant central corridor and locational/spatial relationship between the Paintshop, Traverser No.1 and Carriageworks;
- a major irreversible impact on significant views to and from and across the railtracks and surrounding precincts; and
- an irreversible negative impact on the visual and physical significance of Locomotive Street and its surrounding streetscape as it relates to the Locomotive Workshops and Large Erecting Shed.

<u>Option D – without ramps</u>

The proposed Option D without ramps, as indicated in Figure 1.24 below has less heritage associated impacts than the ramp option, although the required impacts to Traverser No. 1 as discussed in the earlier sub-sections are considered unacceptable from a heritage perspective, and unlikely to gain Heritage NSW approval.

Any mitigation options that aim to offset the impacts associated with the relocation of the traverser for interpretation in a new location would result in a major impact and therefore, almost full loss of significance for the asset as its' significance is primarily associated with its specific location and representation of the site's former functionality within that specific location.

It is understood that of the options, this option without ramps, is the least desirable option as it does not allow for cycling access and would reduce the pedestrian user experience, however, when assessed in terms of visual impacts to South Eveleigh, and within the whole of the ERW precinct, the physical and visual impacts of this proposal are reduced without the introduction of the ramps to the North and South Eveleigh entry/exit points.

In summary:

- There is heritage precedence for a pedestrian bridge overpass between North and South Eveleigh, with the need for ease of access across the two halves of the ERW site identified as having been important to the functionality and day to day use of the ERW;

- Removal and relocation of Traverser No. 1 is a major heritage impact that is unlikely to gain heritage approvals as it is not commensurate the CMP and heritage studies and does not comply with the carefully thought-out principles installed in the recently approved masterplan for the Paint Shop Sub-Precinct;
- The landing of the Pedestrian Overbridge at South Eveleigh is considered to be appropriate and would not have a major physical and visual impact on the Locomotive Workshops, Large Erecting Shed or immediate surround precinct of Locomotive Street;and
- Depending on design, bulk and scale, the impact of the actual overbridge itself has the potential to have a major irreversible impact on significant views to and from and across the railtracks and surrounding precincts.

Figure 1.24 The proposed concept for the Pedestrian Bridge Overpass Option D without the ramp. (Source: TfNSW).

Conclusions and Recommendations

1. It is considered that the proposed Option D for the bridge, with or without ramps has a fundamental conflict with the landing of the bridge in the Traverser No. 1 location of the Paint Shop Sub-Precinct, from a heritage perspective. The landing of the bridge in this location does not comply with the CMP, Masterplan and would have an irreversible impact on the significance of the Traverser and its importance within the ERW Site.
2. The proposed ramps add an additional level of physical and visual impacts that would be unacceptable from a heritage perspective, as a result of the bulk, landing locations and required associated infrastructure. They would be unlikely to gain Heritage NSW support and/or potential support from the NSW Government Architect's State Design Review Panel.
3. The proposed South Eveleigh landing location without the ramps is considered to have less of an impact on the significance of the ERW site then the introduction of ramps. Notwithstanding this, there is the potential for a major irreversible visual impact on the readability of the rail lines, the rail corridor and the overall precinct via the introduction of the proposed overbridge, due to the height clearance and engineering requirements.

4. An alternative solution to the location of the bridge access point at Traverser No. 1 will be required if the overbridge is to gain heritage approvals.
5. Ramps are not likely to be a viable option in any design solution for the overbridge due to the potential visual and physical impacts.

Should you have any further questions please do not hesitate to contact me at s74 Out of scope@curioprojects.com.au or s74 Out of scope

Yours sincerely,

s74 Out of scope

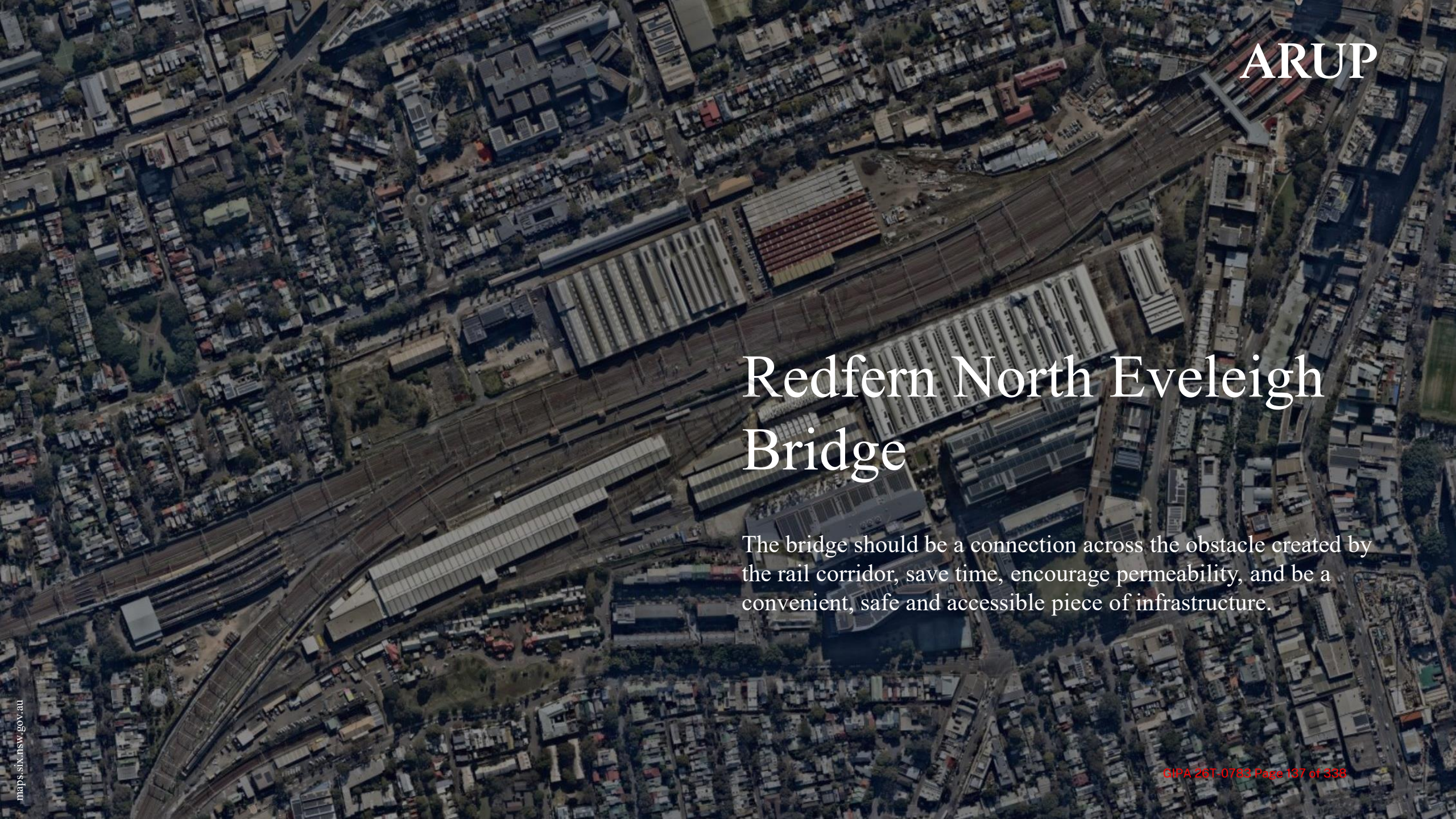
CEO
Curio Projects Pty Ltd.

ARUP

Redfern North Eveleigh Bridge

Feasibility Study

Transport for NSW



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Redfern North Eveleigh Bridge

The bridge should be a connection across the obstacle created by the rail corridor, save time, encourage permeability, and be a convenient, safe and accessible piece of infrastructure.

maps.six.nsw.gov.au

Objectives

What characteristics should the bridge have?

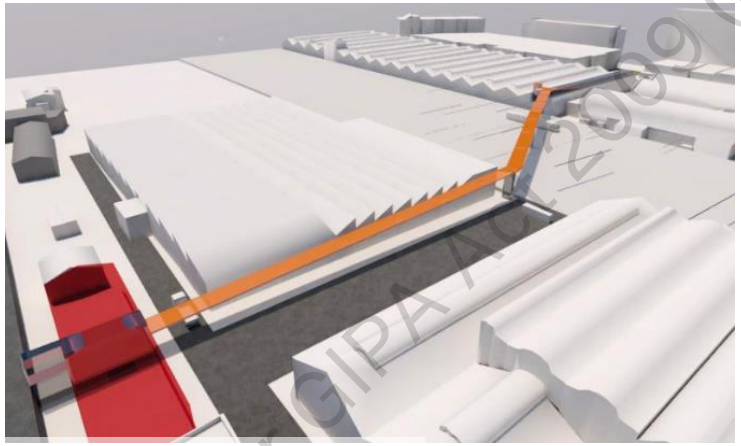
- Connect the North and South Eveleigh communities
- Provide local permeability across the rail corridor
- Safe
- Comfortable
- Convenient
- Provide time savings for pedestrians and cyclists
- Accessible
- Sustainable
- Sympathetic to the industrial heritage of the area
- Connection to Country
- Value for Money

Previous studies

2008 and 2017 Studies for the Carriageworks to Australian Technology Park Pedestrian Link

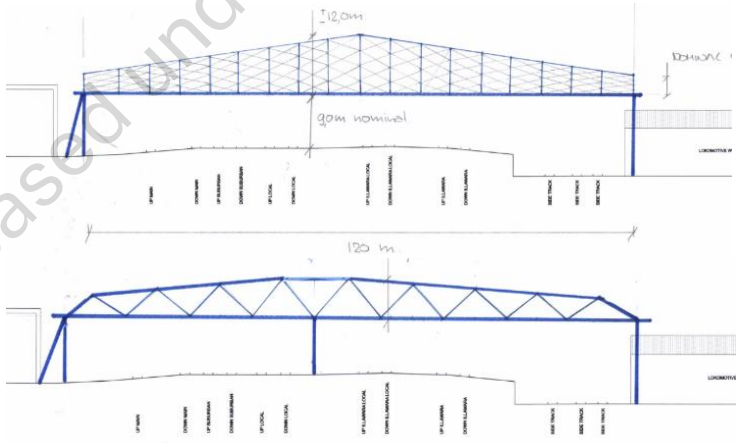
Arup were previously commissioned to review the site constraints including constructability and develop sketches of bridge concepts for preliminary costing. We note that the previous design brief included the requirement to provide DDA ramps (grade 1 in 20) which resulted in substantially longer ramps.

Sites to the east were favoured over the western alignments because the bridge length could be minimized. In addition the siting provided space for a pier at approximately midspan considering the constraints in the rail corridor. As the 2008 study was undertaken prior to the installation of the new Redfern Station crossing, 'duplication' of an existing alignment was not the cause to discount these options. The second platform access bridge at Redfern Station is currently under construction and due for completion in Q1 2023.

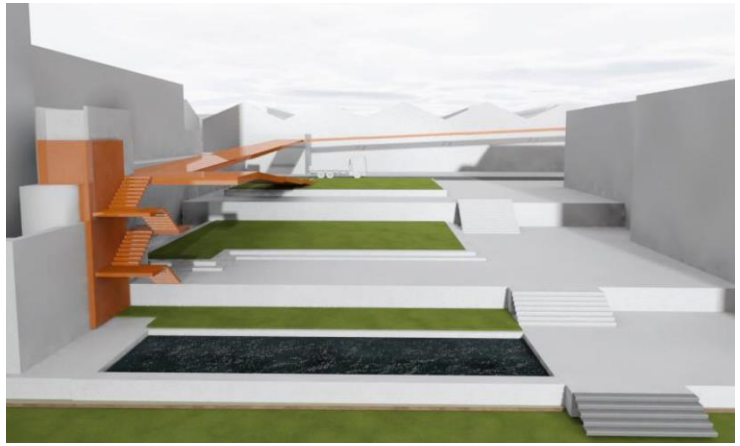


North landing to Wilson Street

South landing option in Locomotive Shed bay



Truss options with pier, clear spans are ~50-120m



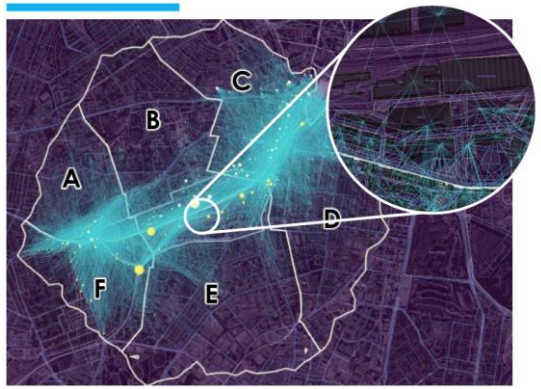
South landing option along village square (between Channel 7 and CBA)

Future demand and travel time savings

Summarised from SCT Consulting, 2021, Bridge Catchment Analysis

Current demand

340-420 journeys per weekday,
53% are less than 1000m in length



Main beneficiaries of the additional bridge are cross-rail corridor journeys to/from:

- Urban residential
- Public services (University of Sydney)
- Commercial (North and South Eveleigh precincts).
- Light industrial and commercial (Waterloo and Green Square)

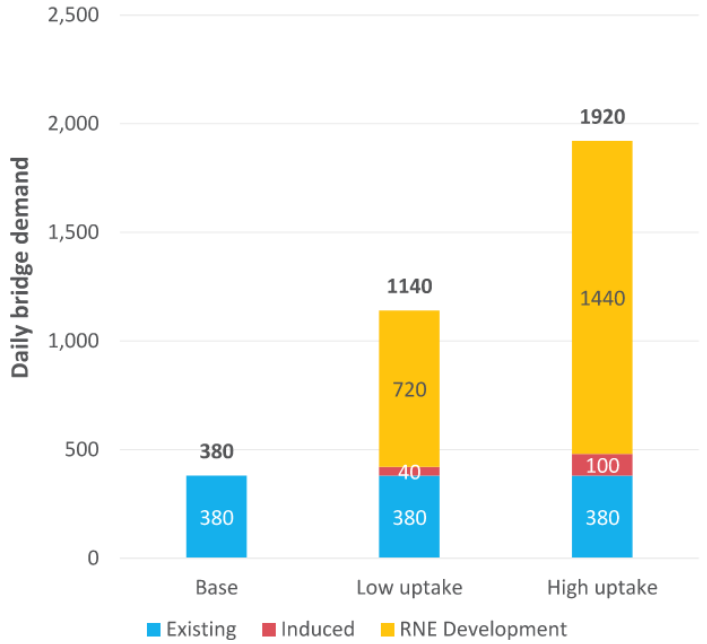
Travel time savings

3-6 minutes per trip

- The average travel time saving is 5-8 minutes (SCT Consulting, 2021).
- This needs to be further reduced to 3-6 minutes to account for time going up and down from the bridge.
- Savings become less pronounced for origins and destinations further away from the bridge.

Future demand

1140 – 1920 crossings per day



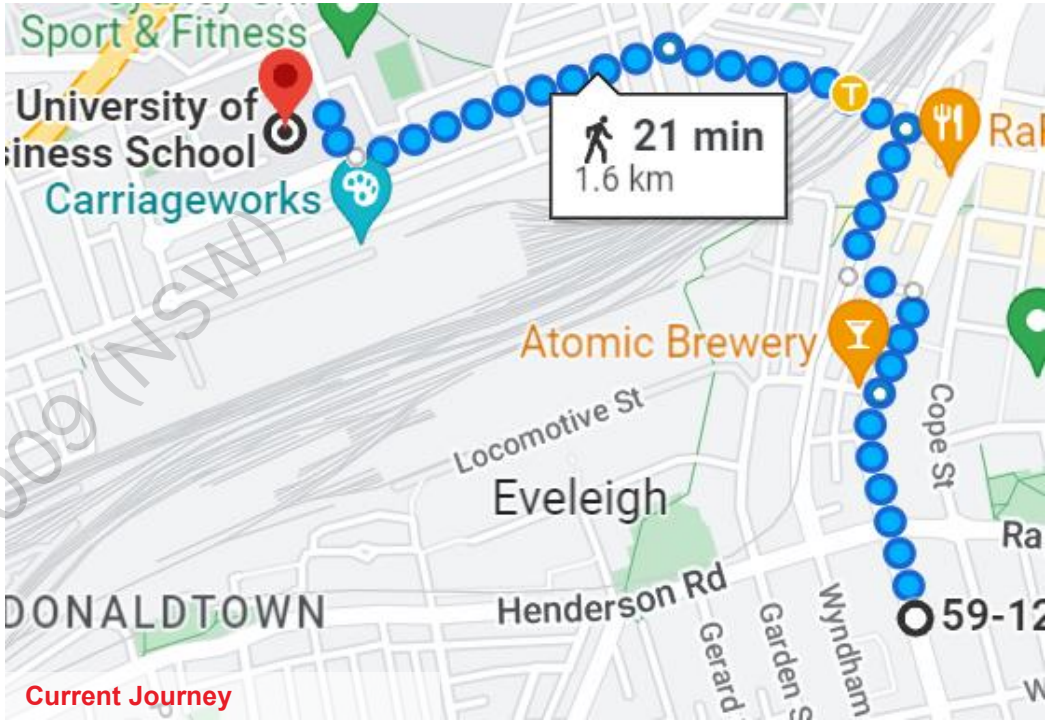
For comparison, George Street, between Albert Street and Phillip Street, Redfern has ~2000 journeys per day on both weekdays and weekends (City of Sydney Open Data Pedestrian Surveys, March 2022)

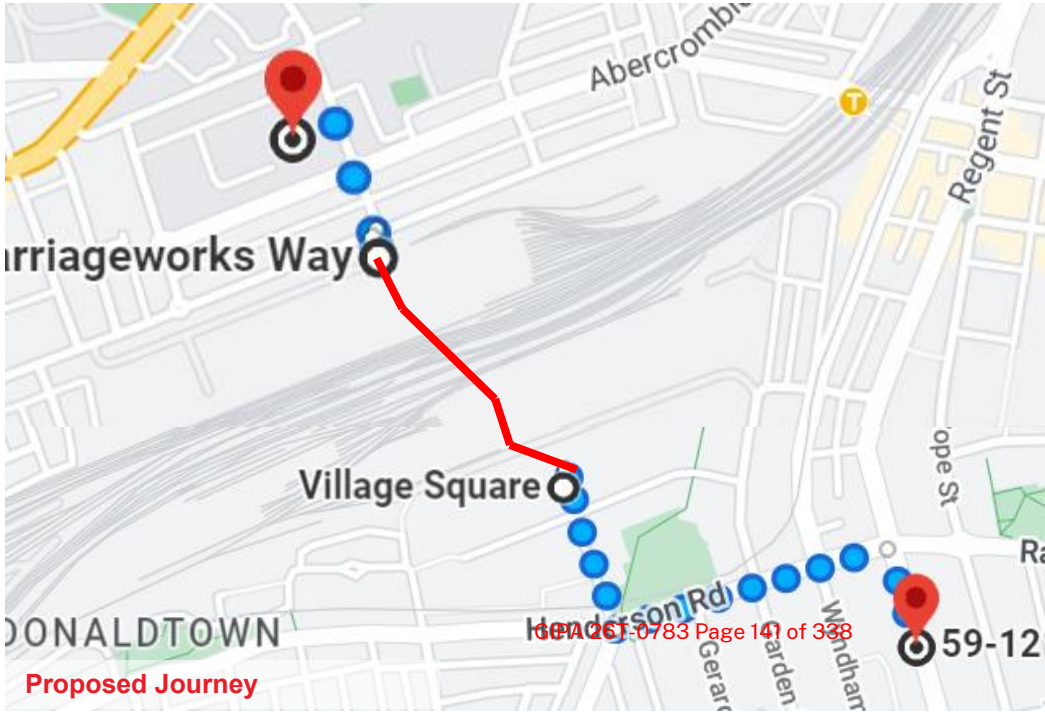
Travel time savings

Example Travel Route from ABS to Waterloo Station

From	University of Sydney Abercrombie Business School (ABS)
To	Waterloo Metro Station

Current journey time:	**21 min**
Proposed journey time:	**17 min**
• ABS to Carriageworks	3 min
• Carriageworks to Village Green via bridge	3 min
• Stairs/Lifts at each end	2 min
• Village Green to Waterloo Station	9 min
Approximate time saving:	**4 min**





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If we did build a bridge, what might it look like?

Bridge alignment options – Where should it go?

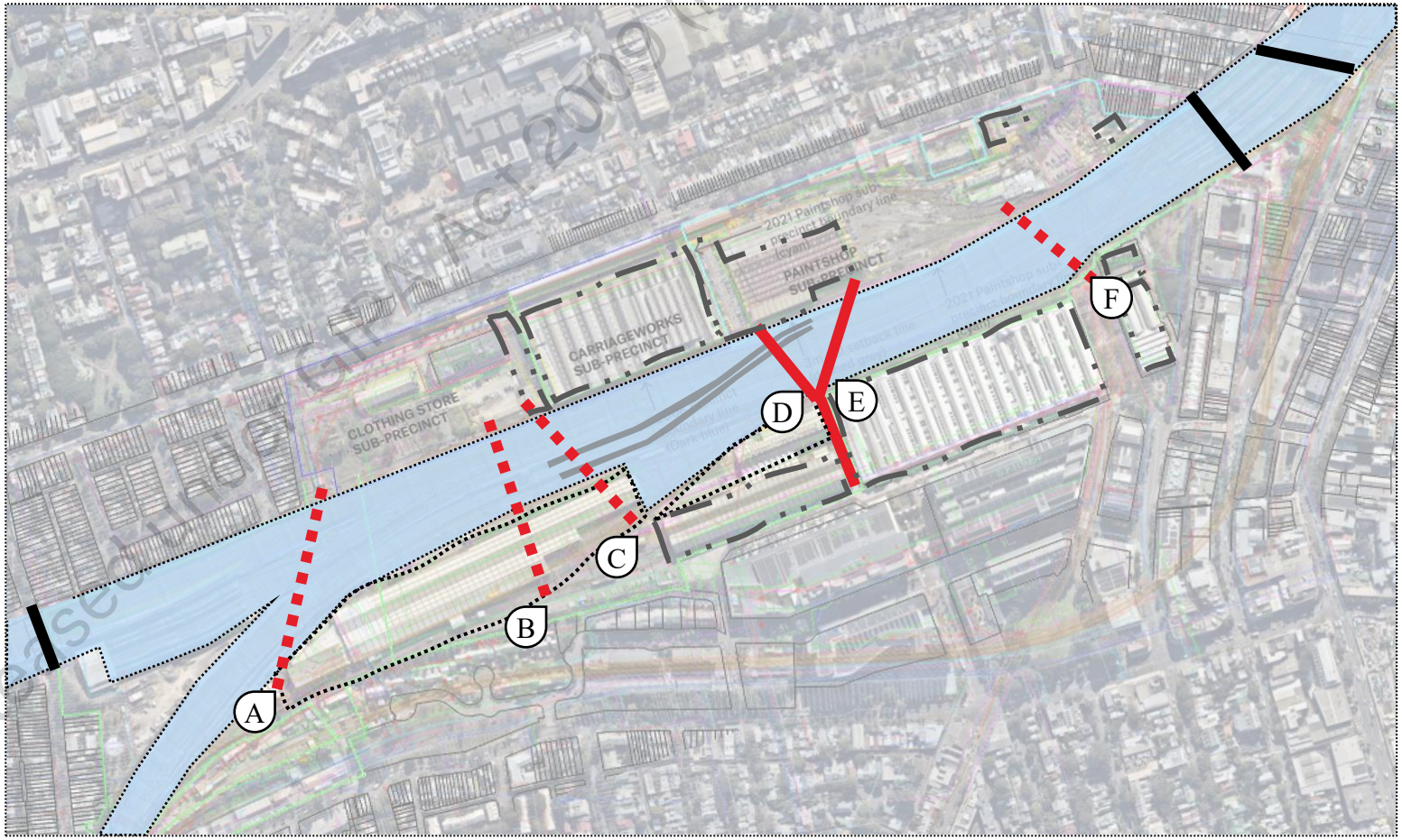
The Carriageworks to LES connection provides the best outcome for permeability. i.e. Alignments D and E.

- Study alignment
- Alternate alignments
- Existing connection

- Minimum 10m clearance height above rail corridor; HV cable, drainage at rail corridor
- Illawarra Dive (tunnel)
- Eveleigh Maintenance Centre
- Heritage

The rail corridor poses significant physical and operational constraints.

Approvals from Sydney Trains will be a pre-requisite for any design or construction activity.

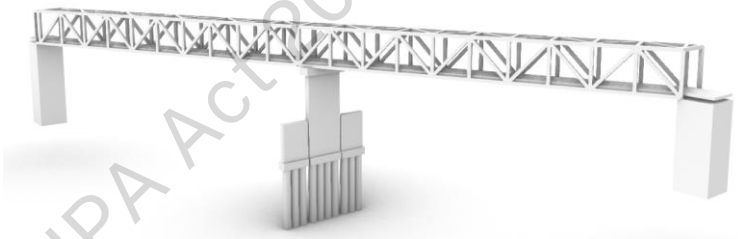
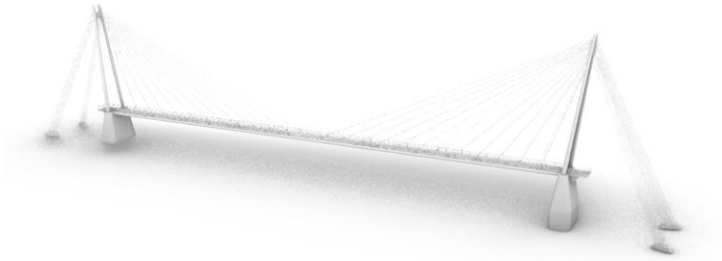


Bridge siting map

Structural Form – What form should the bridge take?

The truss has been selected as an appropriate form for the feasibility study.

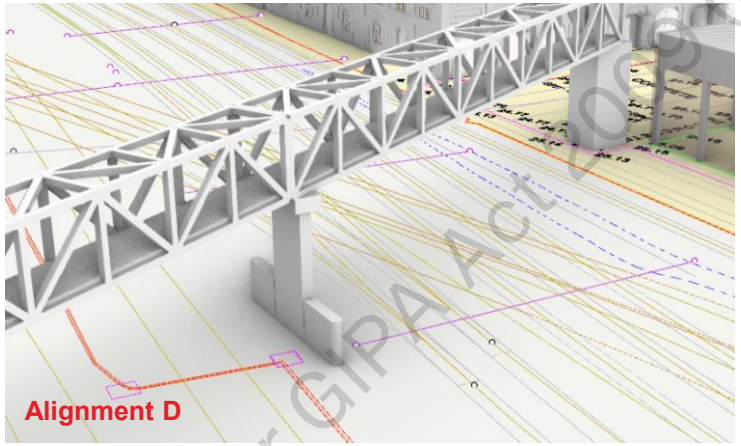
- Access should be through the structure to reduce the elevation required to clear rail assets.
- The structure cannot be 'raised' from the rail corridor but must be craned, launched or pivoted.
- At this stage, focus has been placed on testing a feasible solution and the truss has been selected for that purpose.
- Aesthetics and form will be an important consideration for heritage and Connection to Country.

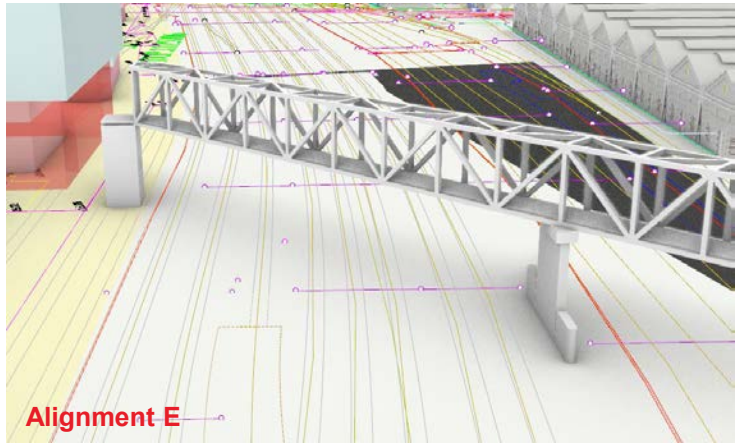
Example structural typologies		Height of spanning structure
Truss		5 – 6.5m
Tied arch		10 – 15m (from tie to highest point of the arch)
Cable-stayed		Pylon height ~25 – 30m

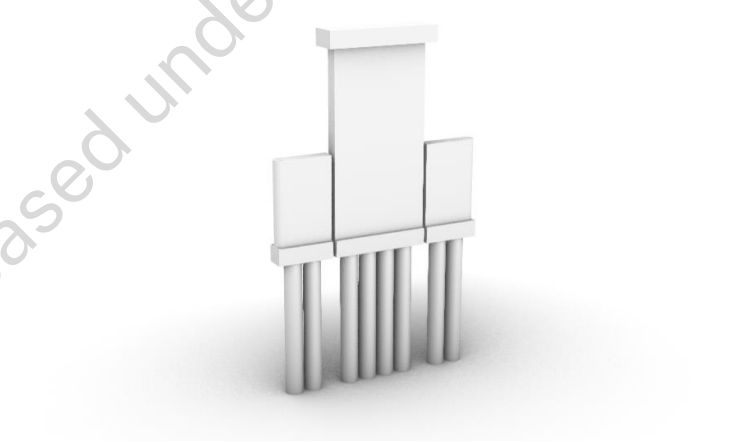
Bridge support in the rail corridor

A pier in the rail corridor is required and needs Sydney Trains approval.

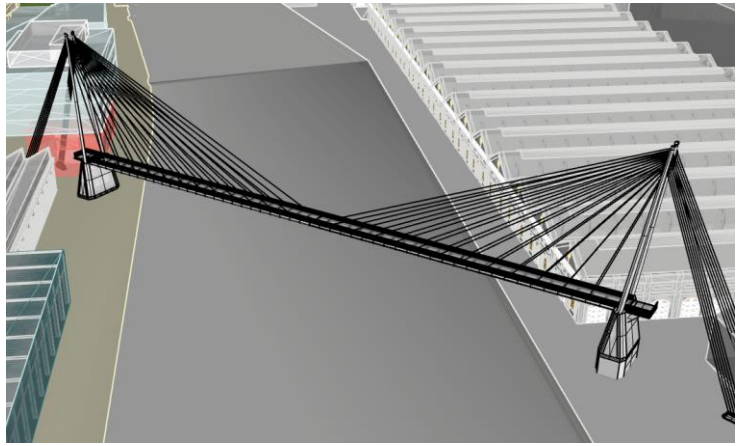
- A pier is required, otherwise the structure becomes very large
- Sydney Trains approval is required to build a pier in the rail corridor
- This section of the rail corridor is a key artery close to Central Station
- Design and construction requirements for the Sydney Trains corridor are very stringent
- Approvals and possession pose a program and cost risk







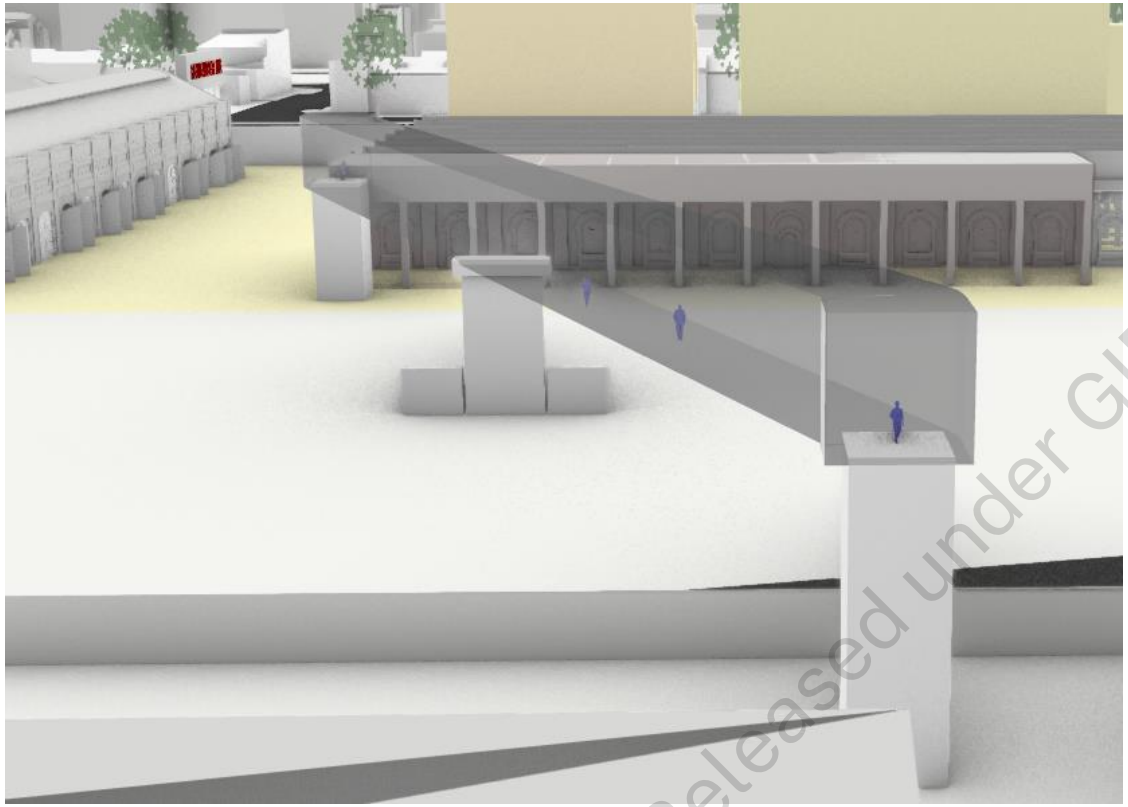
Piles, pile cap, deflection walls and pier



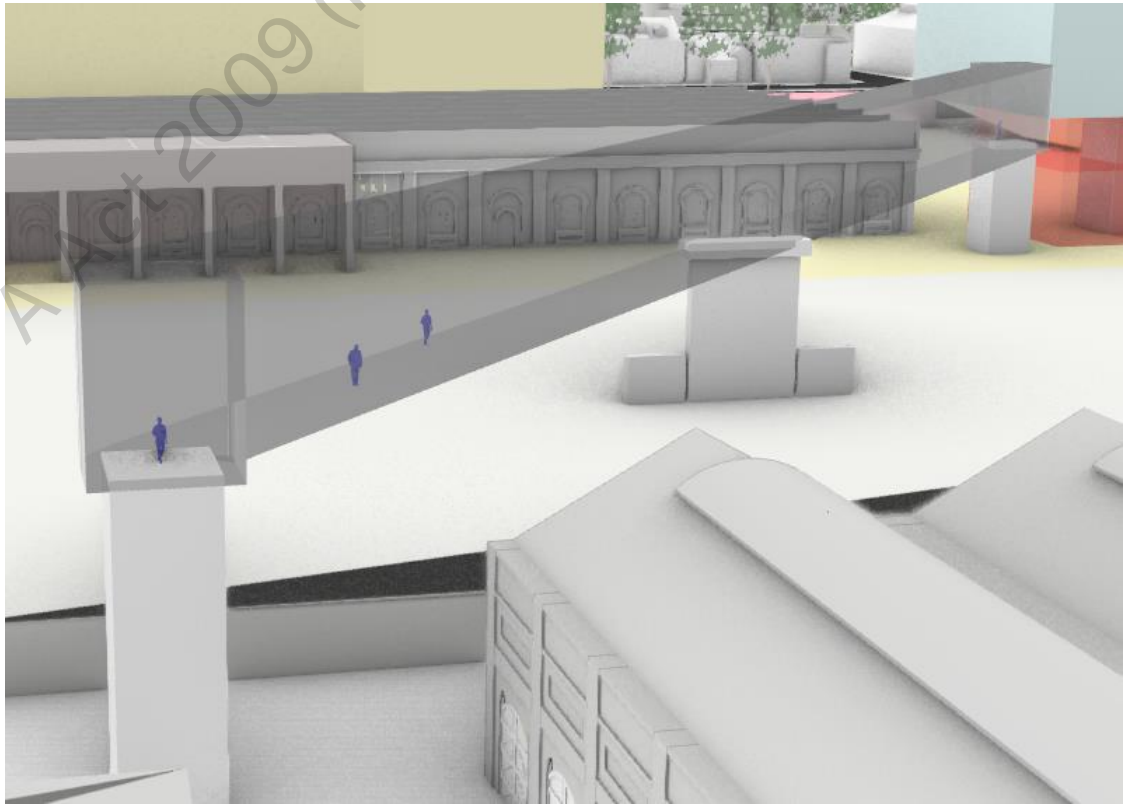
Cable supported bridge clashes with buildings

Bridge size

The bridge will have substantial structural volume.



Alignment D: 5m (W) x 5.5m (H)

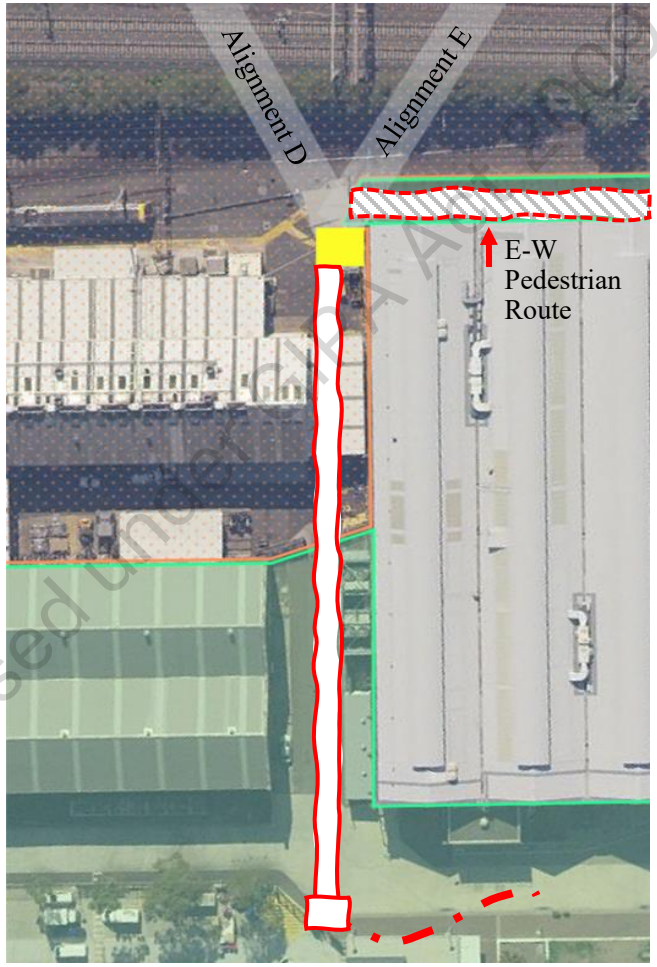


Alignment E: 5m (W) x 7m (H)

Bridge - Southern Abutment

The south landing is complex and will need to comprise of stairs and lifts instead of a ramp.

- An extended deck is required to span over the live maintenance facility.
- E-W pedestrian route interferes with emergency access from the Locomotive Sheds and is not along a desire line.
- Significant engagement and approvals would be required from Sydney Trains.
- A ramp is not appropriate. It would need to be excessively long, and thus would add substantial time and cost due to the size and interfaces.
- At least two lifts will be required for maintenance and to meet demand.



Extended deck over maintenance area

DDA ramp to Village Square (2017 study)

Rail area
Publicly accessible area
Abutment

Pedestrian access
Lift/stairs/deck

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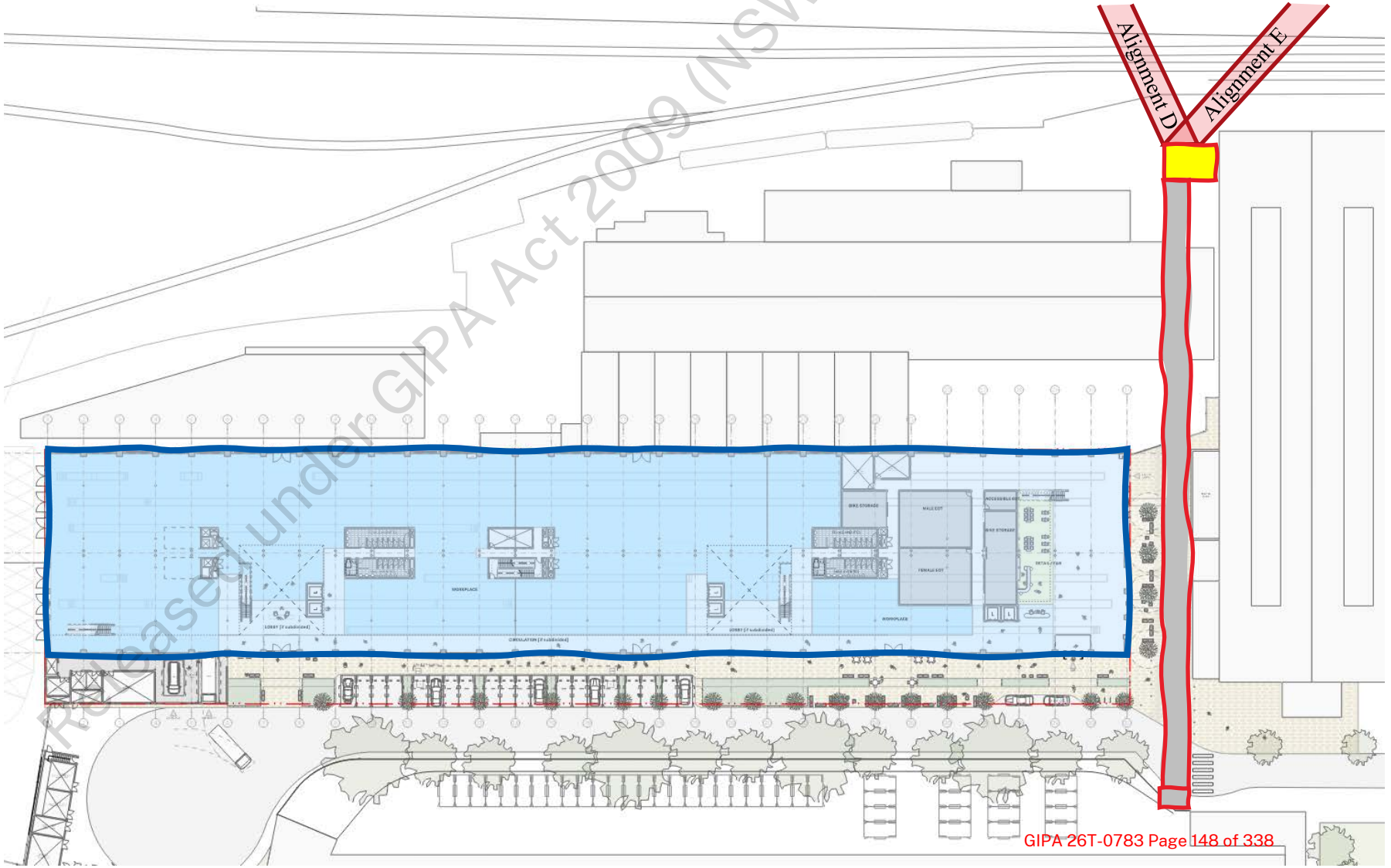
Bridge location in relation to LES building

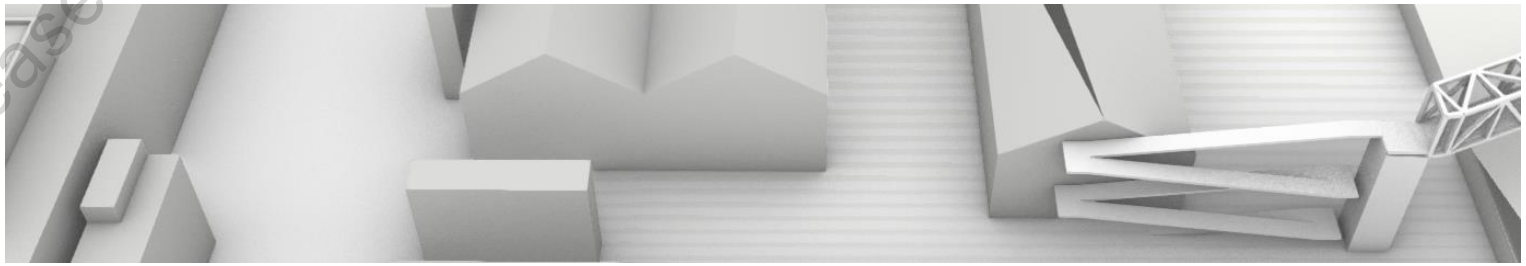
- Bridge Alignments
- Abutment
- Lift/Stairs/Deck
- LES building



Southern ramps

A ramp is not appropriate for the south landing due to the space needed.

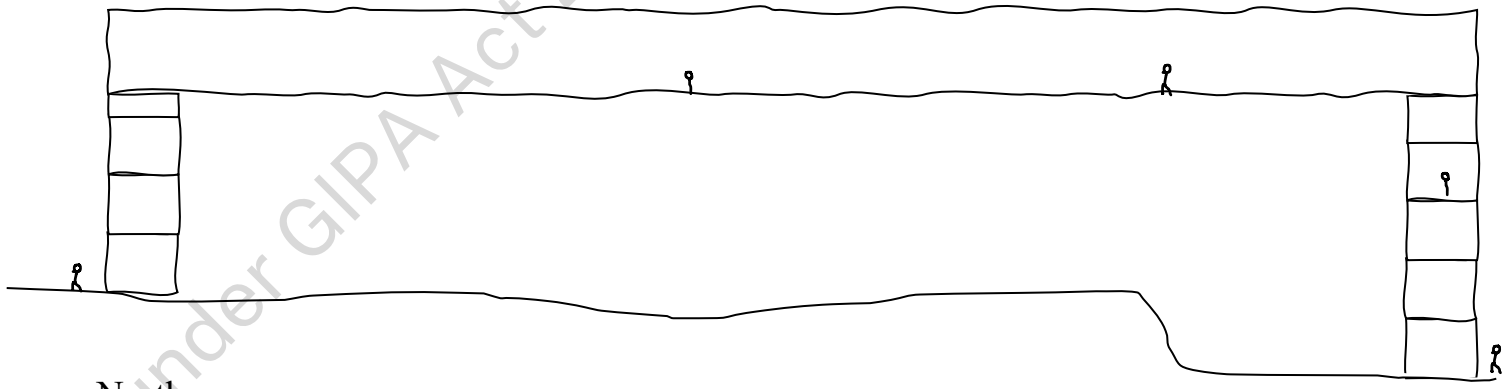
- The substantial changes in level mean a long run is needed.
- E.g. the steepest grade permissible (Grade 1 in 8 cyclist ramp) without rest zones results in a run to the base of the Channel 7 building.
- DDA compliant ramps (grade 1 in 20) would be longer still.
- A long ramp increases the walking time for pedestrians and the number of switchbacks for cyclists to navigate.
- Similar typologies would be applied if ramps were used on the north.



Minimum two lifts at each end

A minimum of two lifts are needed at each end as the stairs are not a convenient means of accessing the bridge.

- The bridge must comply with DDA requirements.
- Stairs alone are not accessible or comfortable for many customers, especially at this elevation.
- E.g. for train stations, 5m is generally where designs start shifting from stairs to escalators.
- Minimum two lifts are required at each end for maintenance and redundancy.
- A staircase is still required in case of breakdowns.



North
10.5m level difference
Approx 3.5 storeys

South
14.5m level difference
Approx 5 storeys

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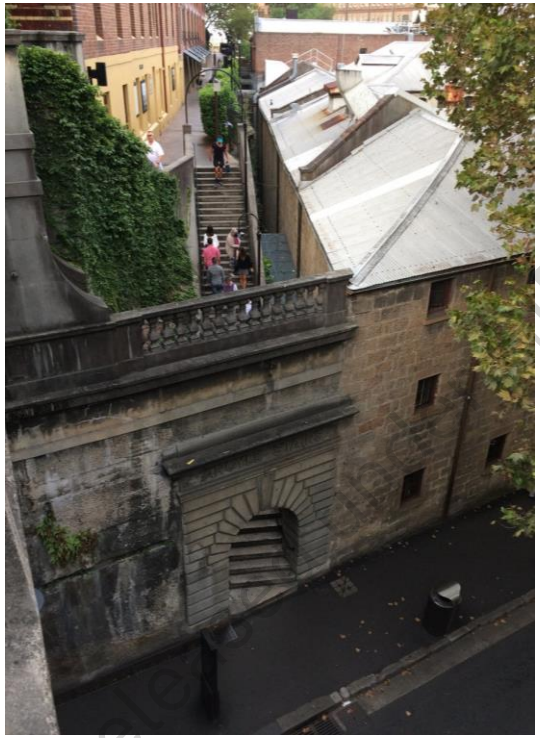
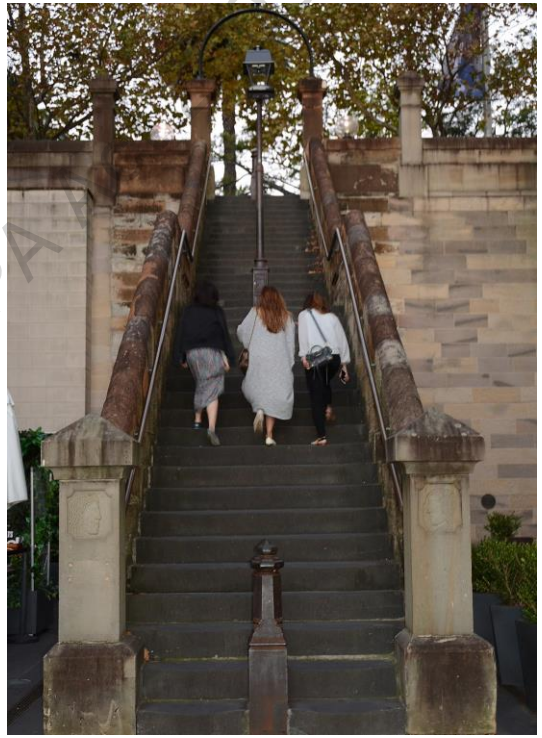
Local comparisons

A minimum of two lifts are needed at each end as the stairs are not a convenient means of accessing the bridge.

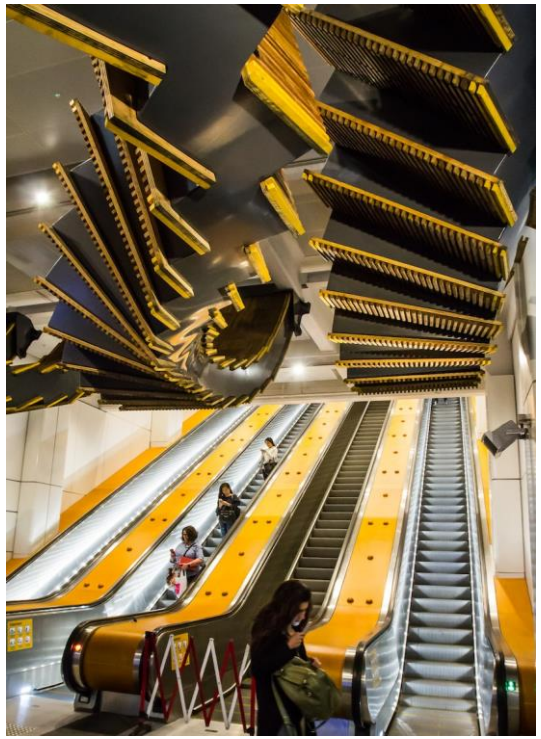
Butler Stairs, from Domain to Woolloomooloo, ~19m



Argyle Stairs, from Argyle Street to Cahill Expressway, ~10m



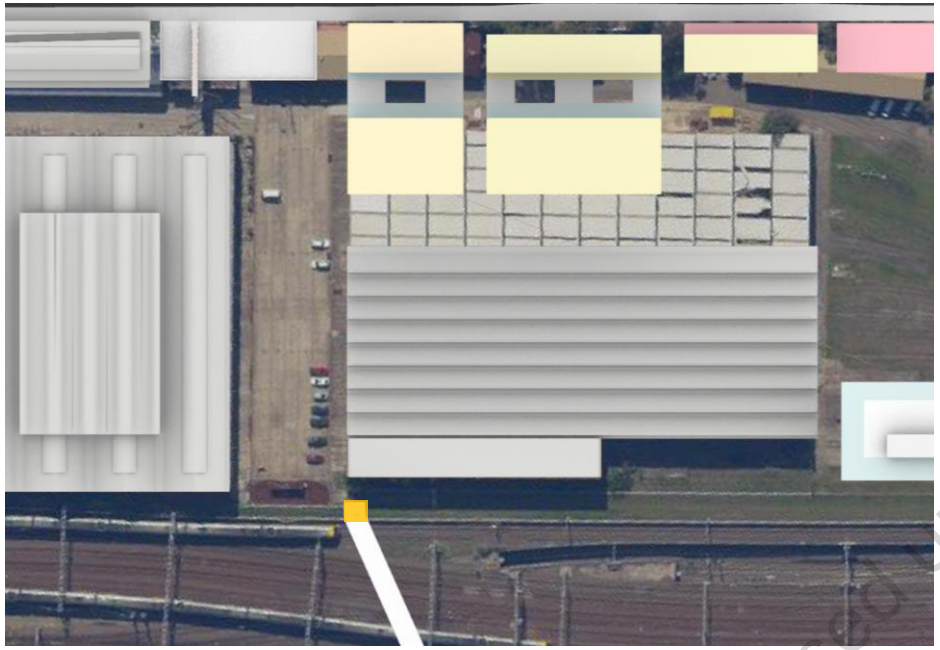
Moore Steps, from East Circular Quay to Macquarie Street, ~8m



Wynyard Station Escalators, ~13m

Bridge - Northern Abutment

The north landing is slightly less complex than the south, and stairs and lifts will generally fit in the space available.



Alignment D – behind the Paintshop annex

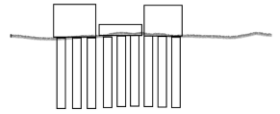
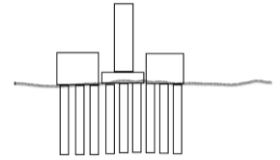
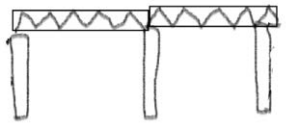
Alignment E – towards the Fan of Tracks

- A ramp has not been considered as there is no ramp in the south, and similar spatial constraints apply.
- The landing choice can influence how people are directed into the development and local area.

Bridge - Construction

Constructing the bridge will be difficult, expensive, and take several years.

- Construction must occur during a rail shut down (i.e., possession).
- Limited number of possessions; best case 2 x 48 hours per year.
- Very optimistic duration of 3.5 years.
- Realistic duration of 4-5 years, excluding design and approvals (additional 1-2 years).
- Future adjacent developments and interfaces not considered.
- All works require Sydney Trains approval.

Example construction sequence (very optimistic)		Minimum possessions	Minimum years
Piles in rail corridor		2	1
Pile cap install and cast, and set formwork deflection wall		1	0.5
Install pier, deflection wall, concrete pour and strip		1	0.5
Bridge: - Lift and bolt north span - Lift and bolt south span		2	1
Fitout and miscellaneous		1	0.5
Total:		**7 possessions** *minimum*	**3.5 years** *minimum*

Conclusion

The Redfern North Eveleigh Bridge will be a very challenging and expensive bridge to build and does not provide outstanding time savings or convenience for users.

Next steps:

Internal TfNSW benefits and value assessment.

Business case preparation and funding submission (subject to passing value and benefits assessment).

If the bridge is built:

There will be a high cost and long program due to physical and operational constraints.

Conclusion

A detailed benefits assessment and business case is required.

Connect the North and South Eveleigh communities	✓
Provide local permeability across the rail corridor	✓
Safe	✓
Comfortable	?
Convenient	?
Provide time savings for pedestrians and cyclists	?

Accessible	✓
Sustainable	!
Sympathetic to the industrial heritage of the area	!
Connection to Country	✓
Value for Money	!

ARUP

Redfern North Eveleigh Paint Shop Precinct

Bridge catchment analysis

19 April 2023 | Version 3.0

Quality Assurance

Project details			
Project number:	SCT_00248		
Document name:	RNE Paint Shop Precinct Working Paper 4 – Bridge Catchment Analysis		
Client:	Transport for NSW	ABN:	18 804 239 602
Prepared by:	SCT Consulting Pty. Ltd.	ABN:	53 612 624 058

Information	Name	Position	Signature
Author:	s74 Out of scope	Principal Consultant	s74 Out of scope
Reviewer:		Director	
Authoriser:		Director	

Version	Date	Details
1.0	11 October 2021	Issued to TfNSW
2.0	18 April 2023	Updated to reflect bridge design
3.0	19 April 2023	Refinement of land-use areas to rezoning approval

Questions to be answered

Is there a need and/or benefit of an active transport bridge between North and South Eveleigh?

1. Who would benefit from the bridge?
   - Spatial catchment analysis

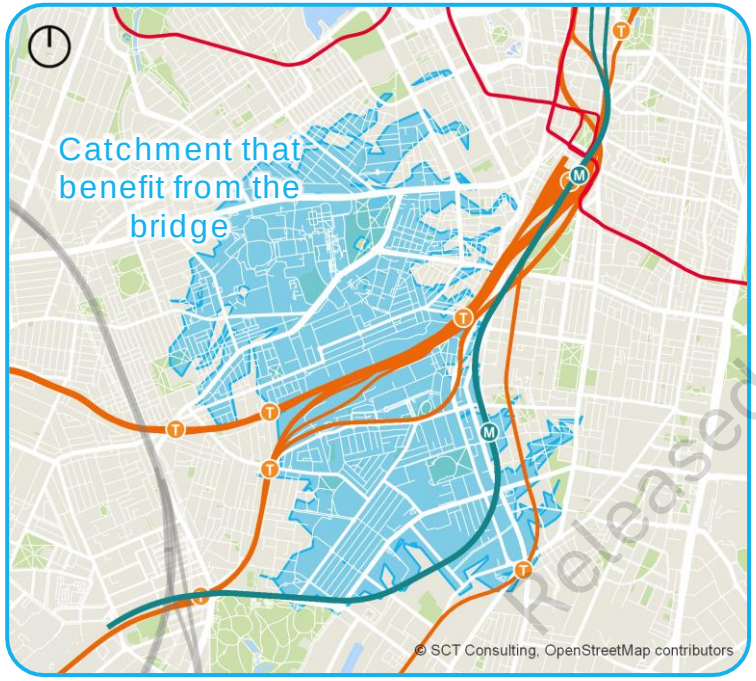
2. What quantum of people are likely to use the bridge?
   - Review of existing travel patterns (analysis of mobile phone data)
   - Confidence in data
   - Expected users of the bridge

3. How integral is the Redfern-North Eveleigh development to improving use of the bridge?
   - Potential increase in users of the bridge based on changes in land-use

Executive summary

Catchment analysis

Determine who benefits from the bridge compared to the existing scenario and future scenario (with Redfern Station southern concourse).



Travel time saving

An estimate of the average travel time benefits for a customer using the bridge (compared to other alternative corridor crossings).

Average travel time saving

3 minutes

per cross-corridor journey.

Executive summary

Current demand

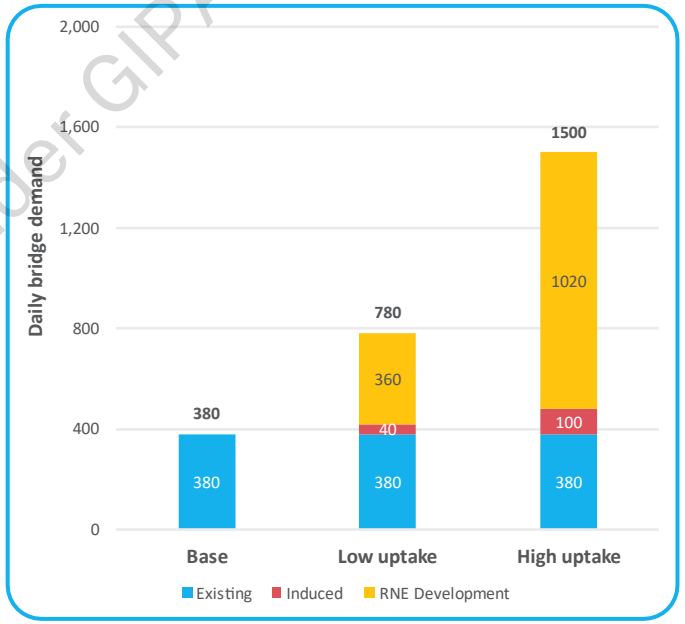
Who may use the bridge based on existing travel patterns?

340-420 journeys per weekday

Future demand

Increase in customers due to:

- Provision of the bridge (induced trips)
- Development of Redfern North Eveleigh Precinct



Productivity

The cumulative benefit of the bridge.

19-75 people-hours saved

per typical weekday.

[01]

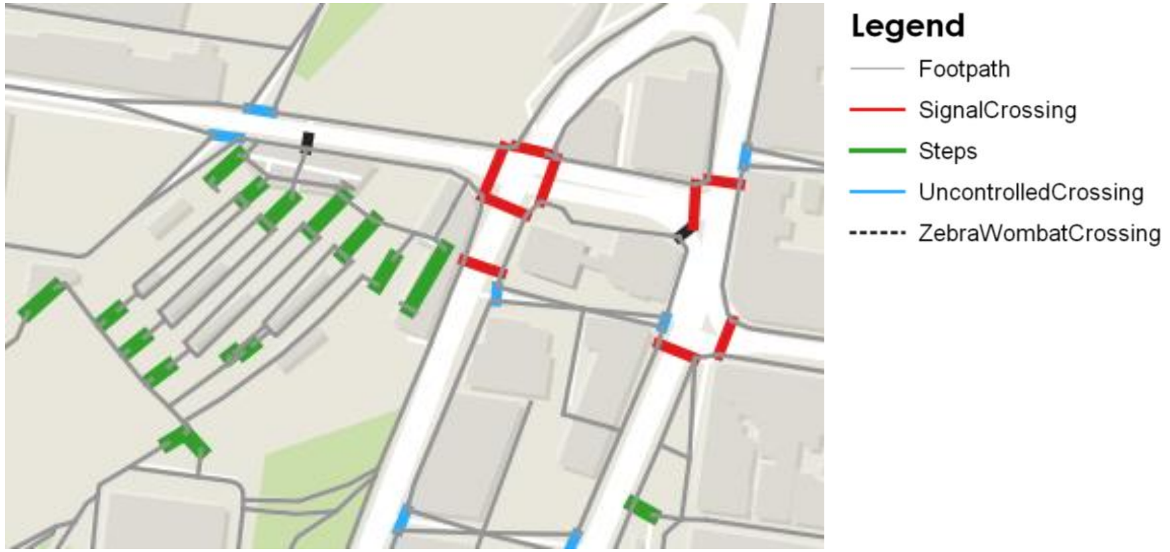
Who would benefit from the bridge?

Existing rail corridor crossings

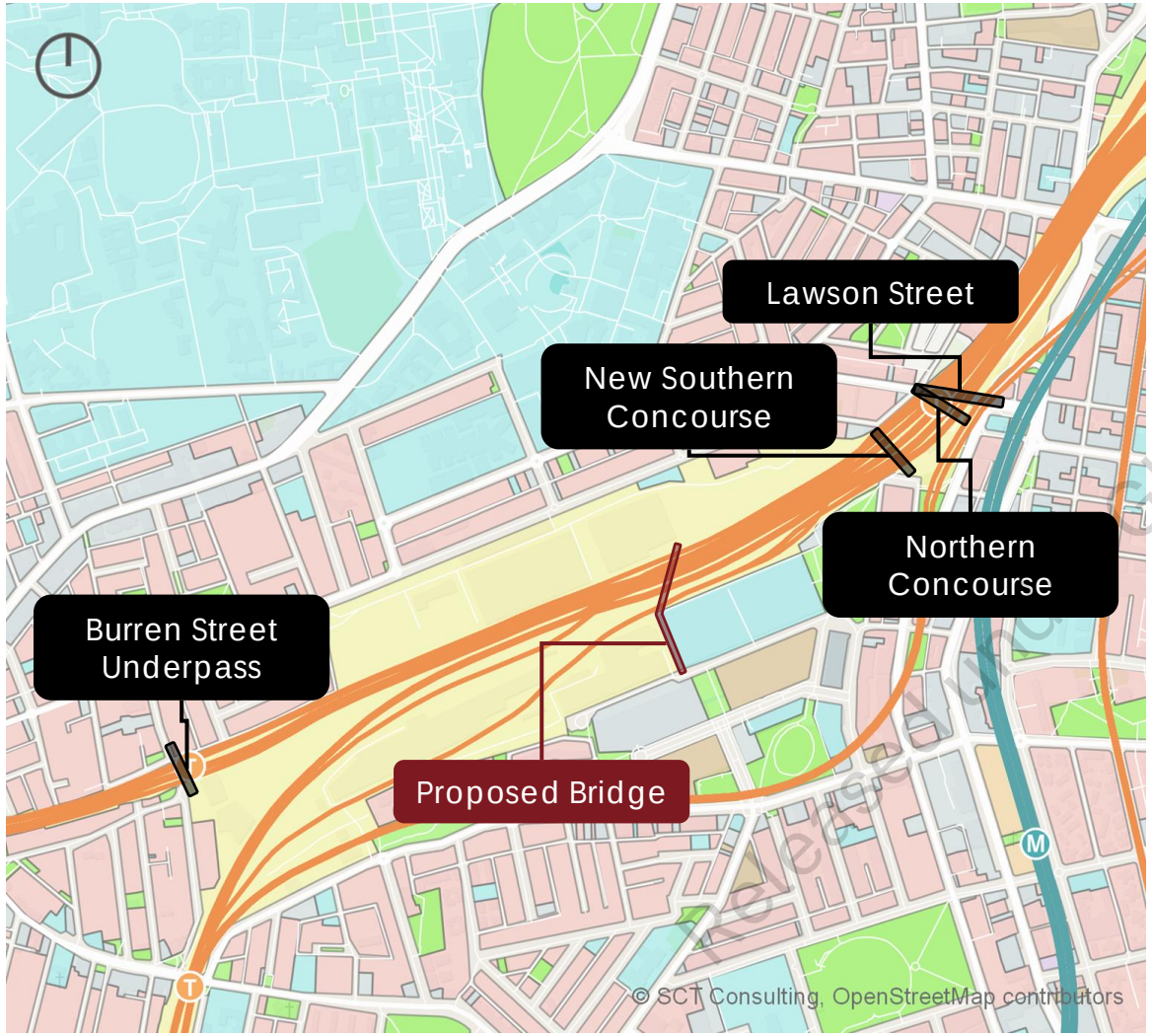
All existing crossings included in analysis.

- Travel time for each route is calculated based on a typical walk speed of 1.35 metres per section
- Additional travel time has been added for:
  - Vertical transport (including stairs or lifts)
  - Road crossings (penalty by type: signalised, zebra and uncontrolled).

Example Extract:
Redfern Station concourses (existing northern and new southern).

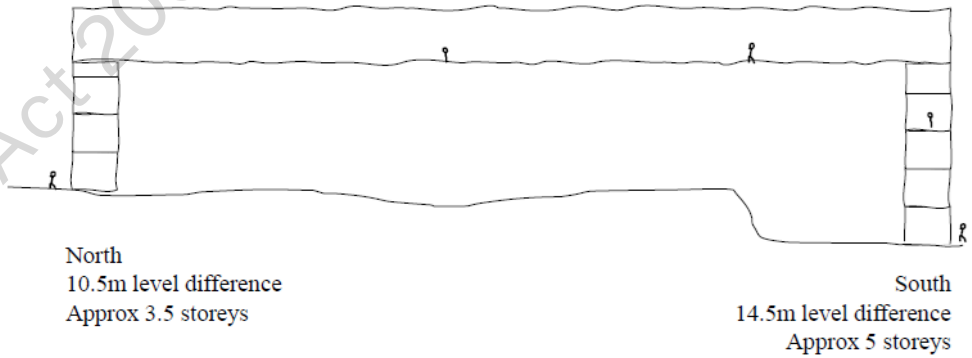


Proposed rail corridor crossing



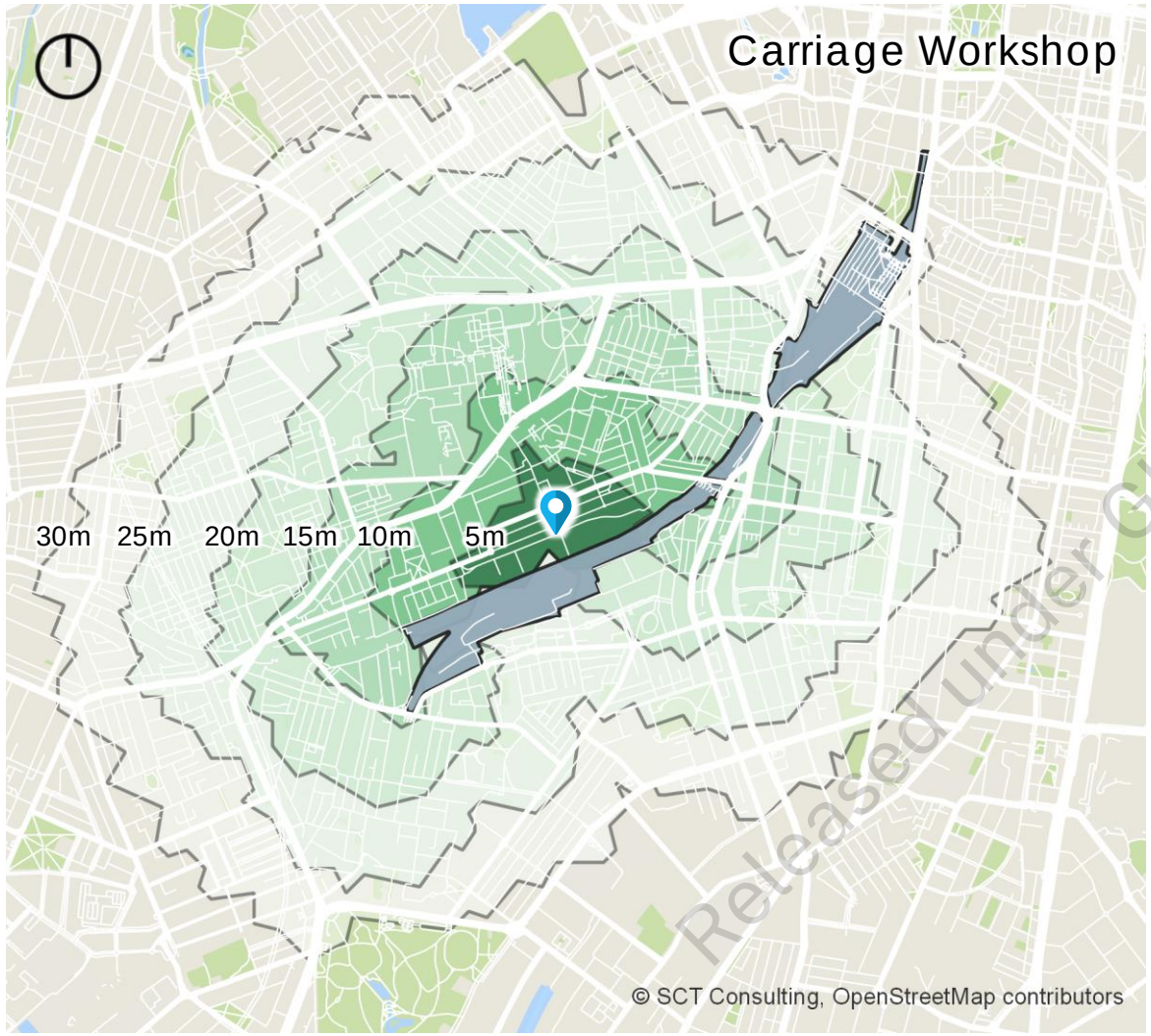
Proposed bridge included in assessment. Based on Arup (November 2022) design pack, the following characteristics have been included:

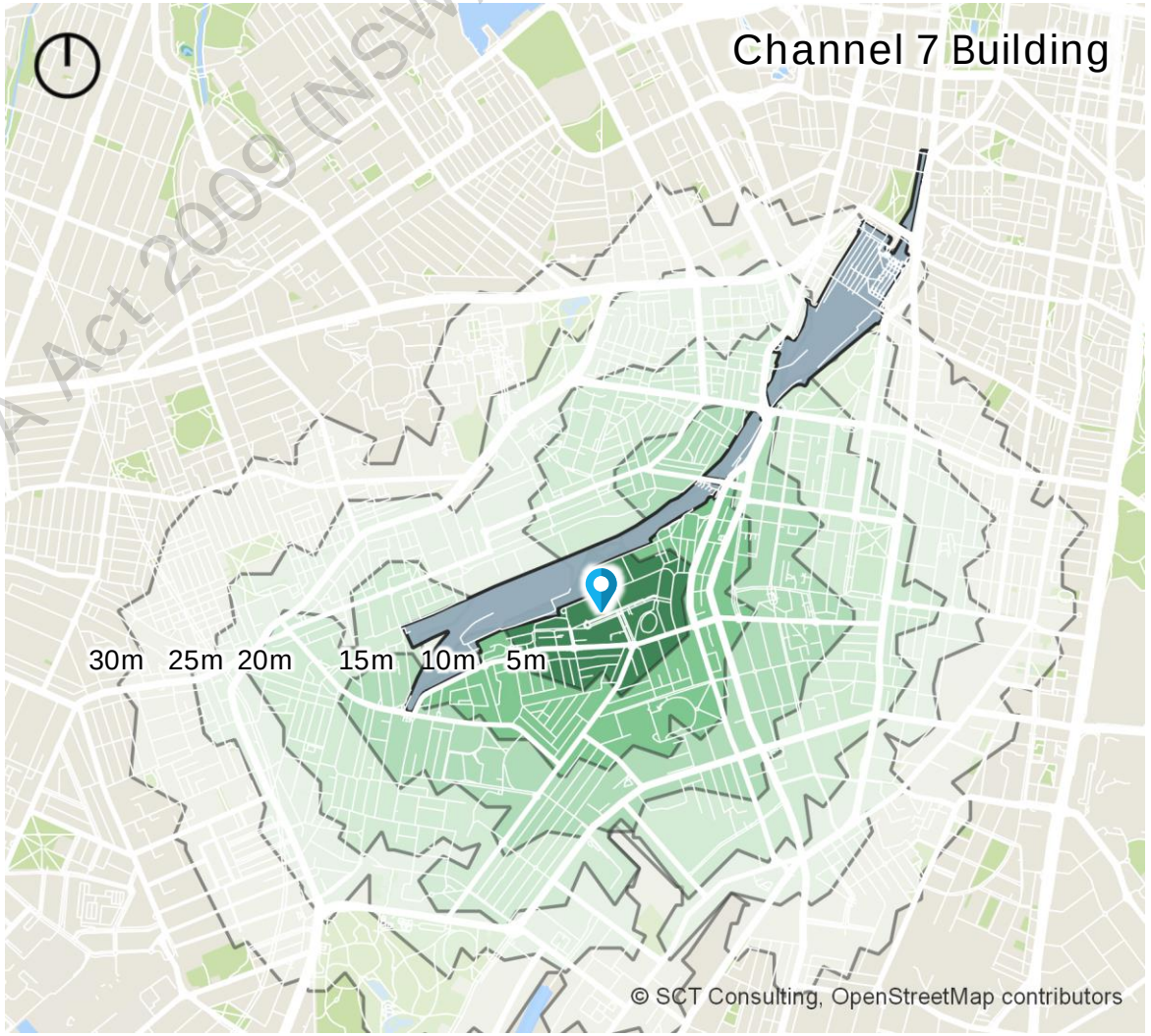
- Bridge connecting North and South Eveleigh
- Lift access is provided on both ends, based on indicative heights:



- Due to the height of the bridge, it is unlikely users would utilise the stairs as the main form of vertical transport (unless they opt to do so from a hedonic perspective i.e. for exercise).
- Therefore the travel time of the bridge has been based on a first-principles lift travel time assessment.
- With two lifts at each end, the average trip time (including wait and travel time) is estimated at 33 seconds (north) and 39 seconds (south).
- Including the lifts and extended deck (over the maintenance facility) on the southern end to Locomotive Street, the total crossing time is approximately 4 minutes.

Existing 30-minute walking catchments

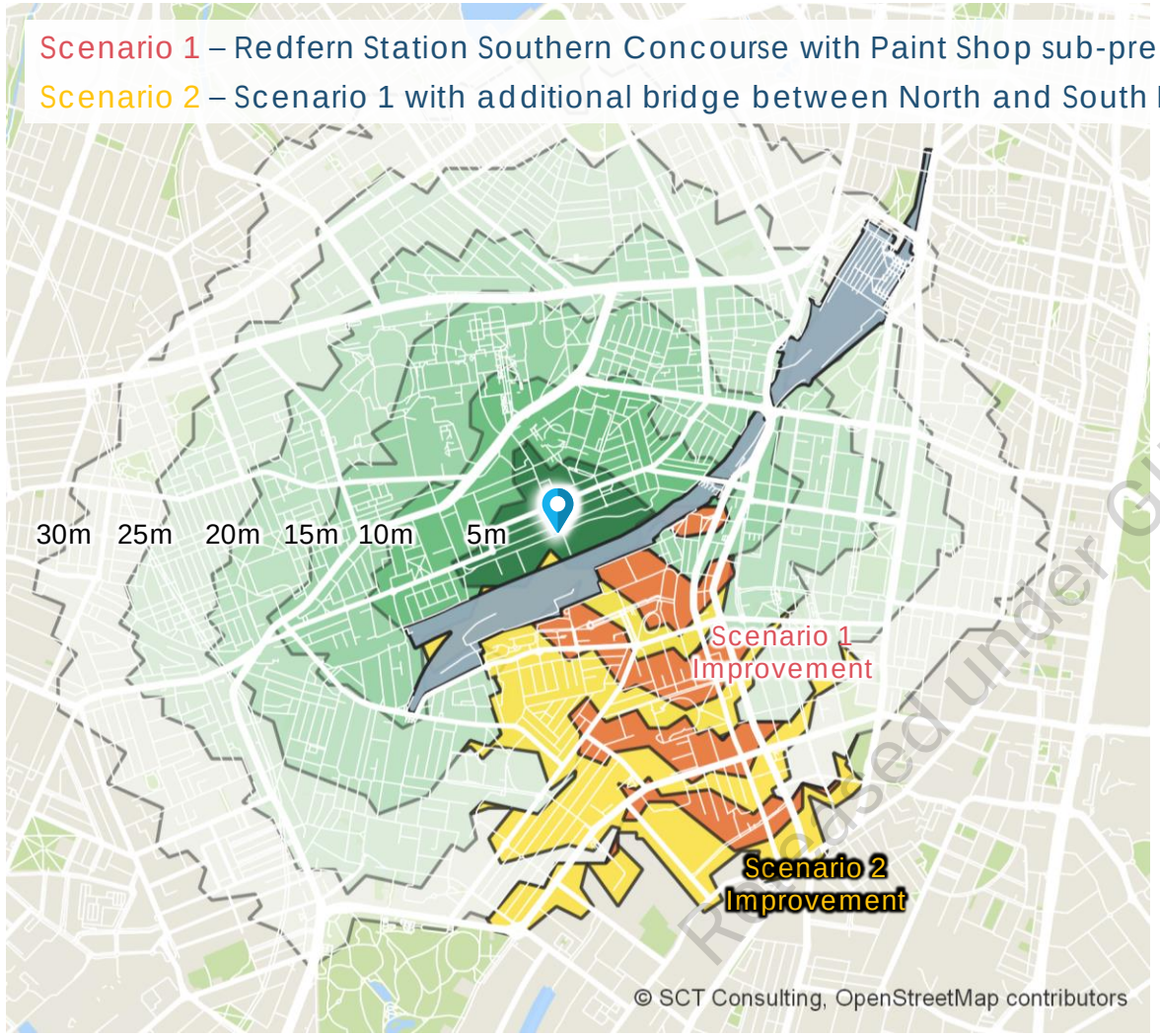


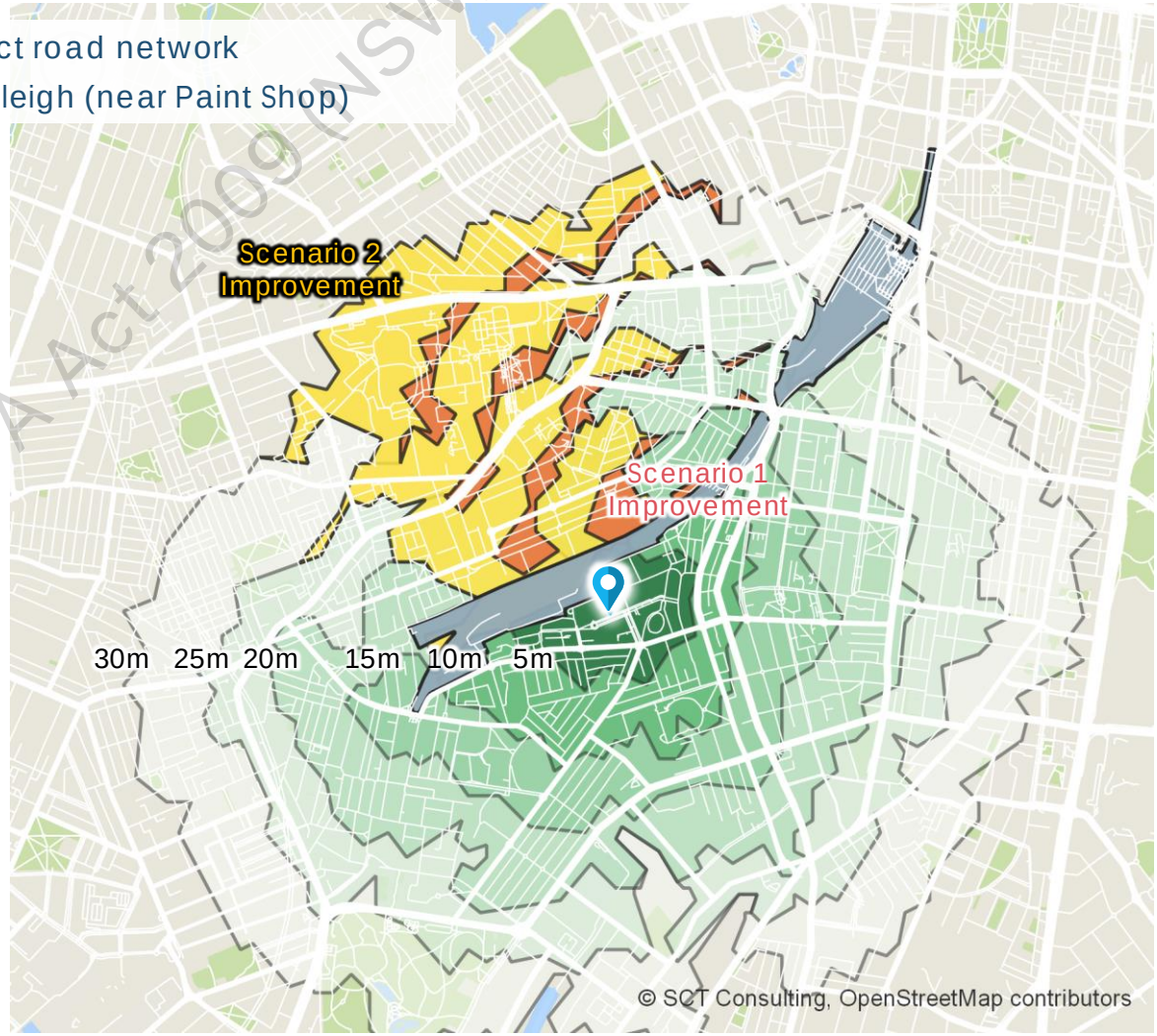


Improvements to 30-minute walking catchments

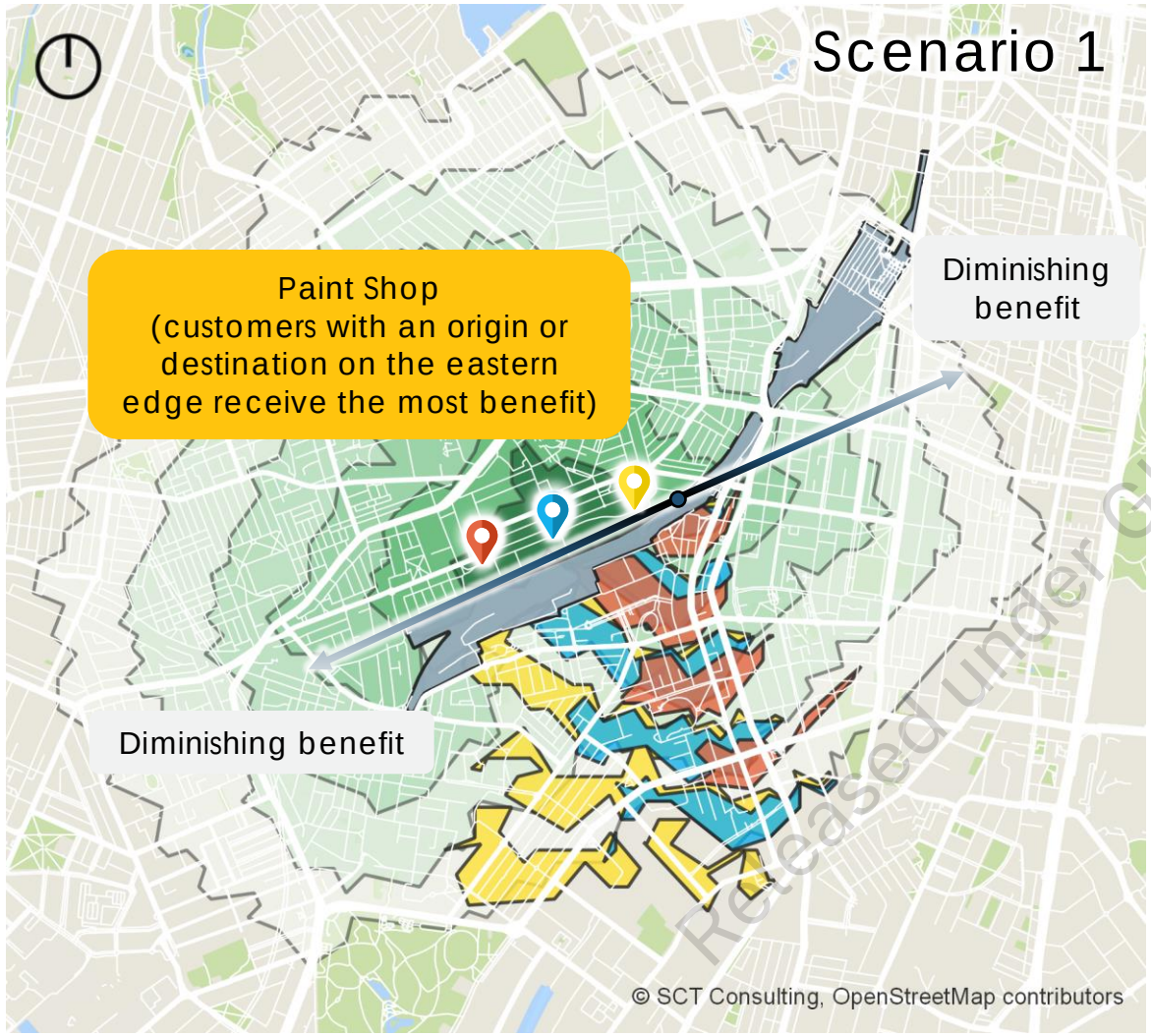
Scenario 1 – Redfern Station Southern Concourse with Paint Shop sub-precinct road network

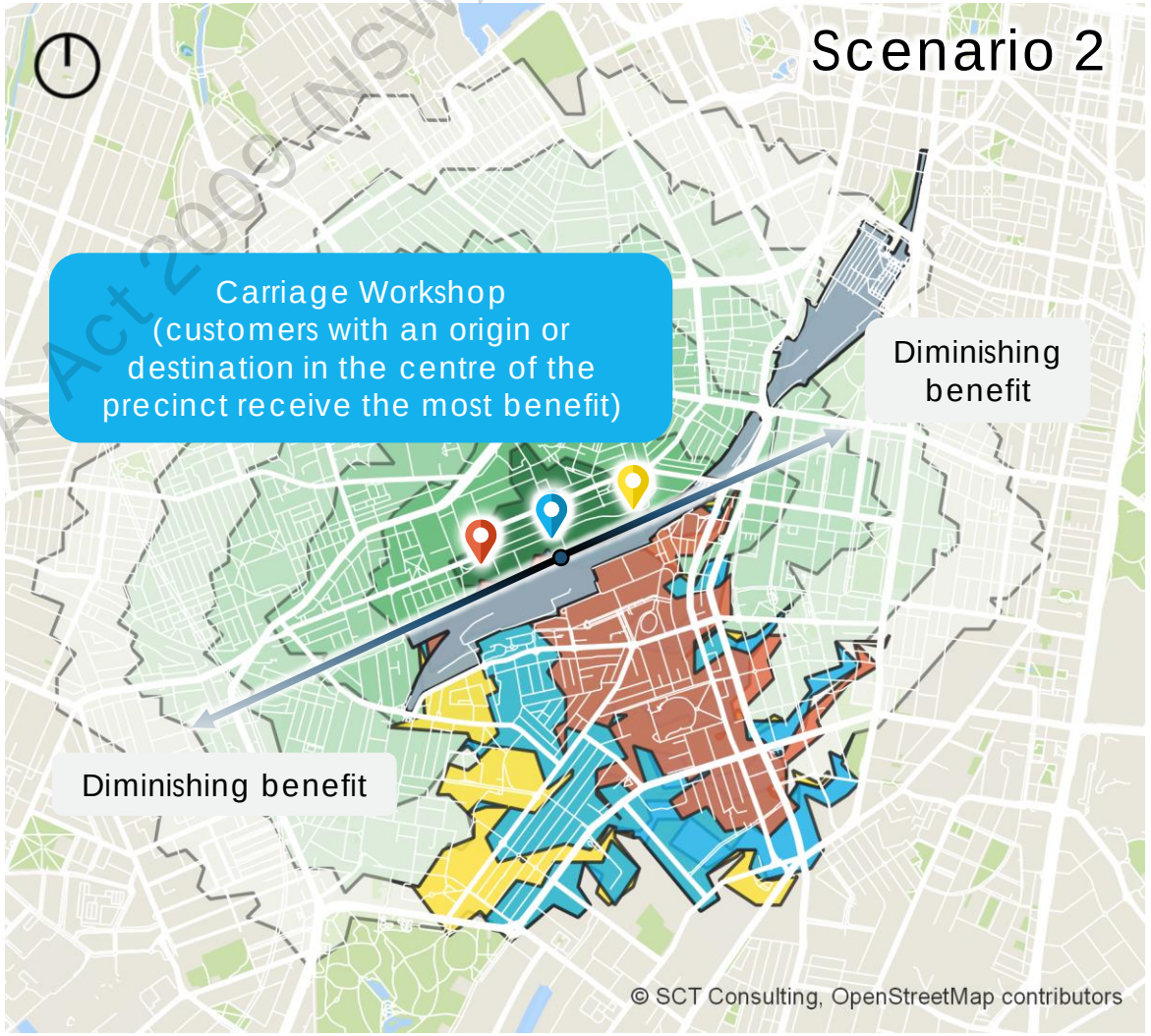
Scenario 2 – Scenario 1 with additional bridge between North and South Eveleigh (near Paint Shop)



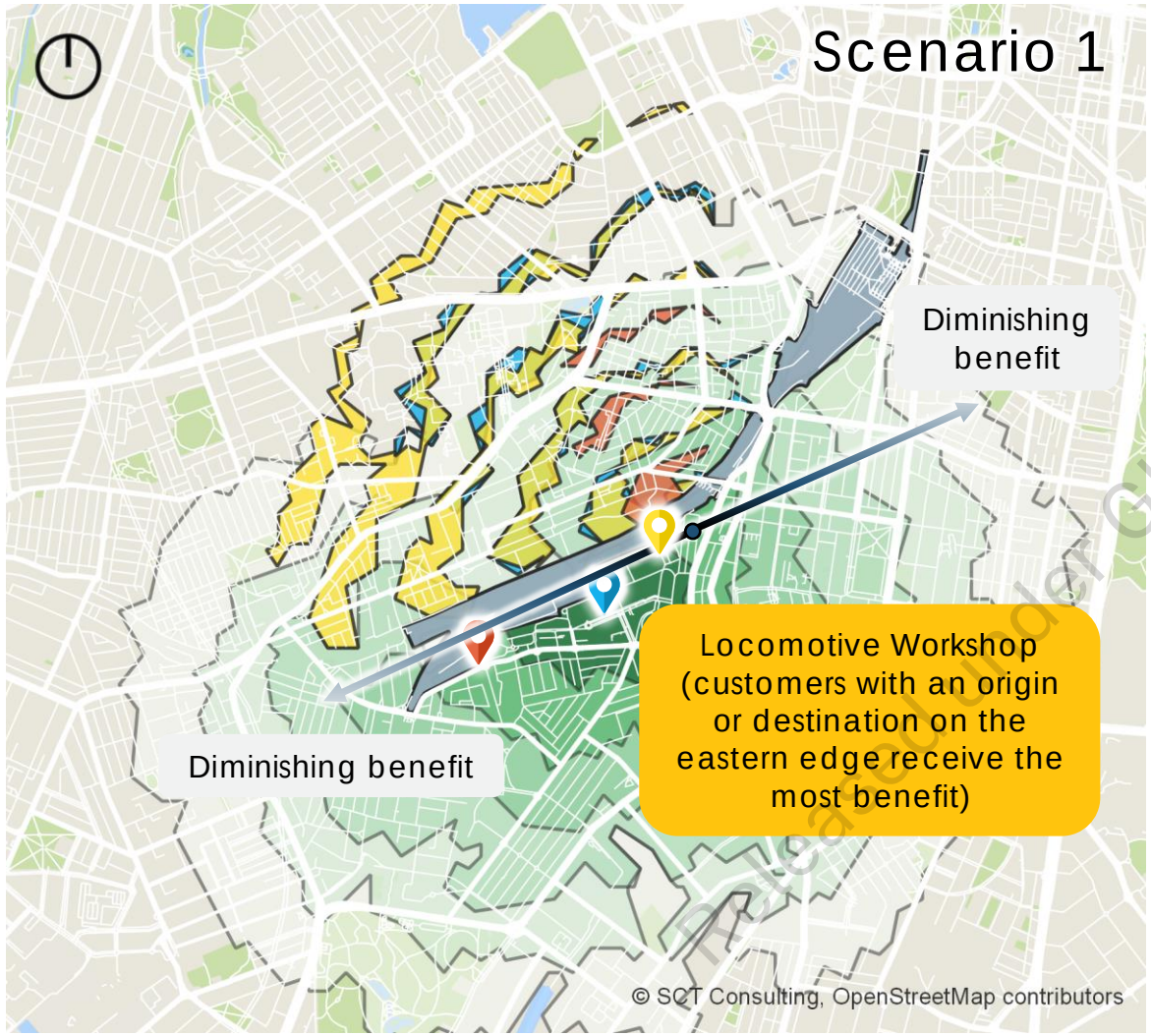


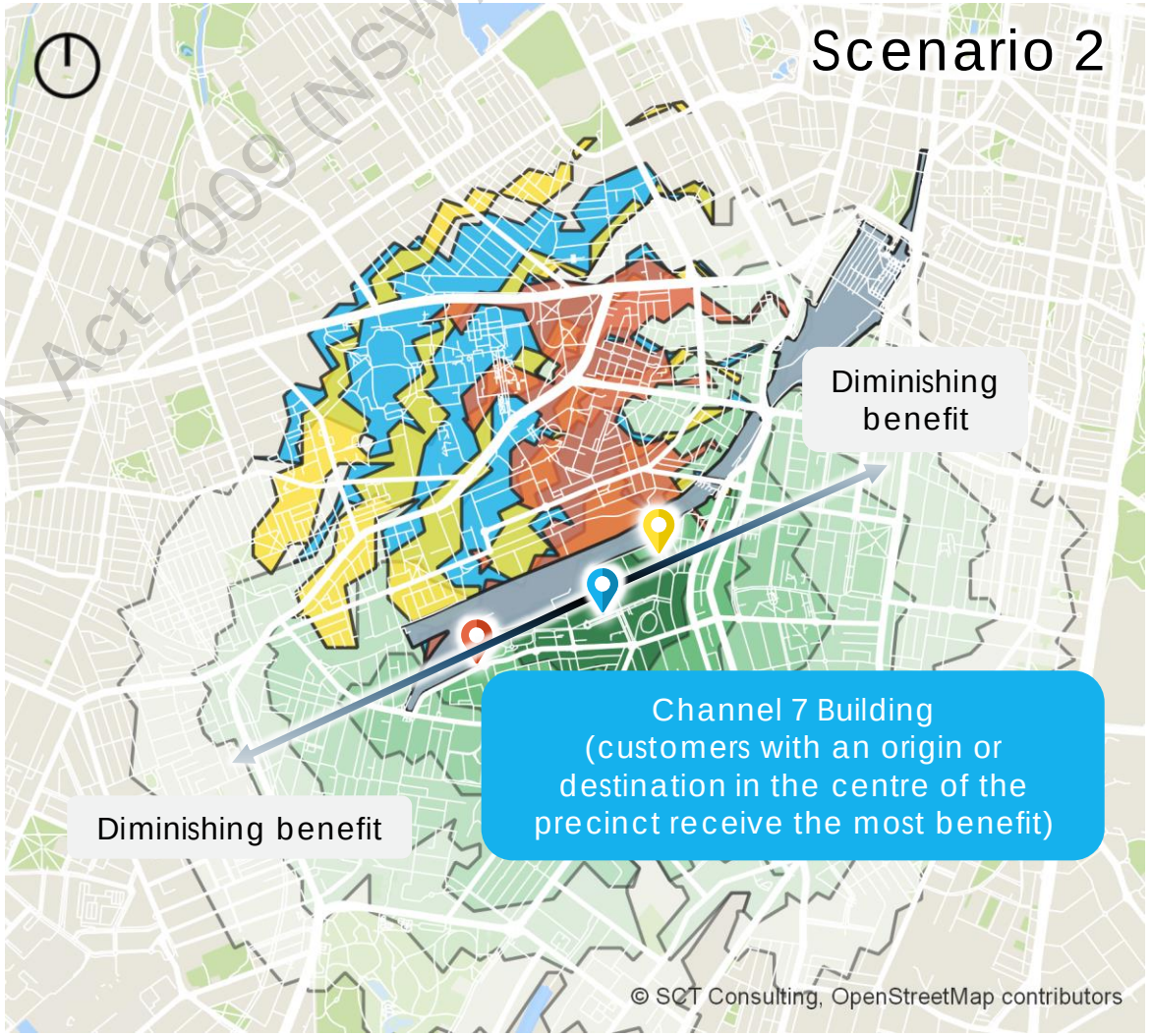
Northern Sites – Improvements by location



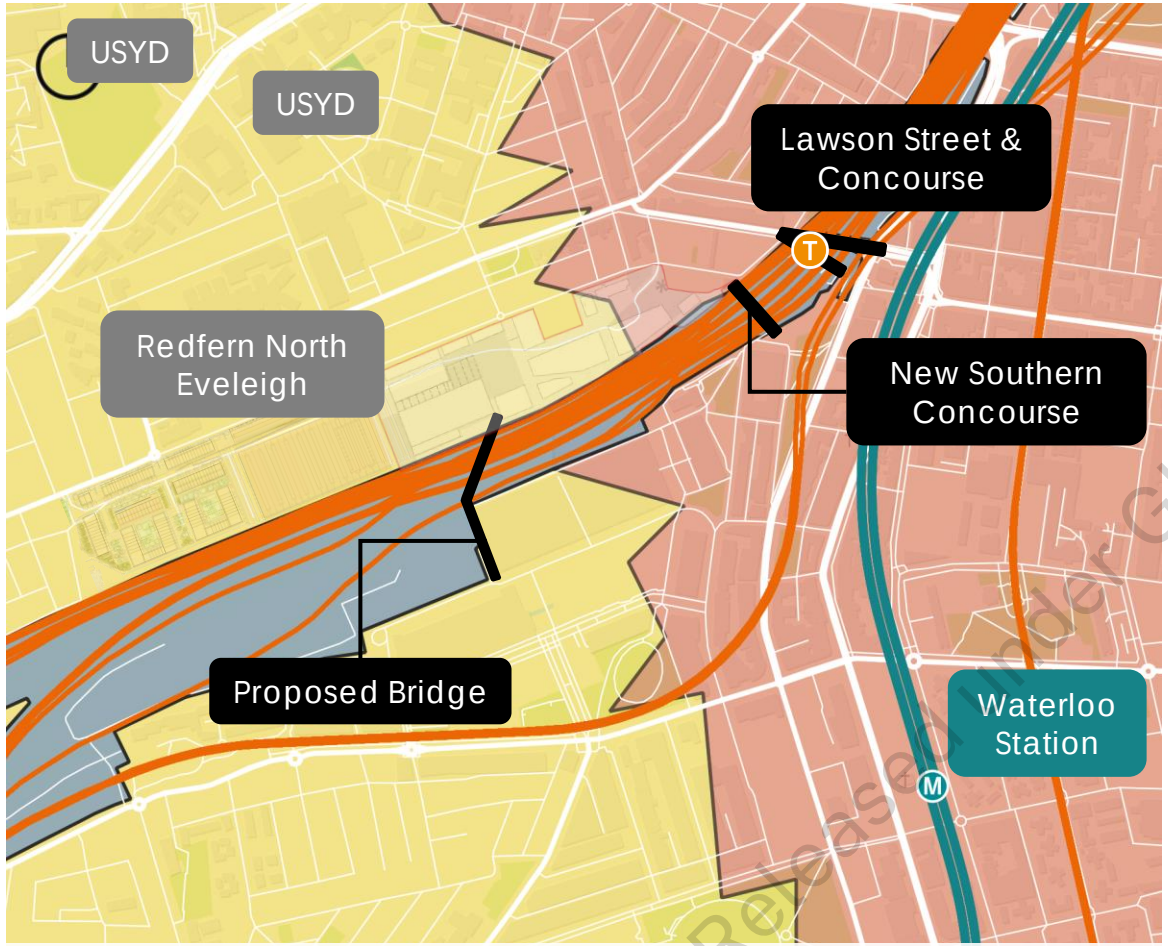


Southern Sites – Improvements by location





Southern Concourse versus Proposed bridge



Scenario 1 – Redfern Station Existing and Southern Concourse

Scenario 2 – Proposed bridge between North and South Eveleigh

A comparison of the two alternative groups of crossing options, resulted in the following observations of cross-corridor journeys:

- Bridge connecting North and South Eveleigh is the most attractive (from a travel time perspective) for majority of the RNE precinct.
- The New Southern Concourse is more attractive for access to the commercial developments on the eastern end of RNE.
- Customers (in particular students) who may travel between Waterloo Station (Sydney Metro City & Southwest) and the University of Sydney (USYD) Campus may find it more attractive to use the new proposed bridge between the station and campus.
- Other key destinations such as Broadway Shopping Centre, University of Technology Sydney (UTS) are better served by the New Southern Concourse and existing connections to the north.

Scenario 2 benefit – land use

Main beneficiaries of the additional bridge are cross-rail corridor journeys to/from:

- Urban residential
- Public services (University of Sydney)
- Commercial (North and South Eveleigh precincts). Noting RNE precinct is currently listed as infrastructure (railways).
- Light industrial and commercial (Waterloo and Green Square)

Travel time saving (range)

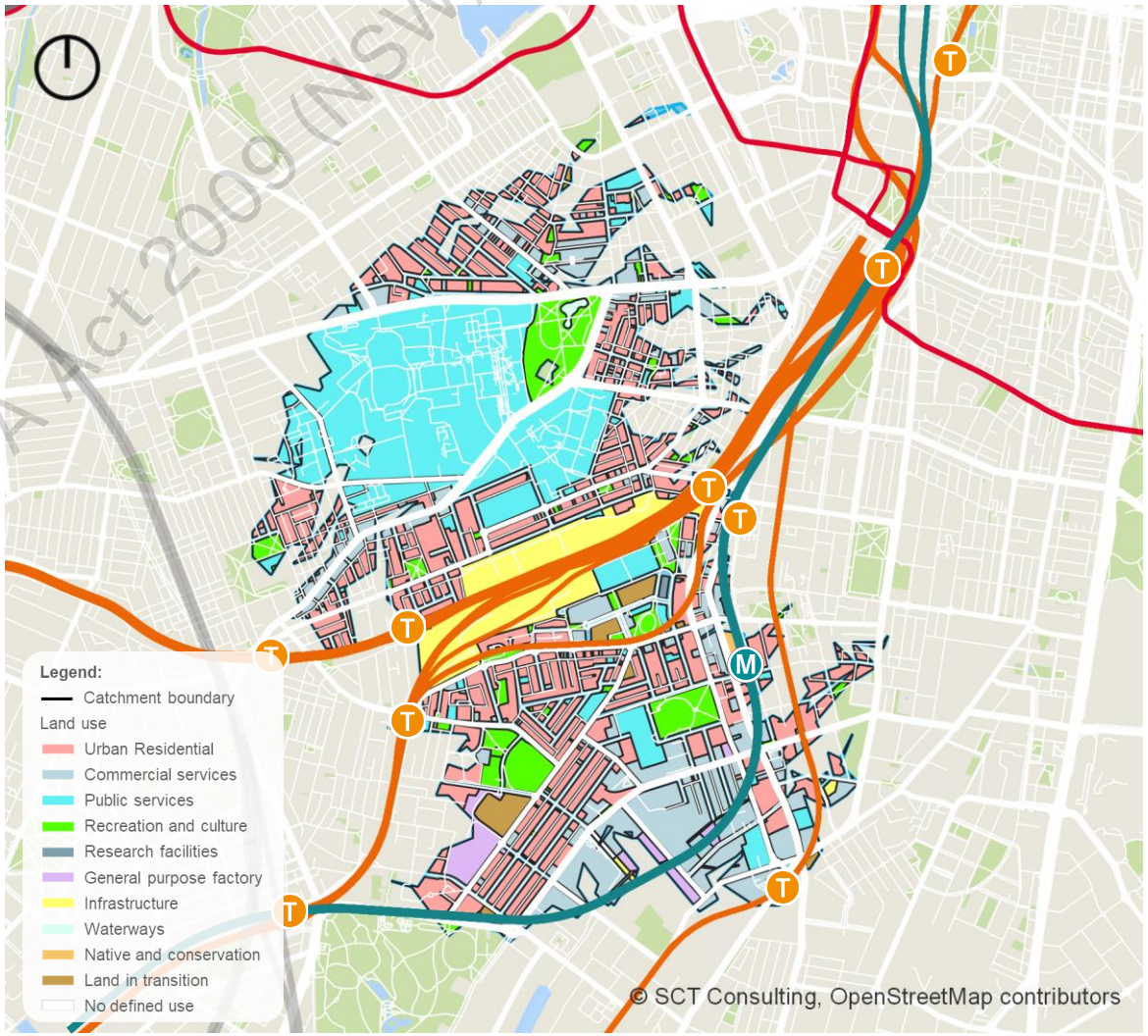
Up to 12 minutes

For cross-corridor journeys in the highlighted regions. For some customers, the benefit may be more; likewise, the benefit may be less for others.

Average of travel-time saving

4 minutes

Weighted average based on forecast population and employment data (2036) across the walking catchment.

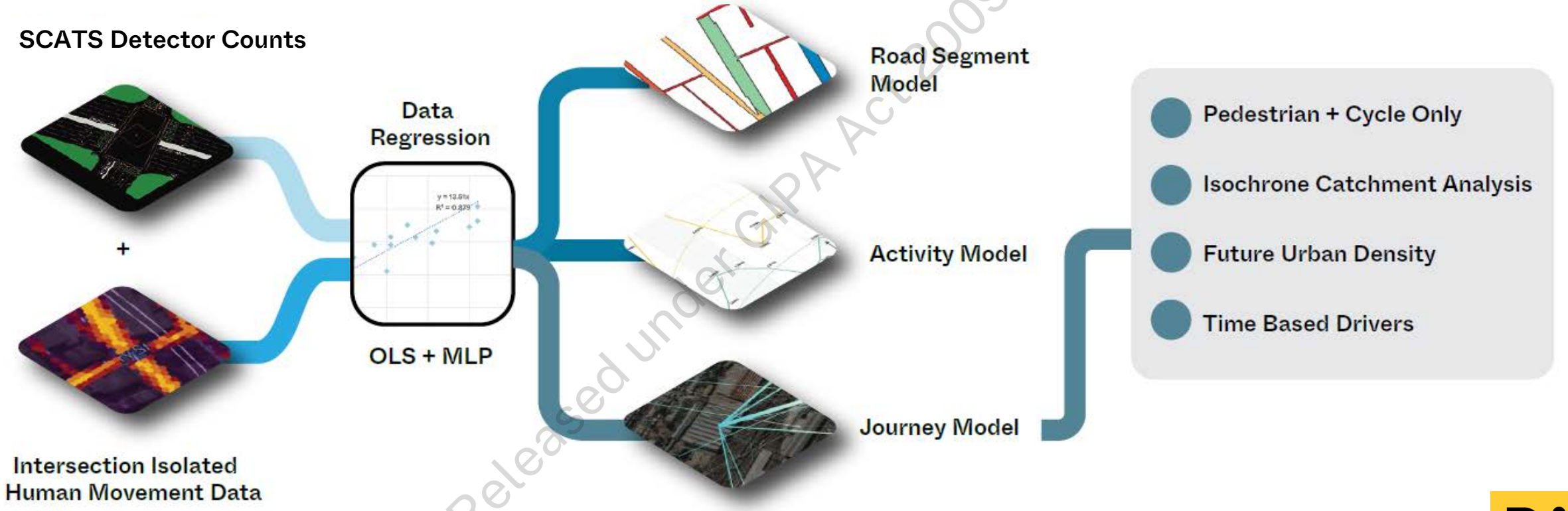


[02]

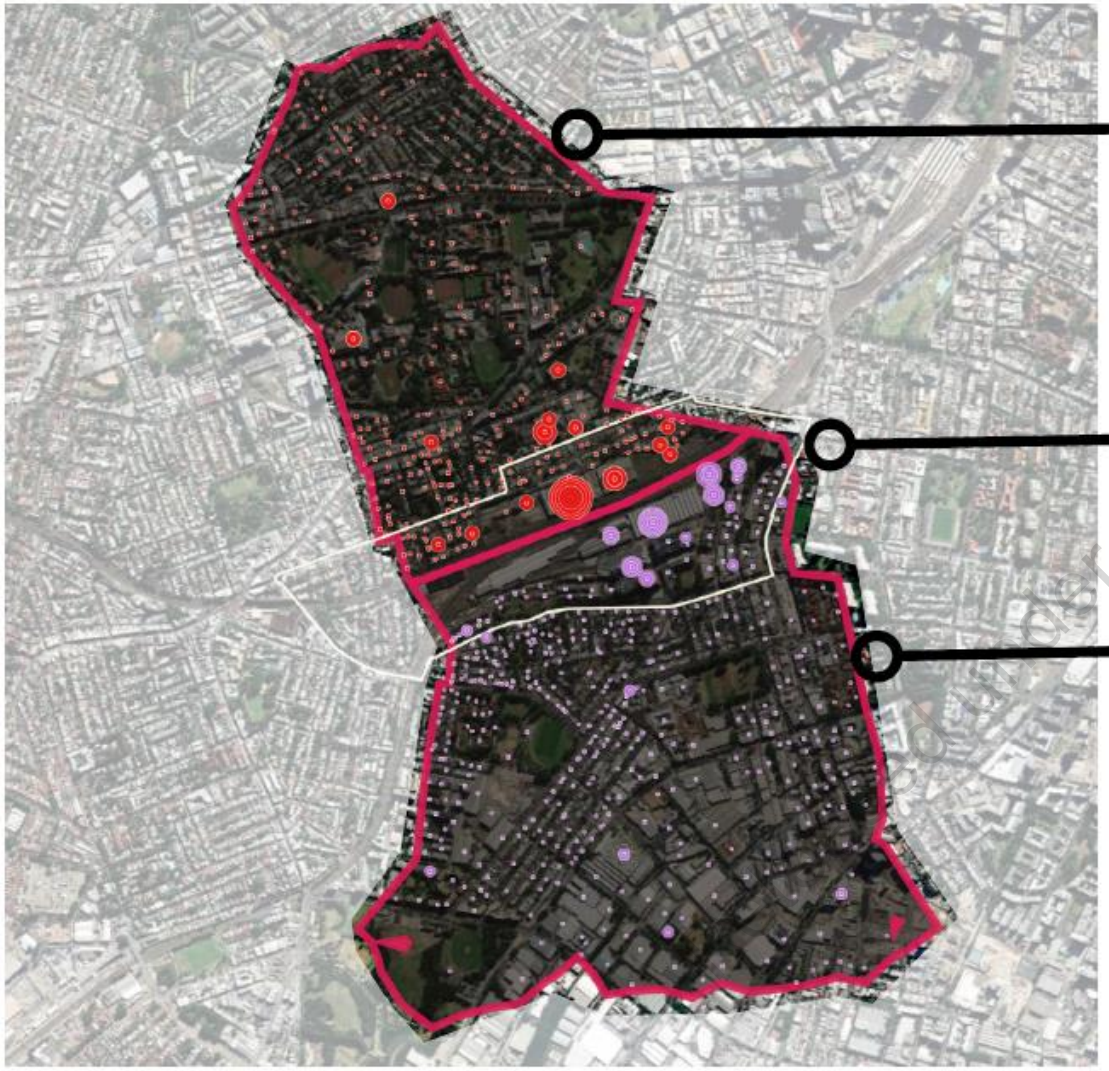
What quantum of people are likely to use the bridge?

Bridge demand analysis - process

We used a number of data processing methods to predict the number of journeys per hour that would use the proposed bridge.



Current observed cross-corridor origins and destinations



North

Primary Generator: University of Sydney

Precinct Boundary

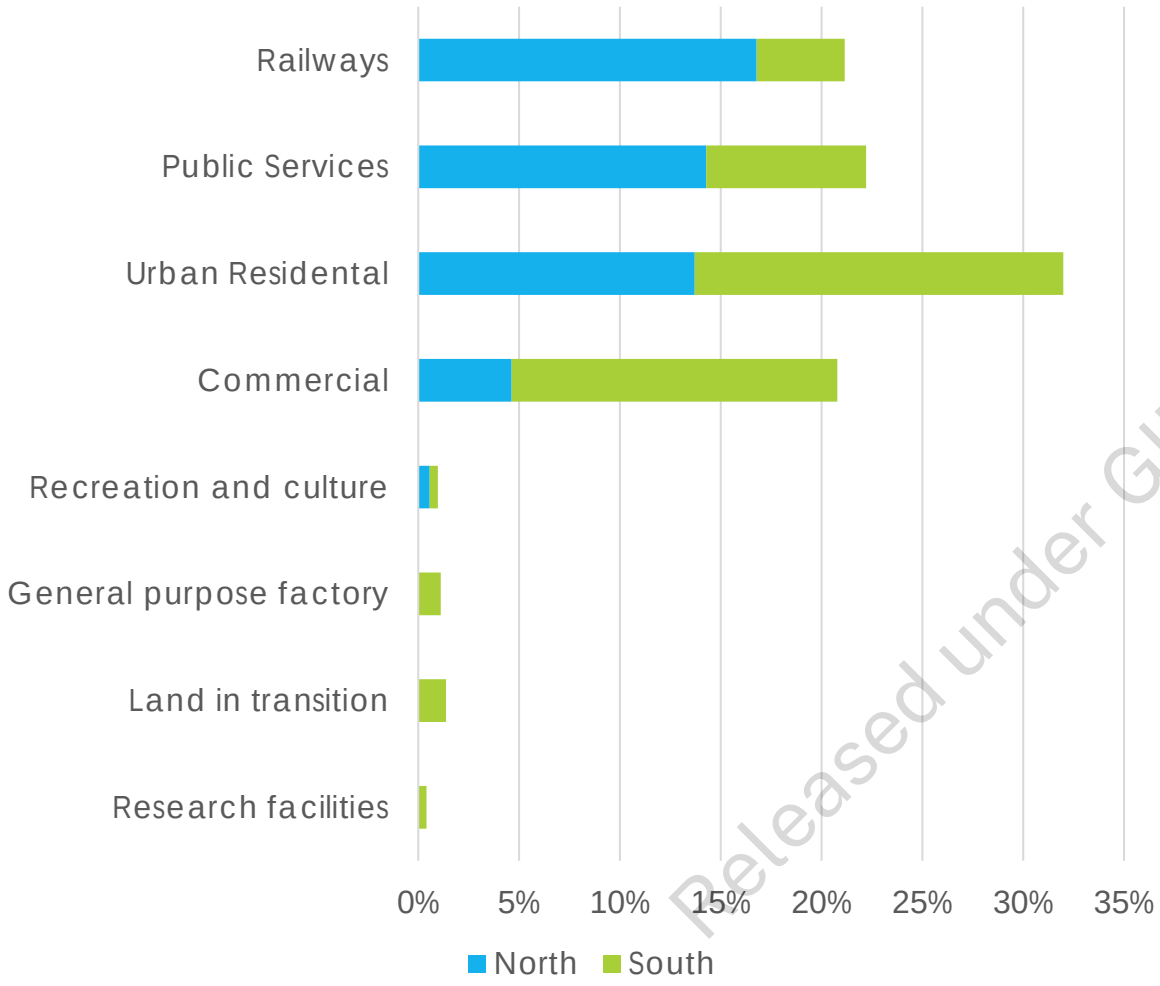
Percent of Total Journeys: 26%

(Excludes Redfern Station activity)

South

Primary Generator: Urban Residential

Cross-corridor trips by land-use



(Excludes Redfern Station activity – some areas around corridor including RNE precinct are classified as Railways)

Journey origins

(the reciprocal can be assumed for a return journey)

32%

Journeys originate from residential land-uses

<2%

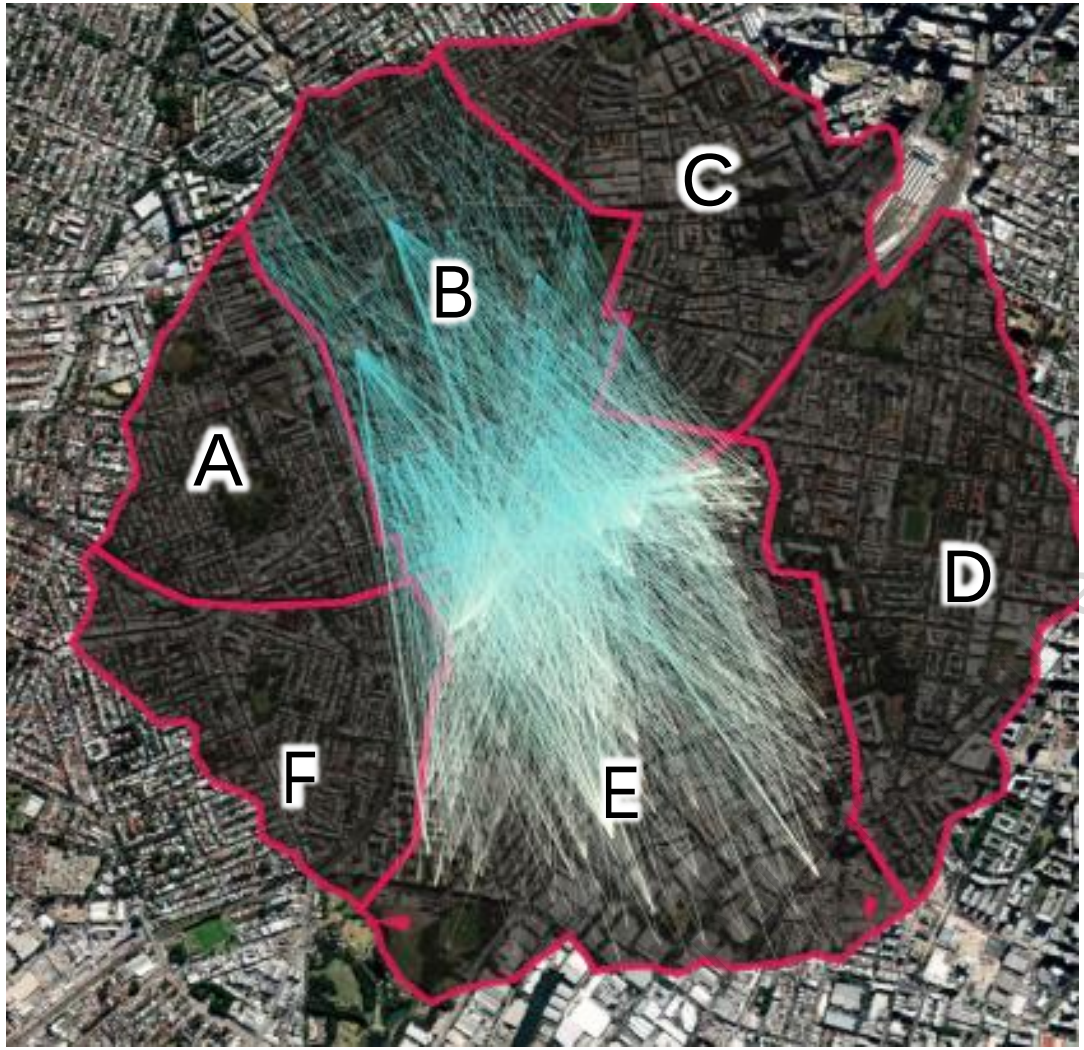
Journeys originate from land-uses classified as recreation and culture.

Study area - benefiting regions (and O-D connections)

Catchment analysis indicates greatest benefit to Regions B and E (and travel to and from these locations).

Regions A – F and C –D already have high levels of permeability, which is corroborated by high observed trips.

Current demand for bridge



Validated trips

340-420 journeys per day

R^2 Average

0.8875

Typical walking characteristics

53% less than 1000m in length

Peaks:

8:15-9:15 AM

4:45-5:45 PM

About the model:

Model Size: 152,470 Journeys

Number of Buildings: 1,391

Time Interval: 15 minutes

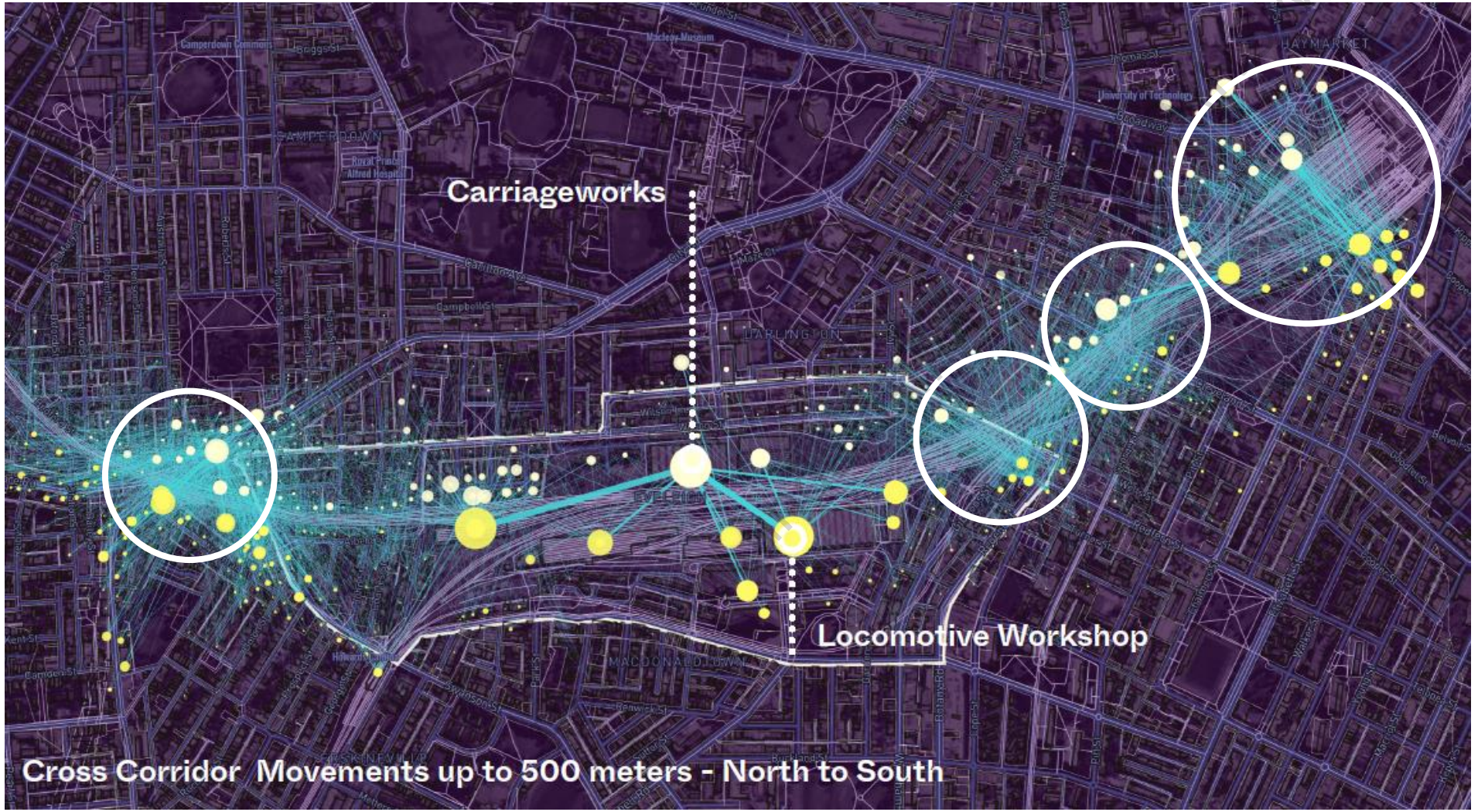
Time Series: Weekdays Only

Mode: Non-Vehicle

[03]

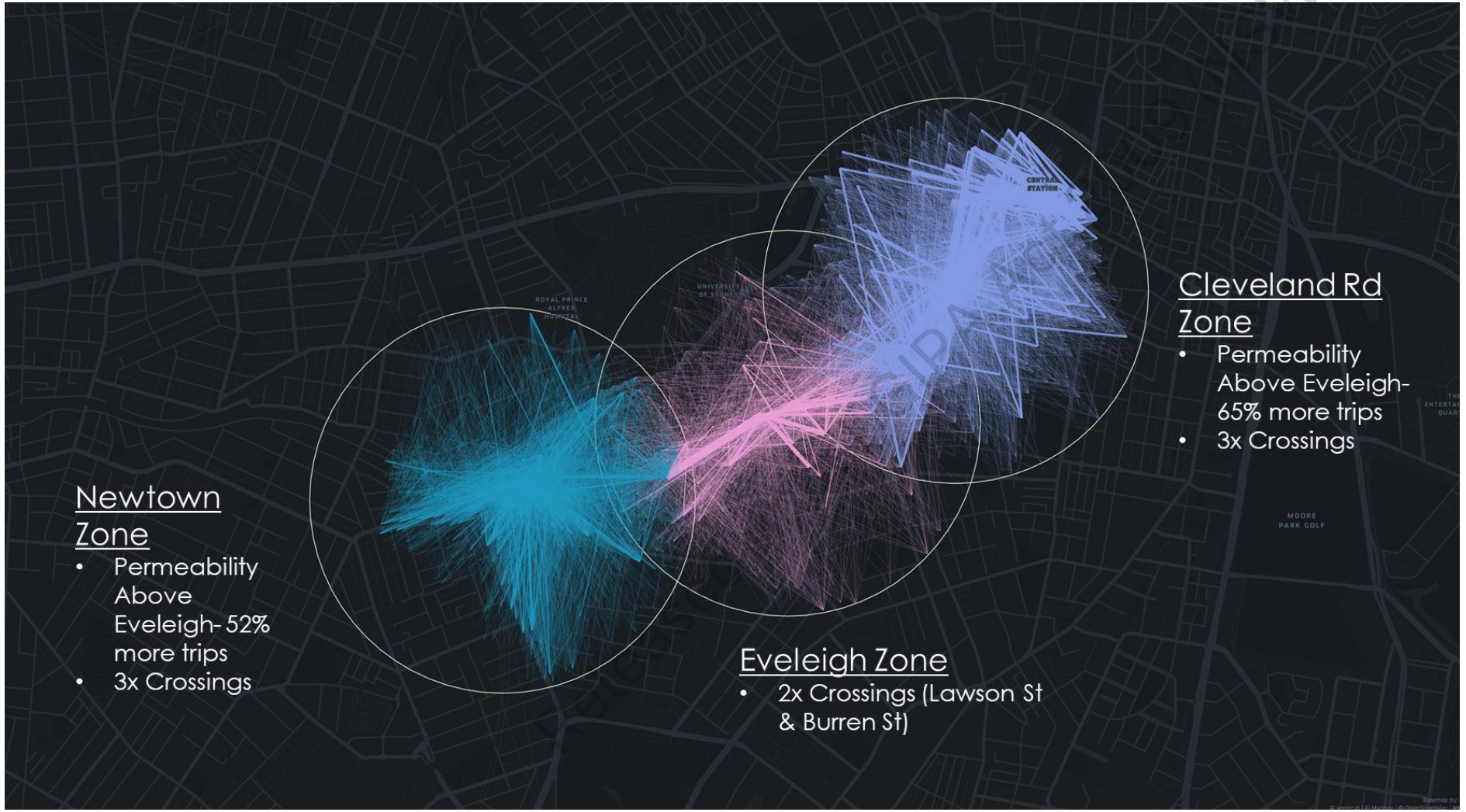
Role of Redfern-North Eveleigh development?

Increased activity due to attractions



Observed activity due to generators and attractions either side of the rail corridor (with a nearby crossing).

Increased activity due to attractions



Conservative assumption for uptake in activity

+10% to +25%

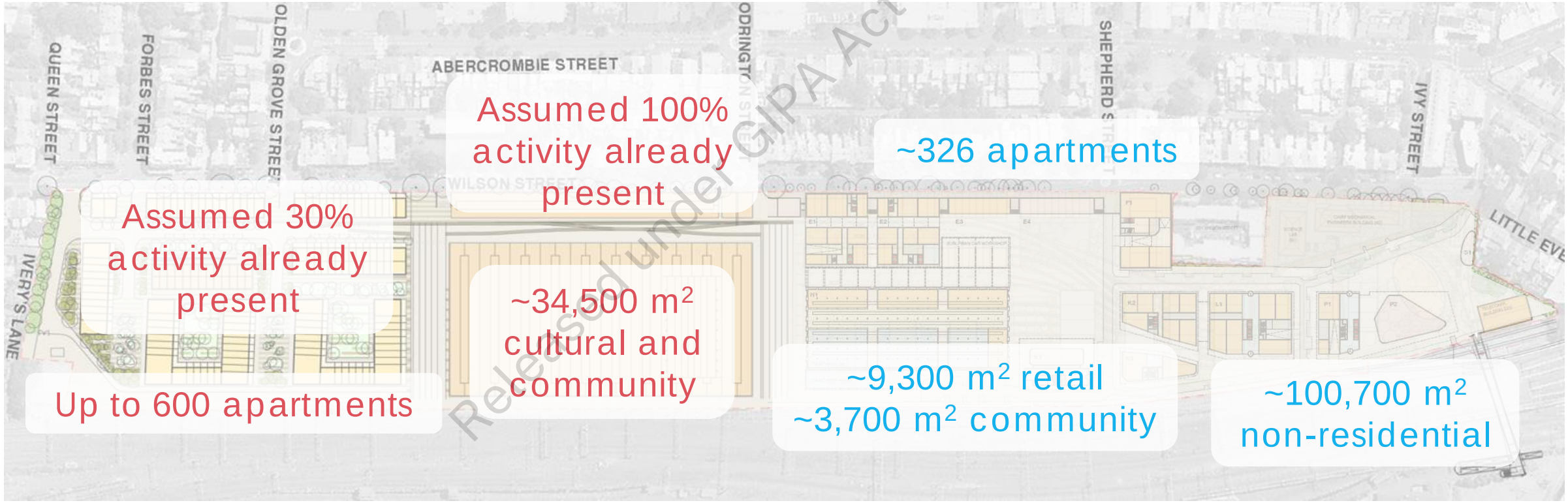
Based on observed activity in adjacent regions.

Increased activity due to land-use uplift

Proportion of Redfern-North Eveleigh precinct will utilise the bridge. Bridge may be used for access to and from the precinct and recreational purposes including lunch breaks to move between attractions at either the north or south precinct.

+10-20% of RNE precinct daily population

(includes customers who would use the bridge multiple times per day – with current 10-20% walk mode share for the precinct)



[04]

Outcomes

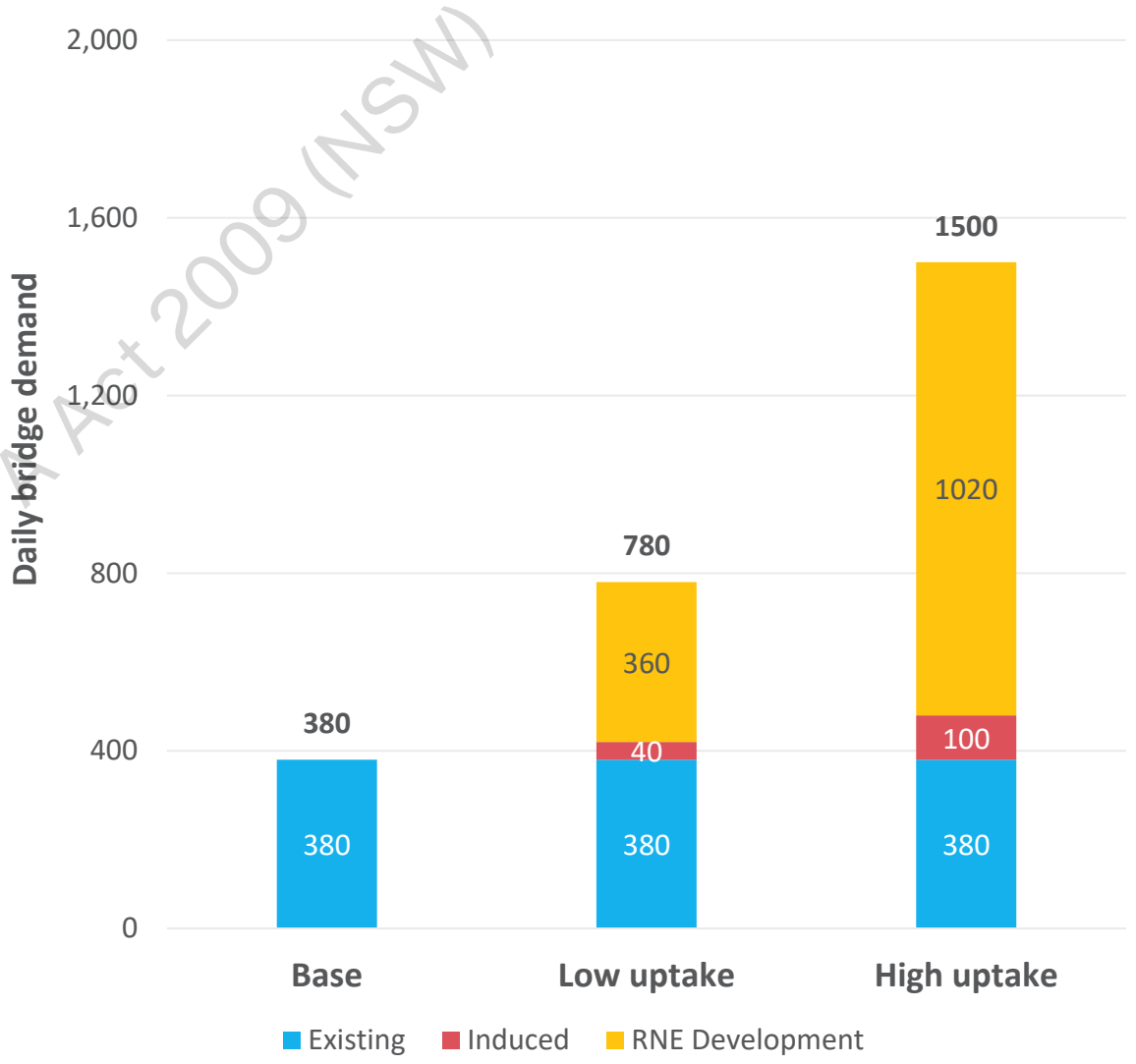
Potential bridge users

Induced demand:

- Increased permeability between generators and attracts
- Lower level of activity either side of rail corridor compared to regions like Newtown

RNE development related demand:

- Single largest contributor to use. Daily count includes an estimate for trips to and from the precinct.
- Assumes the proposed bridge is the most attractive option for:
  - 100% of residential, community and cultural land-uses.
  - 70% of commercial land-use. Some high-density commercial is located on the eastern edge which is closer to the southern concourse, making the proposed bridge less attractive for these customers.
- Assumes precincts are being established as self-serving for residents and employees.
  - If land-uses are linked between RNE and South Eveleigh we would expect more daily trips.



Potential benefit – daily productivity

Average travel time saving

3 minutes

per cross-corridor journey.

Base scenario

19 hours

Reduced travel time for customers daily (typical weekday).

Low uptake scenario

39 hours

Reduced travel time for customers daily (typical weekday).

High uptake scenario

75 hours

Reduced travel time for customers daily (typical weekday).

sctconsulting.com.au

SCT Consulting

Redfern North Eveleigh Bridge

Transport for New South Wales

Constraints Review

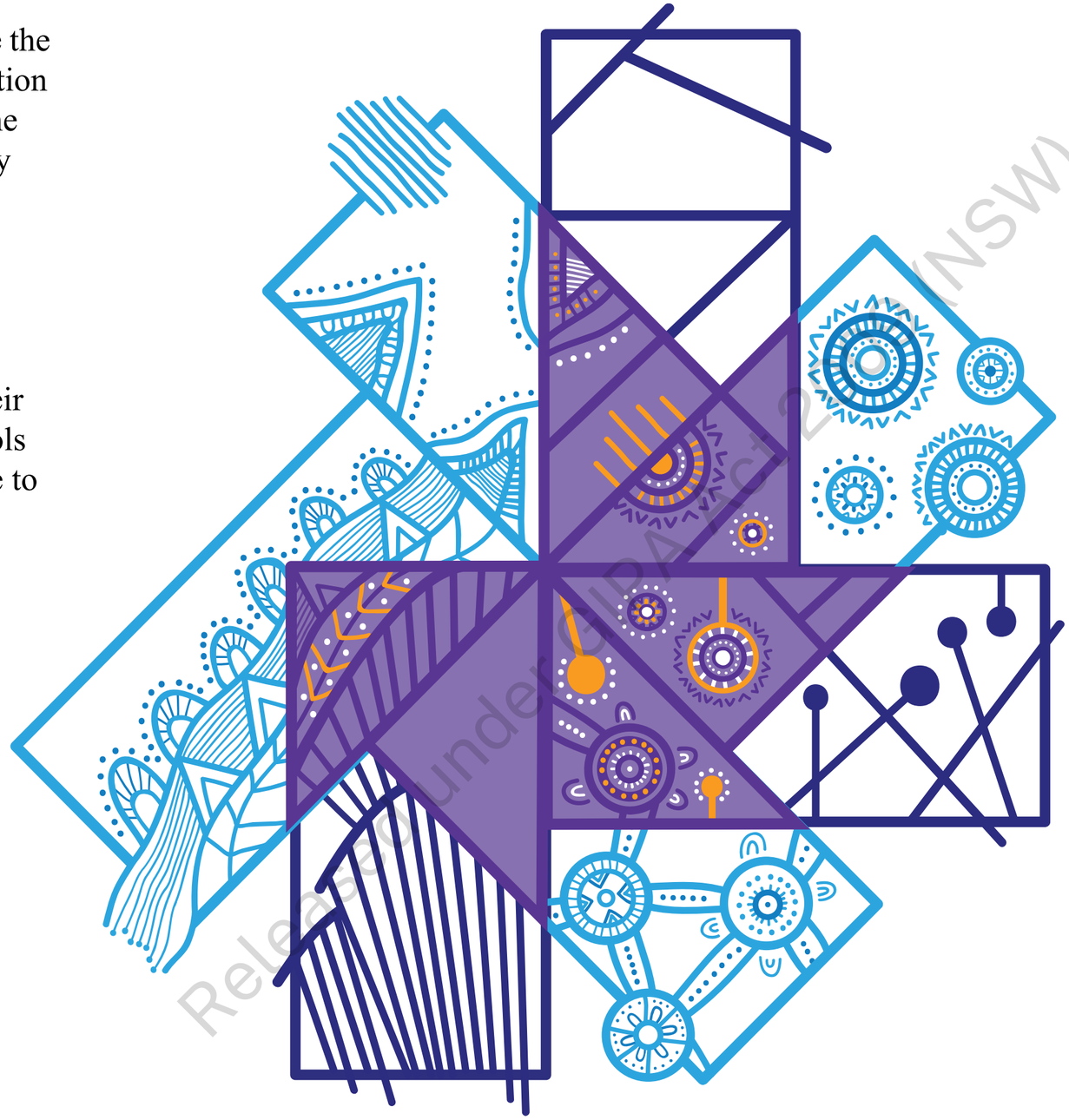
Rev 1

25 November 2022

We would like to acknowledge the Gadigal people of the Eora Nation as the Traditional Owners of the land on which the Arup Sydney office is located.

We pay respect to Elders past, present and emerging.

We recognise and celebrate their cultures, traditions and protocols and the contribution they make to the life of our city and beyond.



Reconciliation Action Plan

Relationships, Respect and Opportunities

Discover more on arup.com

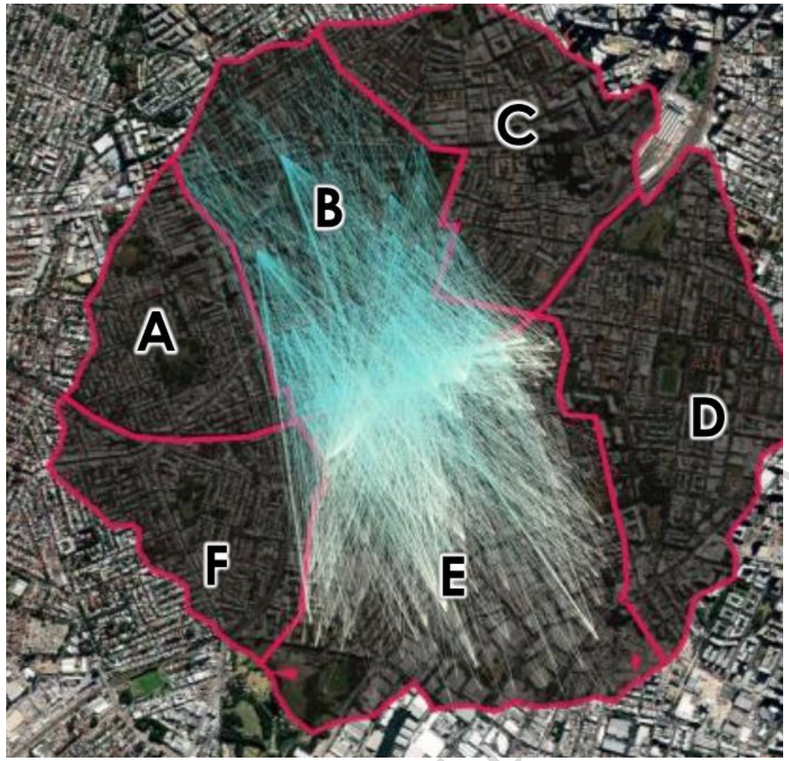
The artwork is *Shift to shape an even better world* by Gilimbaa Artist Tarni O'Shea.

ARUP

Overview

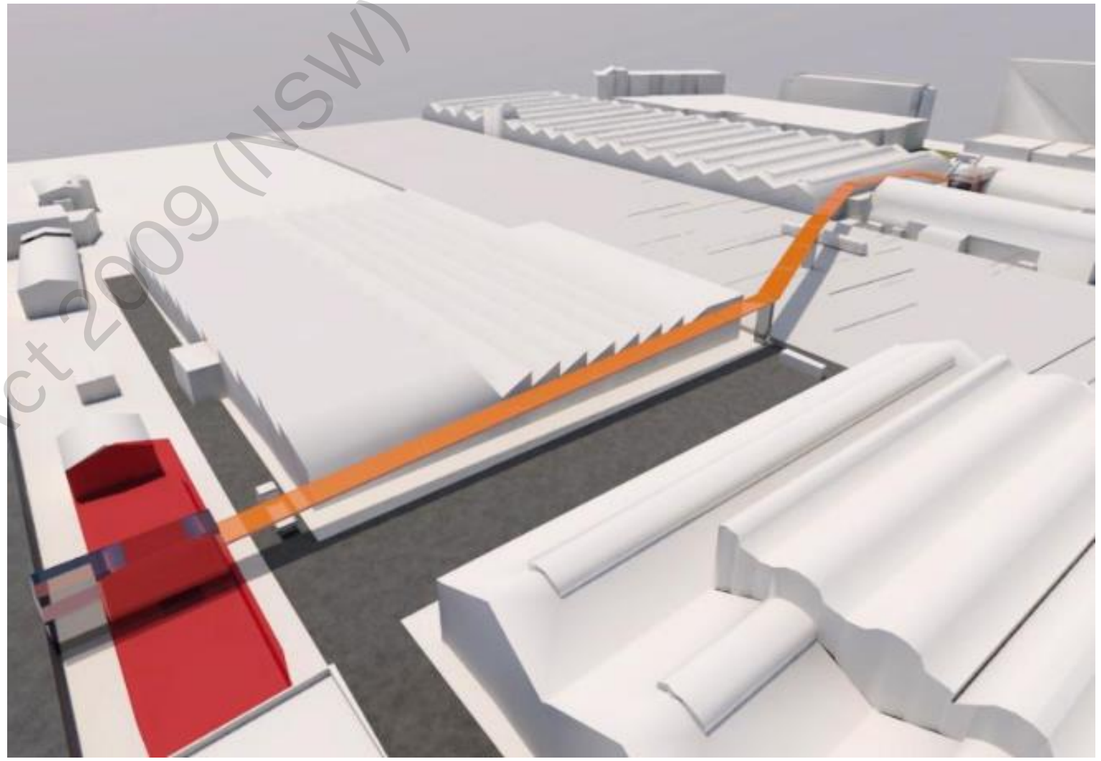
Objective

To investigate the feasibility of a bridge that connects RNE to South Eveleigh and enables pedestrian and cyclist patronage by considering constraints, design requirements, bridge form, risks, opportunities and future design development.



340-420 journeys per day during weekdays

Redfern North Eveleigh Paint Shop Precinct – Bridge catchment analysis, SCT Consulting, 2021



Option from previous study

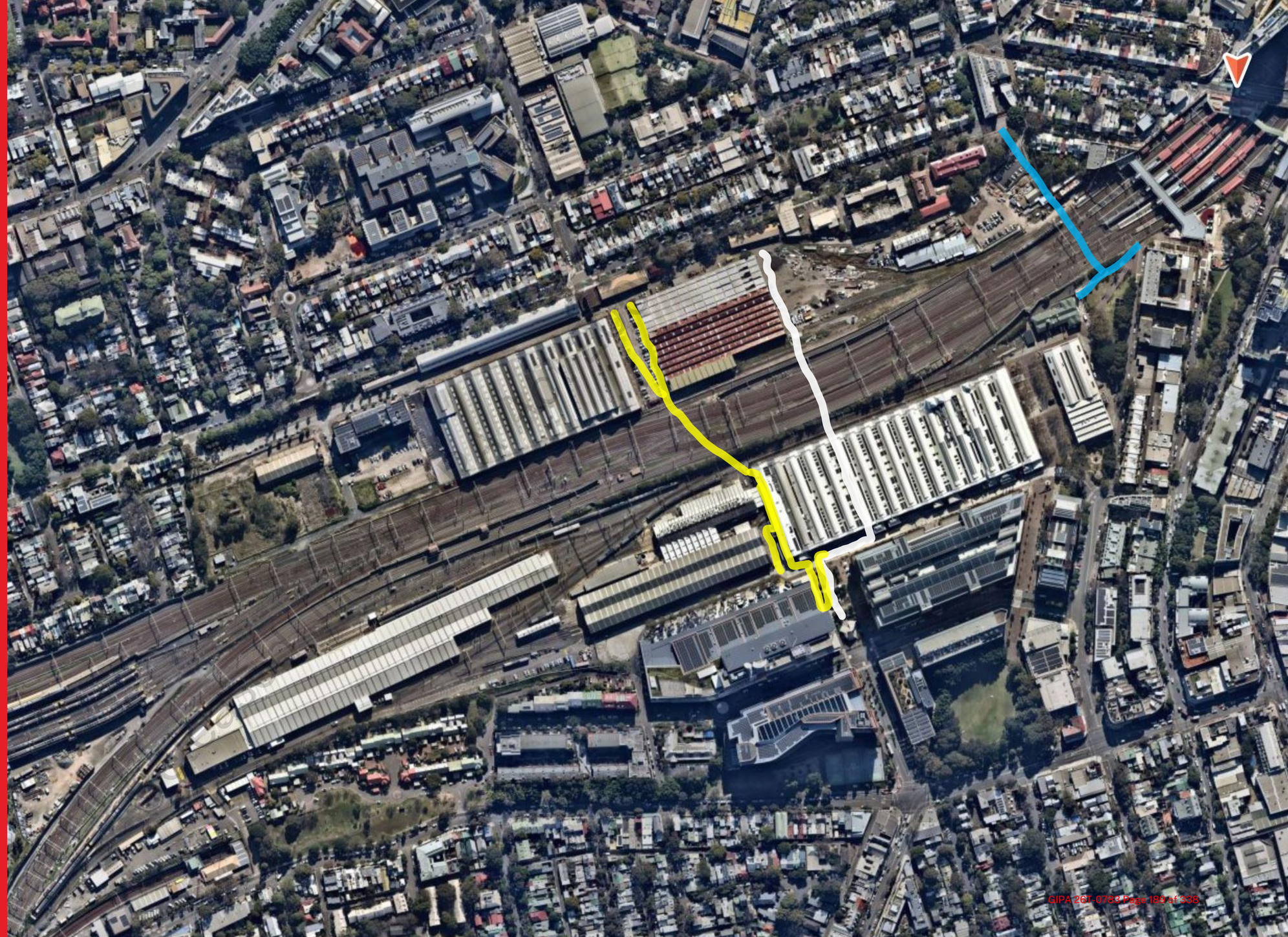
Eveleigh Pedestrian Bridge, TZG , 2017

Contents

Review of Previous Studies

Eveleigh Heritage Walk Report *for Redfern Waterloo Authority* [2008]

Carriageworks to Australian Technology Park – North-South Pedestrian Link *for UrbanGrowth NSW* [2017]



Summary

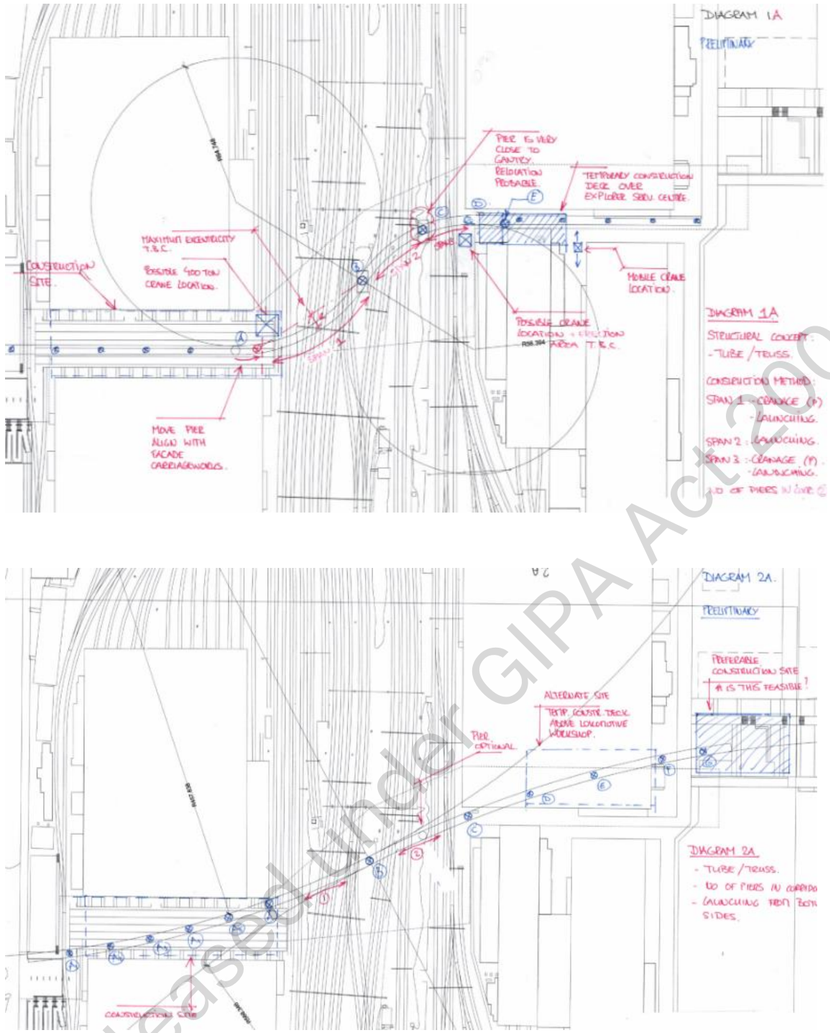
Multiple structural concepts were proposed, and some were developed into options in 2008 study.

Two preferred locations for bridge placement were considered:

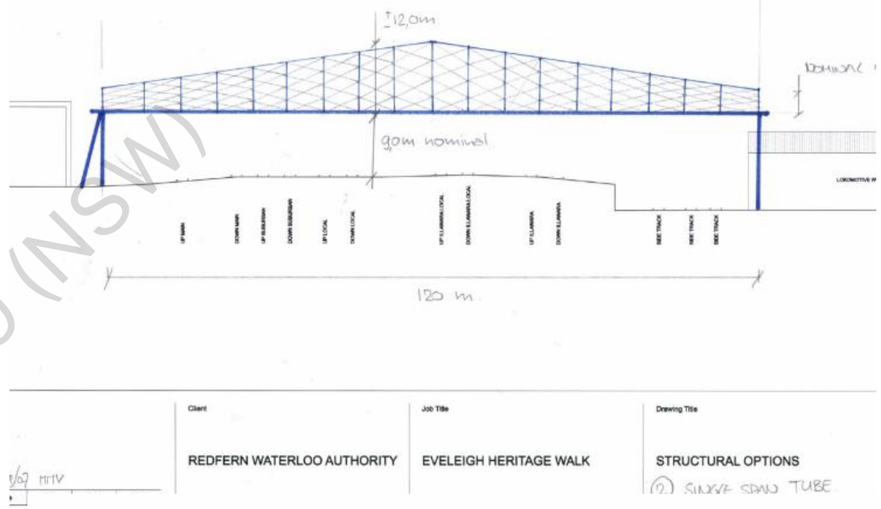
1. The north landing is at Eveleigh rail yard near Little Eveleigh Street, near the western end of the Redfern Station platform. The south landing is located at the Australian Technology Park (ATP) near Cornwallis Street.
2. Near Carriageworks and the stabling yard on the northern side of the railway line and the Locomotive workshop and LES building on the south

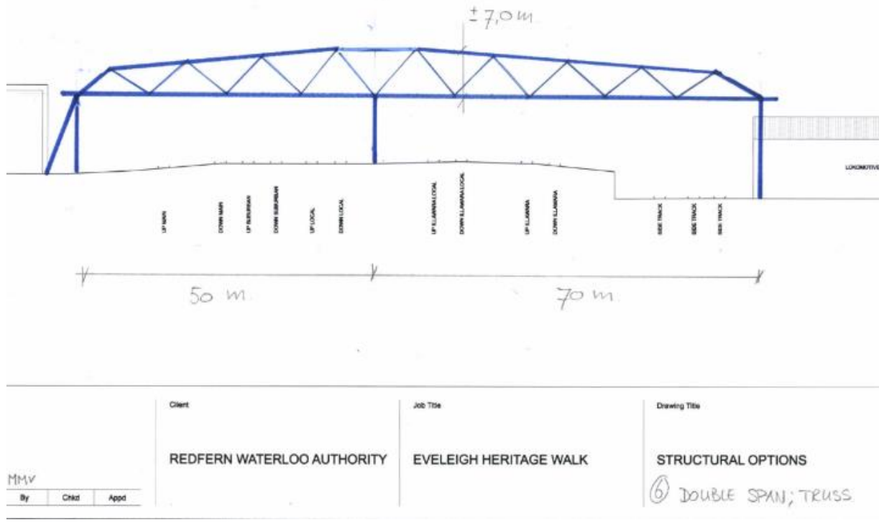
Second preferred location is in the same position as for this report.

Preliminary structural concepts and construction methodologies were presented in the 2008 study, however, the study focus was redirected to consider mostly options in the first location.



Example bridge design options for second preferred location in 2008 study





Example Structural Concepts

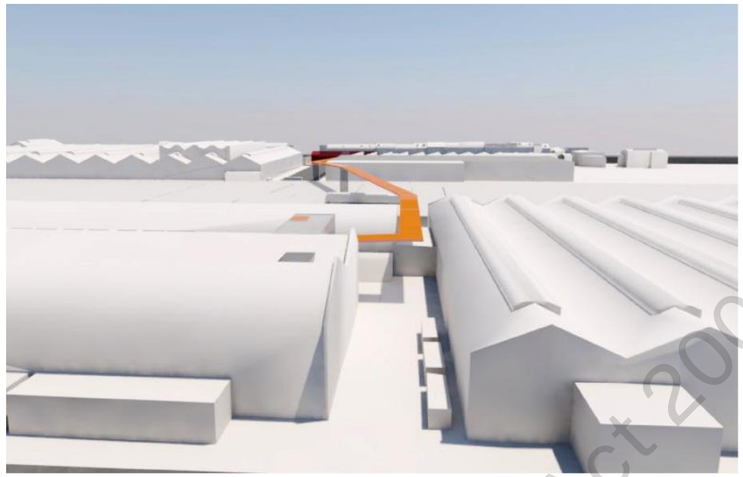
2008 Study

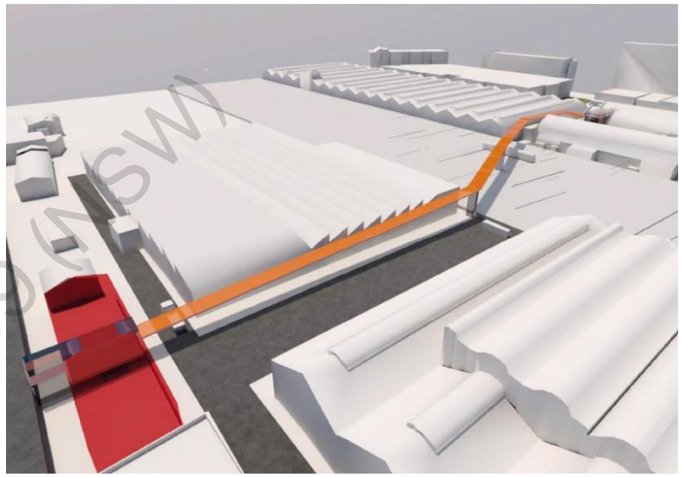
Eveleigh Heritage Walk

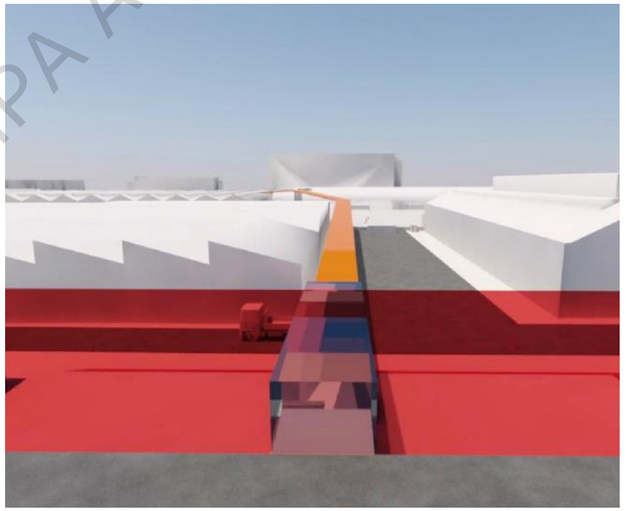
ARUP

Summary

- Alignment options identified
- Known constraints identified
    - Heritage
    - Services
    - Geotechnical
    - Contamination
    - Possession
    - Eveleigh Yard Subway
    - Main West to CBD “exclusion zone”
- Structural forms presented
- Construction methods identified
    - Installed by crane
    - Launched with lateral
    - Rotation of both segments
    - Segmental construction
- Structurally feasible option presented
- Overall feasibility still to be determined







Renderings of Option 1c

2017 Study

Carriageworks to Australian Technology Park – North-South Pedestrian Link

Previous Studies

Optioneering Feasibility Study (2017)

Option 1a (Village Square)

- Segmental Construction
- 461m long (incl. ramps)

Option 1b (LocoB16)

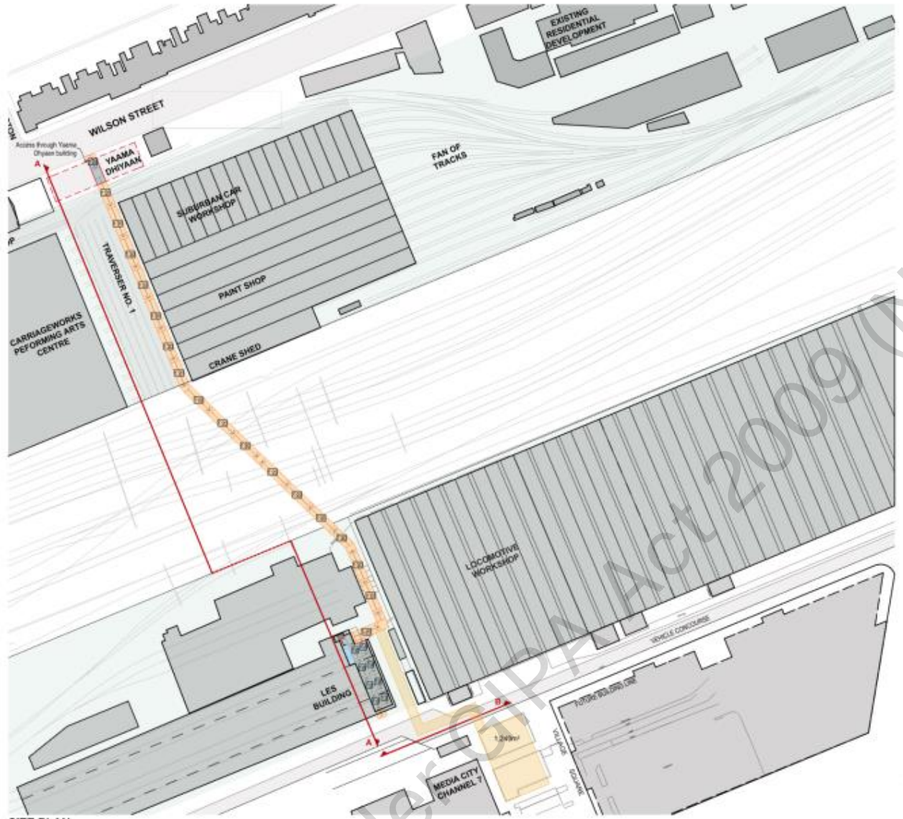
- Launched bridge
- 257m long (incl. ramps)

Option 1c (LES) – Preferred

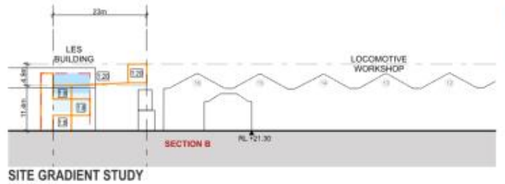
- **Launched bridge**
- **310m long (incl. ramps)**

Option 4 (LocoB11)

- Launched bridge
- 421m long (incl. ramps)



SITE PLAN
Scale 1:2000



SITE GRADIENT STUDY
Scale 1:1000

(DIAGONAL-THROUGH LES BUILDING)

OPTION 1c

The ramp commences at the existing Yaama Dhiyaan building along Wilson Street (RL +30.00). It will require partial or complete building demolition.

An access appropriate gradient of 1:20 travels parallel to the Suburban Car Workshop and the Paintshop. This section of the ramp will need to be designed to consider heritage impacts to the western elevation of the Paintshop.

The bridge then approaches the Railway lines, diagonally angled towards the corridor between the Locomotive Workshop ant the LES Building. It follows a 1:20 gradient towards the centre, reaching a total height of 7.25m, before descending at 1:20 west of the Workshop, 13.5m over the vehicular road (RL +34.86)

The bridge turns so that it parallel with the Locomotive Workshop. The ramp continues to descend at 1:20, taking a 90 degree turn before the first cooling tower. This ramps into the LES Building, dropping 4.8m from the bridge centre point over the Railway. At this point, access to the Ground Floor can be via a steeper 1:8 ramp, falling an extra 11m (RL +21.30)

Sensitivity will need to be taken with the intersection of the bridge into the LES Building with a built up enclosure.

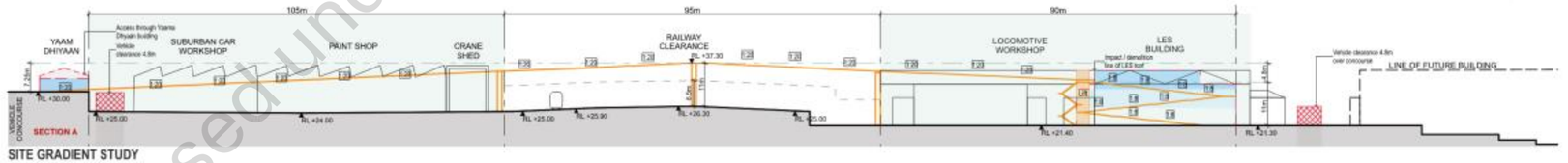
A continued, access appropriate, 1:20 ramp into the Village Square would require a further 1,240m² (RL +19.07).

LEGEND

- Bridge / Ramp
- 1:20 possible ramp extended area
- Building impact area
- Demolished building

DESIRABLE GRADIENTS FOR A SHARDED (CYCLE + PEDESTRIAN + WHEELCHAIR) PATHWAY
[max. lengths]

(Based on Australian Standards AS 1428)
-- 3% (1:33) for general cycleways < 25m*
-- 4% (1:25) for lengths < 19m*
-- 5% (1:20) for lengths < 15m*
*max. interval length before a landing

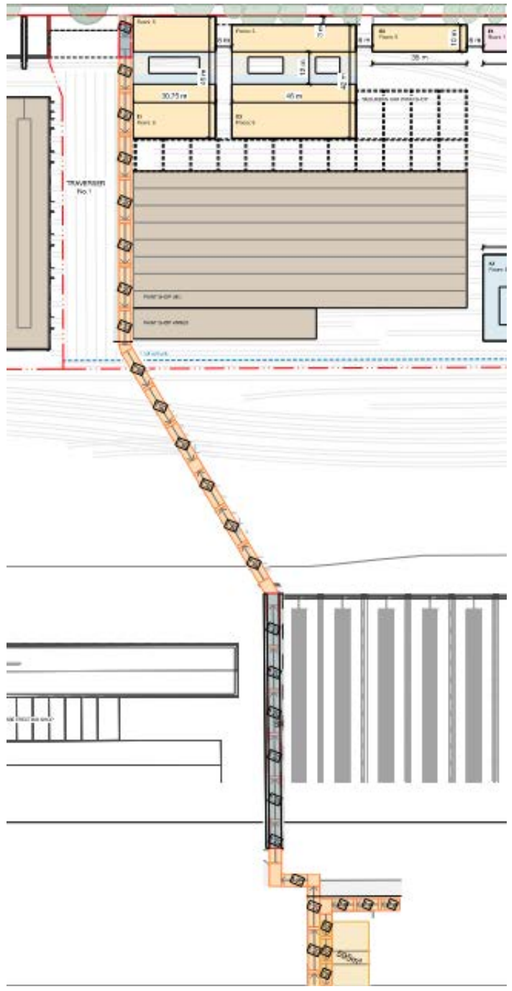


SITE GRADIENT STUDY
Scale 1:1000

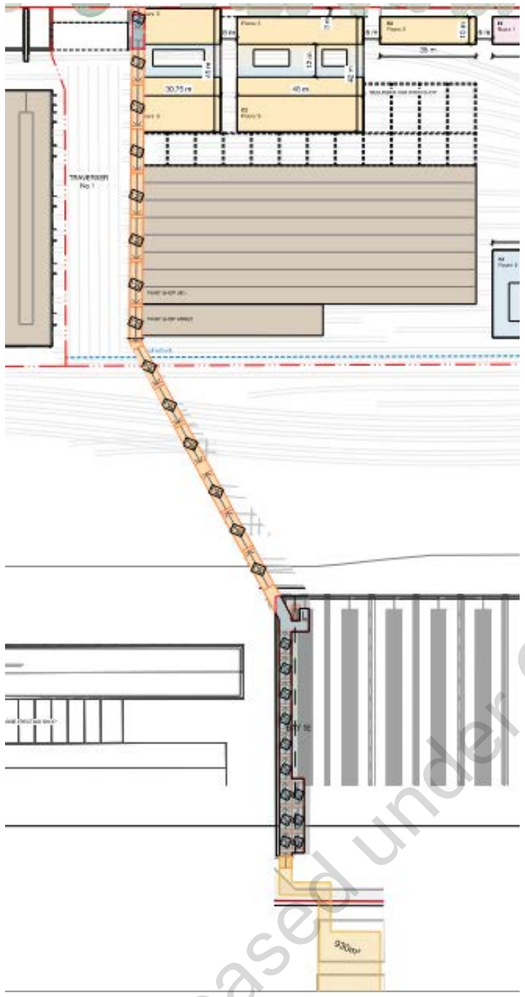
PROJECT: EVELEIGH PEDESTRIAN BRIDGE
ARCHITECT: TONKIN ZULAIKHA GREER ARCHITECTS
DRAWING TITLE: OPTION 1c_DIAGONAL THROUGH LES_1
SCALES: 1:1000, 1:2000
DRAWING NO: 005

2017 Study

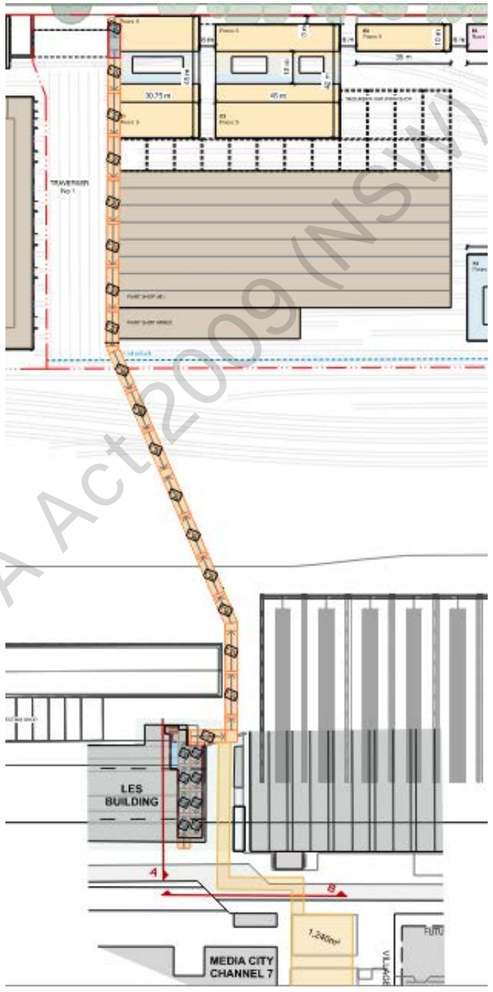
Carriageworks to Australian Technology Park – North-South Pedestrian Link



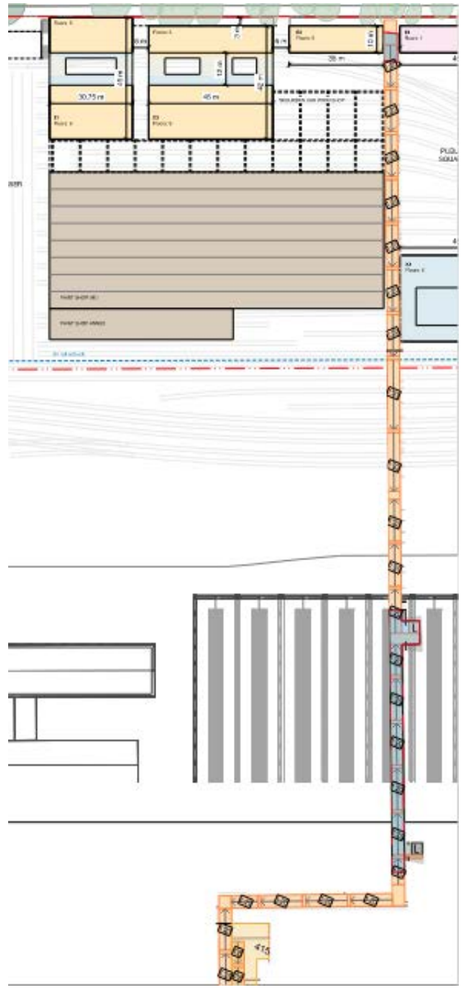
Option 1A



Option 1B



Option 1C



Option 4

2017 Options

2017 Options Study | Current Masterplan

Constraints Overview

Rail Infrastructure

Drainage

Historical Maintenance Tunnel

Geotechnical

Contamination

Third Party Utilities

Heritage

Environmental

Topography | Property

Urban Planning

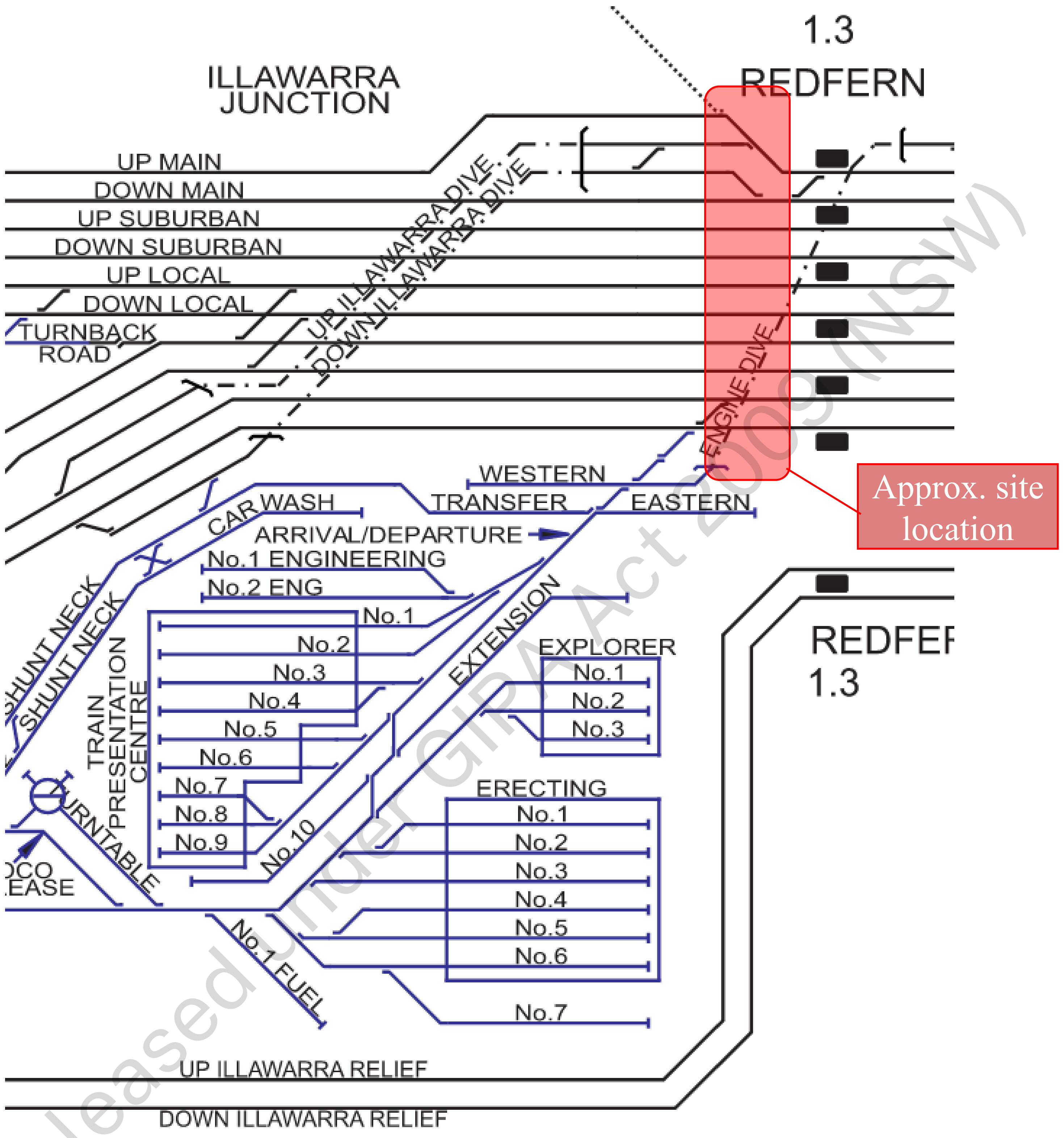
Rail Infrastructure

Redfern is a major heavy rail junction across a series of lines including:

- Western Lines (Mains, Suburban and Local)
- Illawarra Lines
- Access to the Eveleigh maintenance yards servicing the Explorer, Oscar and Intercity fleet, including the engine dive

Constraints

- Construction of the bridge will need to align with the possession configurations.
- Rail lines must remain fully operational. The bridge may need to remain in-situ partially constructed.



Indicative zone of bridge in red on the Metropolitan Network Diagram V3 TfNSW Config Diagram (2010)

Constraints Overview

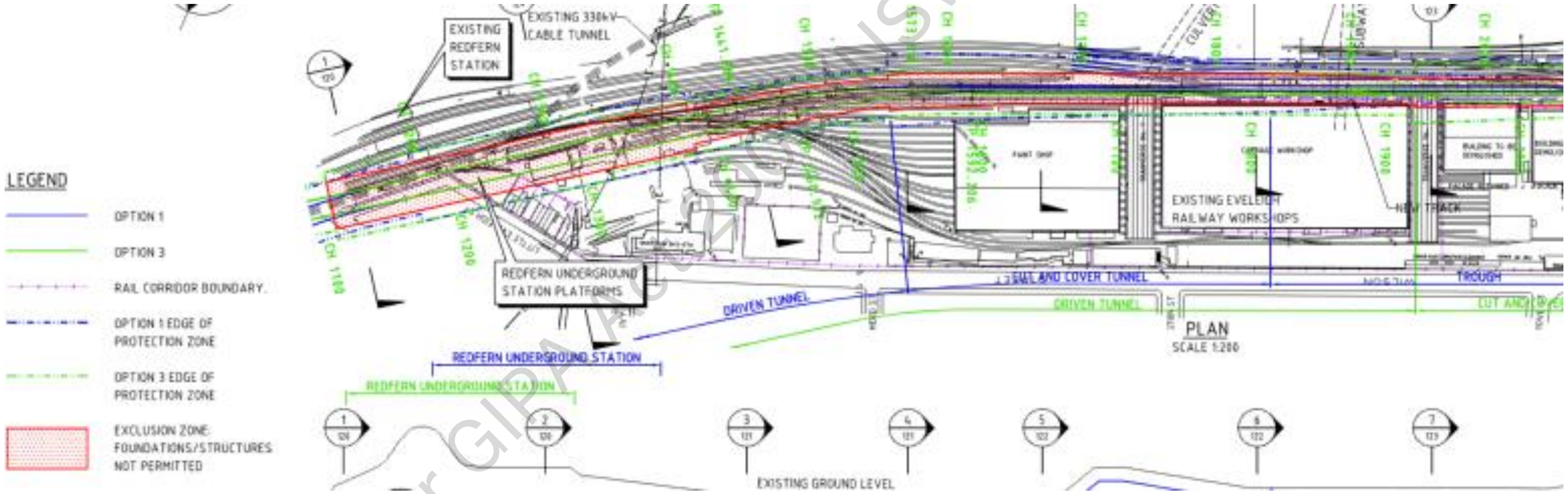
Current Heavy Rail Lines

Rail Infrastructure

Future Main West Line connection to CBD with future underground station at Redfern.

Constraints

- Exclusion zone where foundations are not permitted, directly within proposed landing zone.
- The corridor protection may be now redundant as it is understood that was the precursor to the now under-construction Metro West Line. This will need to be confirmed.



Main West Line to the CBD - Exclusion and Protection zones
Confidential – Not for Distribution

Constraints Overview

Future Main West Line

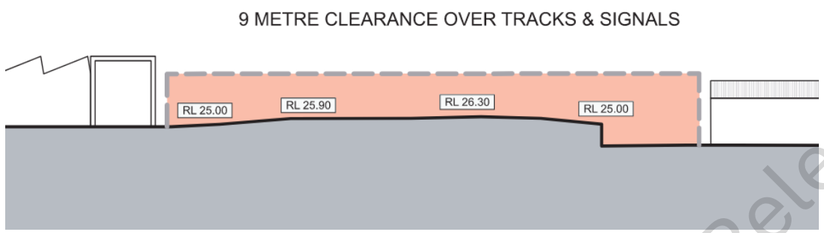
Rail Infrastructure

There are significant numbers of OHW and signal gantries along the rail corridor. The design and construction must consider the physical constraint of the existing assets.

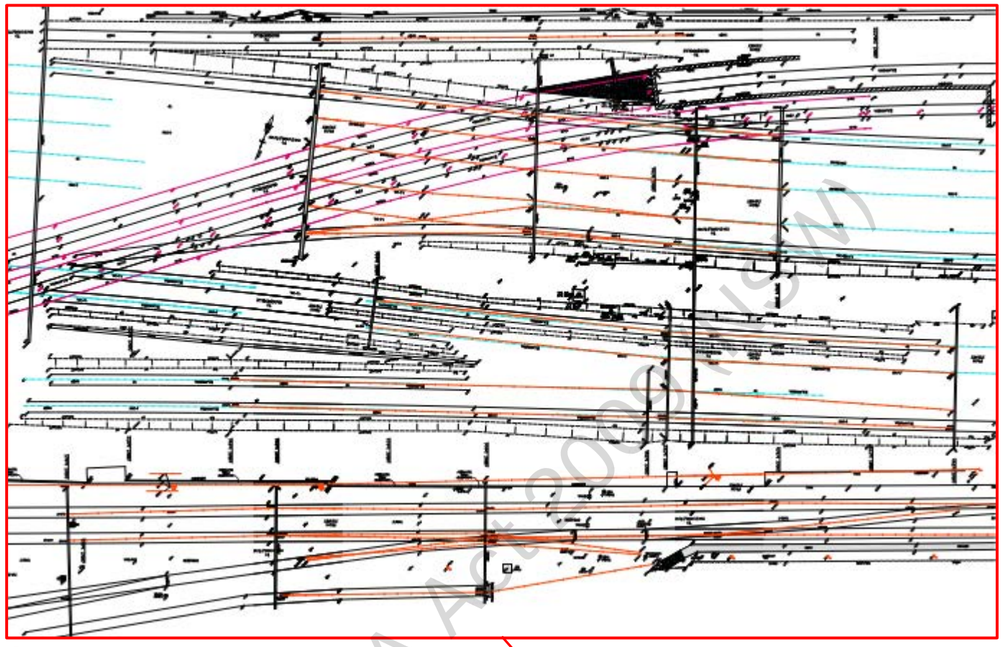
RWA Brief Document – Part D Project Brief in 2007 specifies a minimum clearance of 9 metres above the railway tracks to allow for future flexibility of installing overhead wiring structures. We believe this clearance requirement can be challenged.

Constraints

- Clearance from OHW and gantries governing the bridge deck level
- Consider earthing and bonding requirements (typical cost to bond structure)



Cox sketch (2017) – Section at Rail Corridor



Survey at Eveleigh (2007)

LEGEND :-

+21.59	DENOTES SPOT LEVEL.
+24.12TW	DENOTES TOP OF WALL LEVEL.
+21.56BW	DENOTES BOTTOM OF WALL LEVEL.
+34.85TOP	DENOTES TOP OF FEATURE LEVEL.
+28.33CAT	DENOTES CATENARY WIRE LEVEL.
+26.88CON	DENOTES CONTACT WIRE LEVEL.
+34.83W	DENOTES WIRE LEVEL.
+34.16MID	DENOTES MID WIRE LEVEL.
+20.19	DENOTES TUNNEL LEVEL.
+24.45R	DENOTES ROOF OF TUNNEL LEVEL.
PP	DENOTES POWER POLE.
LP	DENOTES LIGHT POST.
BLR	DENOTES BOOT LEG RISER. (EARTH POT)
KC	DENOTES KRONE CABINET.
	DENOTES STANCHION.
	DENOTES TRACK ALIGNMENT.

Google Map (2022)

Constraints Overview

Current Overhead and Signalling Configuration

ARUP

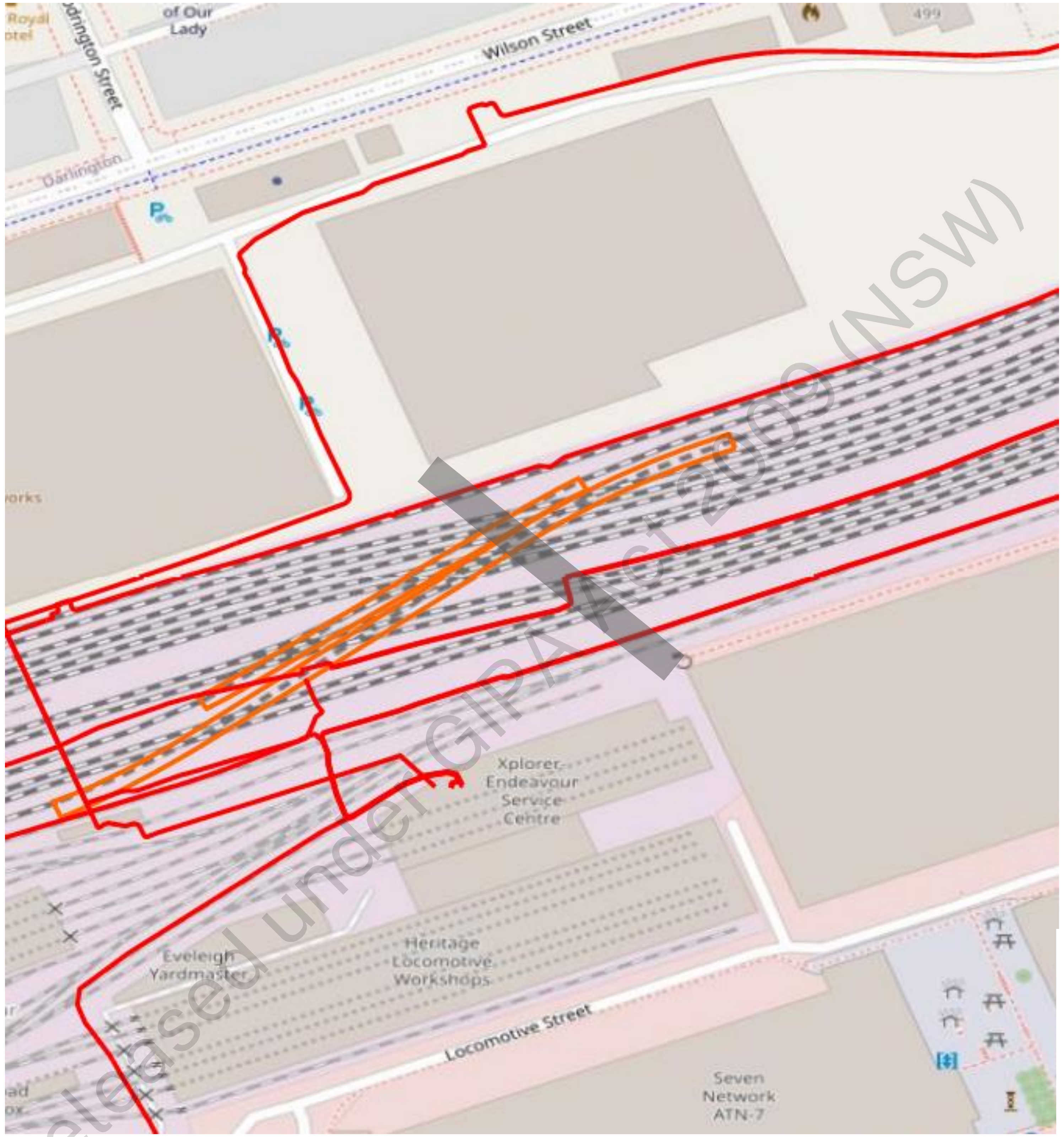
Rail Infrastructure

Sydney Trains active assets in the area, identified in Dial Before You Dig (DBYD) search in the area:

- HV cable
- Illawarra Dives (Tunnel)
- Potential for other underground services

Constraints

- Works are not undertaken within 5 metre radius of any RailCorp electrical, communication assets, and within 25 metres of any other RailCorp tunnel and/or Airport Line tunnel, according to the current RailCorp DBYD Terms and Conditions.
- These constraints impact on the placement of pier and foundation location across the rail corridor and the Traverser at North Eveleigh.



LEGEND:

Affected BYDA Work Area
HV Cable
Tunnel
Communications

Sydney Train – Before You Dig Australia Location Information (2022)

ARUP

Constraints Overview

Current underground Rail HV

Drainage

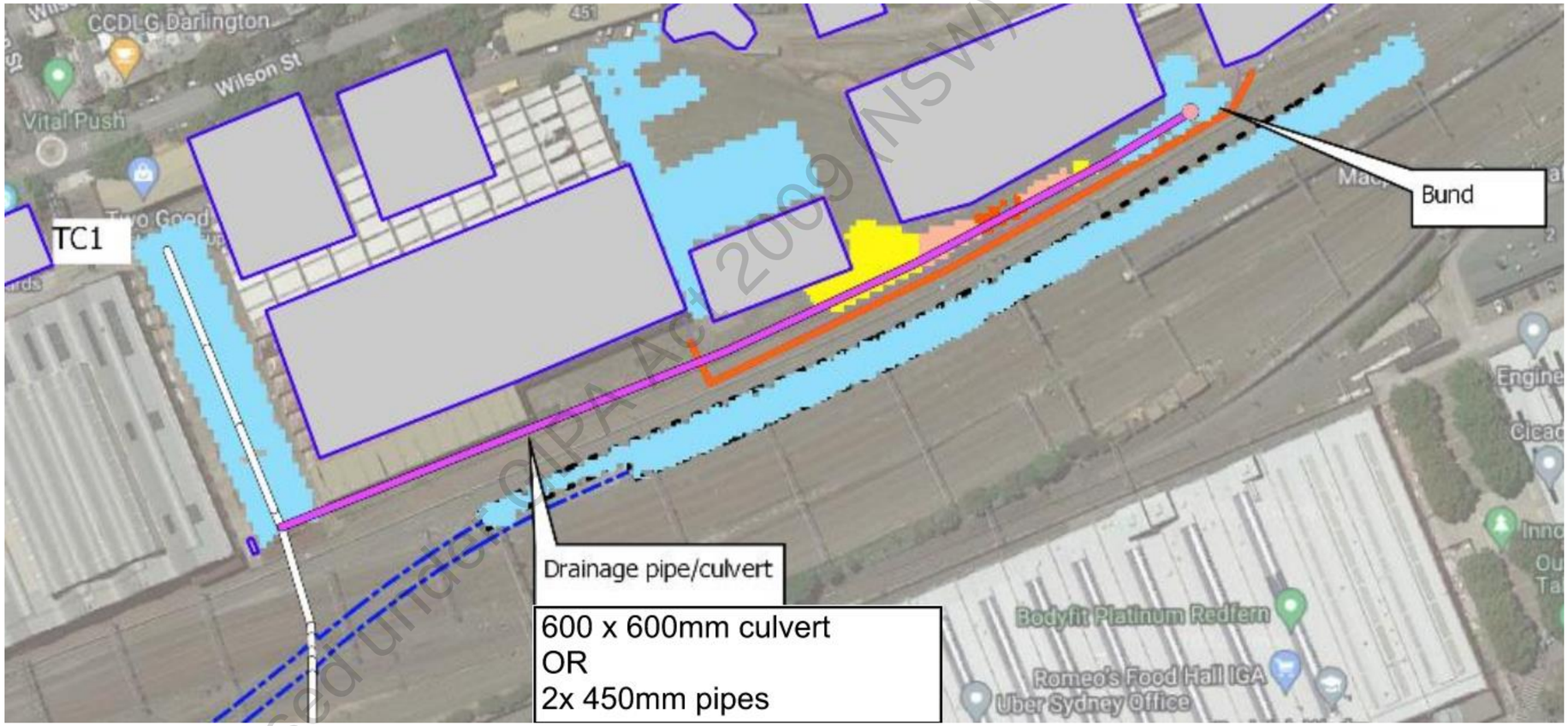
Sub-Surface Drainage

The AECOM flooding report proposes a <900mm deep, ~600x600mm or twin 450mm dia trunk drain along the southern edge of the paint shop precinct. A new 250 dia pipe and pits are also proposed to the south of the paintworks as part of the MTMS2 works. This is a potential landing zone for the piers of the northern approach ramp.

An existing drainage culvert (TC1) runs the length of the traverser.

Overland Drainage

Ballasted track relies on efficient drainage to prevent ponding and degradation of track. The placement of any piers should consider impacts to drainage.



1% AEP Impact map with proposed mitigations, AECOM Water Quality, Flooding and Stormwater Assessment (SSP Study No. 13) 60660346-RP-IU-01

Constraints Overview

Drainage Current | Proposed

Existing Maintenance Tunnel

Eveleigh Yard Subway

A 'tunnel' was indicated diagrammatically and described briefly in various sources of drawing and reports, running approximately along the alignment drawn from the west end of the LES building to the south centre of the Carriageworks building, but not the entire length.

The NSW Office of Environment & Heritage provides the following description under Eveleigh Railway Workshops, listed under s.170 Register.

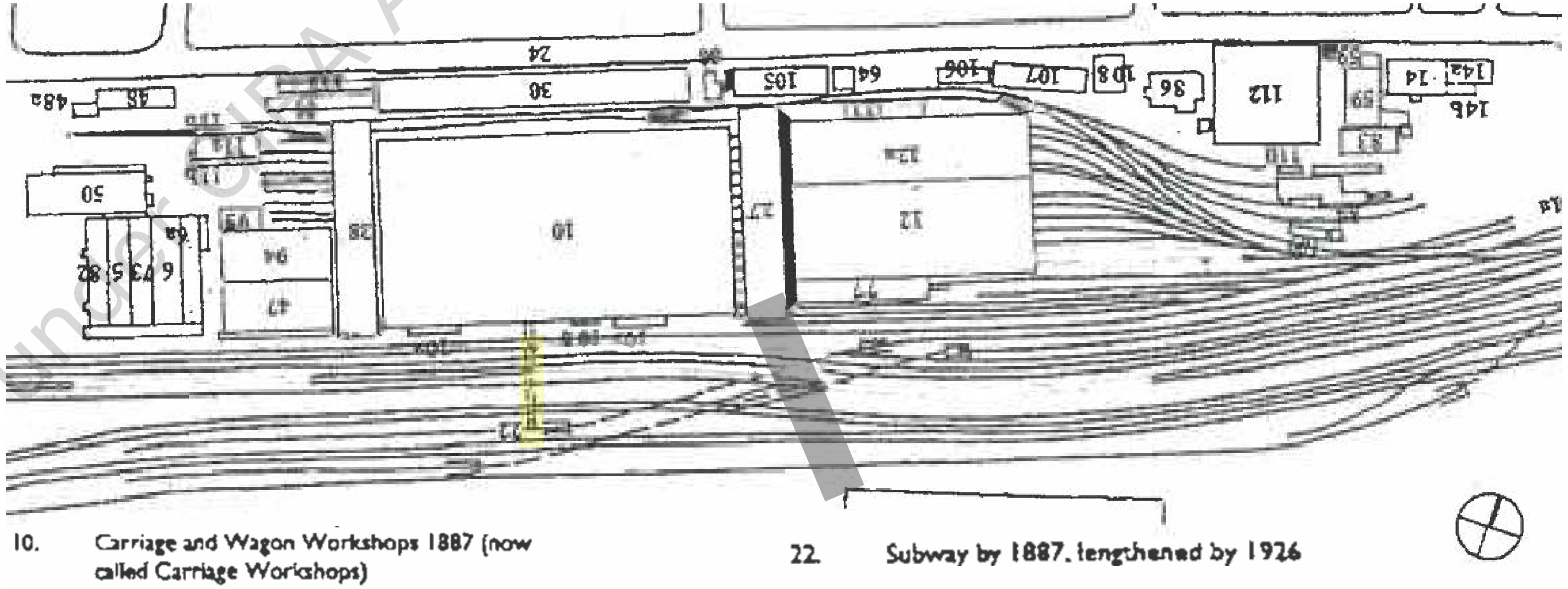
Heritage Description: S34: Eveleigh Yard Subway (1925-1927): The subway is a rectangular tunnel 80 metres in length, running below the rail tracks between the Carriage Workshops and the Loco Workshops at Eveleigh. Walls are brick lined and the floor and ceiling are concrete. Both ends are accessed by a flight of brick steps from ground level and there is one flight of steps within the tunnel, near the southern end.

Constraints

- Although the subway has the potential for access of workers, materials and equipment into the required construction zone between tracks during the construction of piers or temporary support, its use would be limited by the operation of railway above.
- The tunnel may be considered as confined space, pending on further investigation of the site setting.

NSW Office of Environment & Heritage website

Eveleigh Carriageworks – Conservation Management Plan Volume 1



Statement of Heritage Impact - Carriageworks at Eveleigh Contemporary Performing Arts Centre (2003)
Subway location (Image placed upside down for North pointing upwards)

Constraints Overview

Existing Subsurface Access Tunnel

Geotechnical

Historical Geotechnical Investigations

Carriageworks

Jeffery + Katauskas 1998

→ 6m to Shale

South Eveleigh

Johnson Environmental Technology 1993

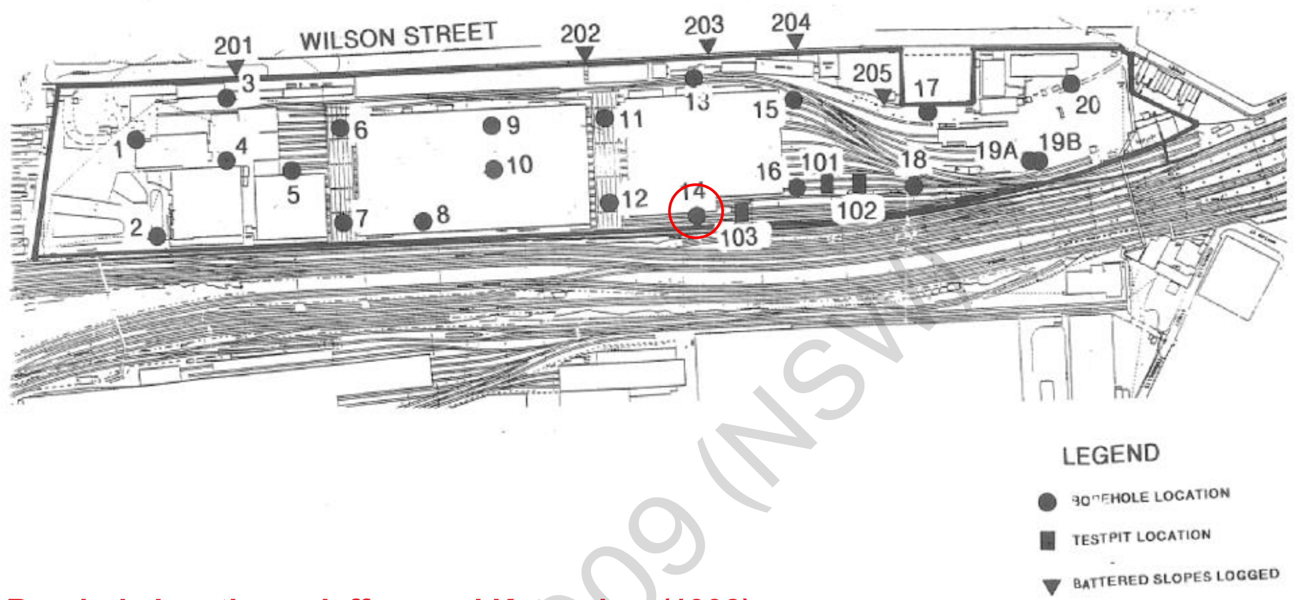
→ 8m depth of sands, no rock observed

Observations

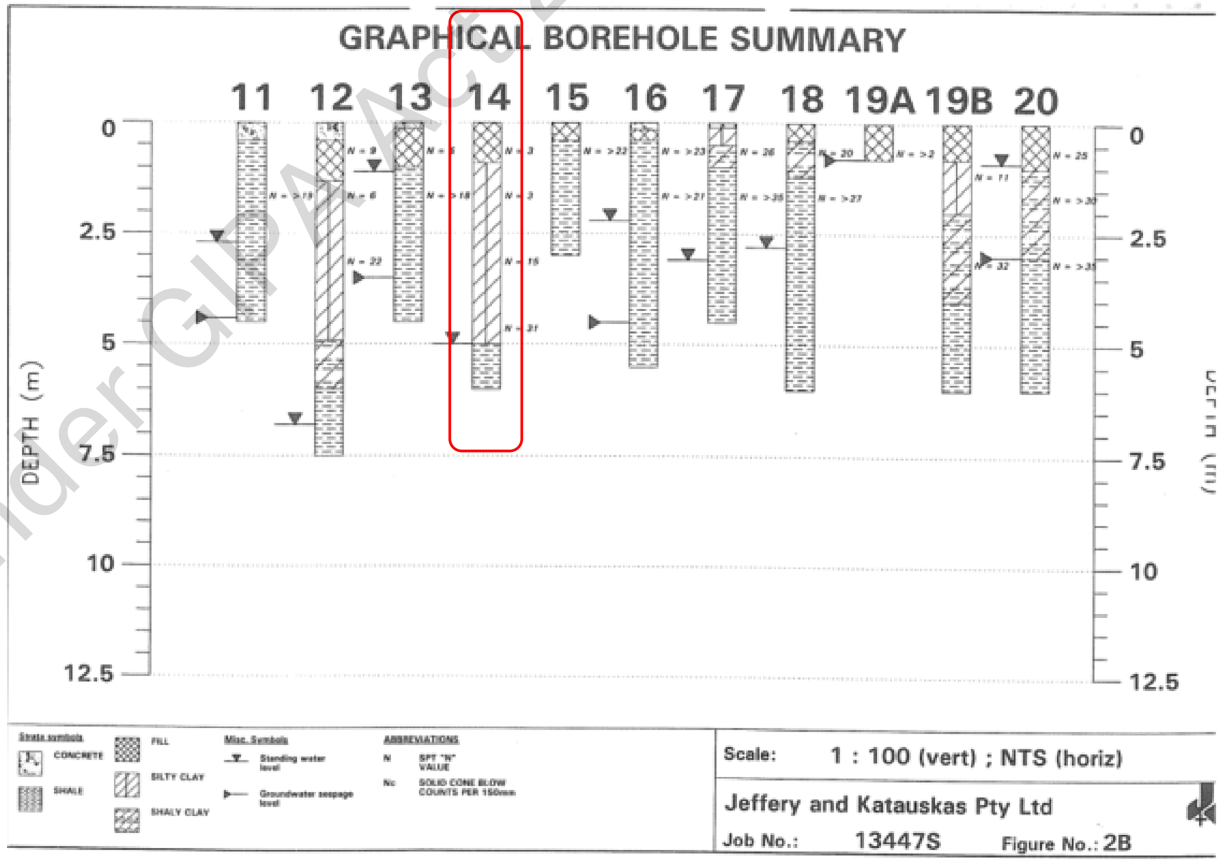
→ Driven or cast in place bored piles into shale is the likely solution for bridge foundations. Driven piles may not be acceptable given the noise and vibration produced by pile driving.

→ The design of midspan pier foundations in the corridor will likely be governed by rail collision loading.

→ The dimensions of the substructure to the midspan pier and deflection wall may not be compatible with the existing rail infrastructure.



Borehole locations, Jeffrey and Katauskas (1998)



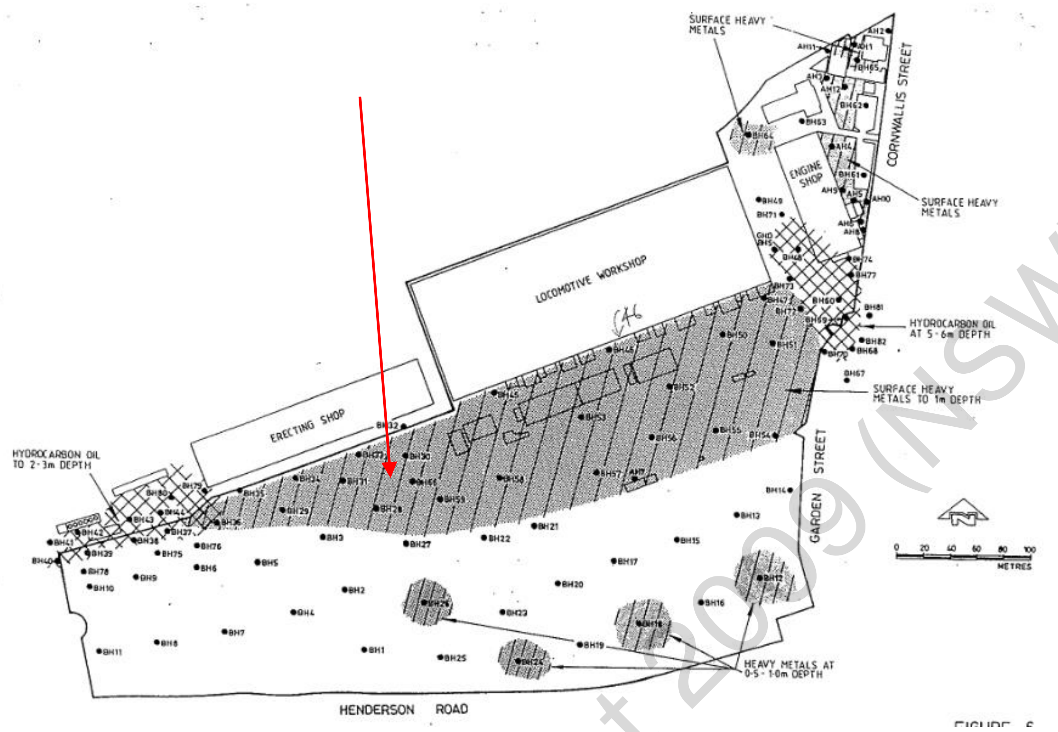
Borehole summary, Jeffrey and Katauskas (1998)

Constraints Overview

Historical Geotechnical Investigations

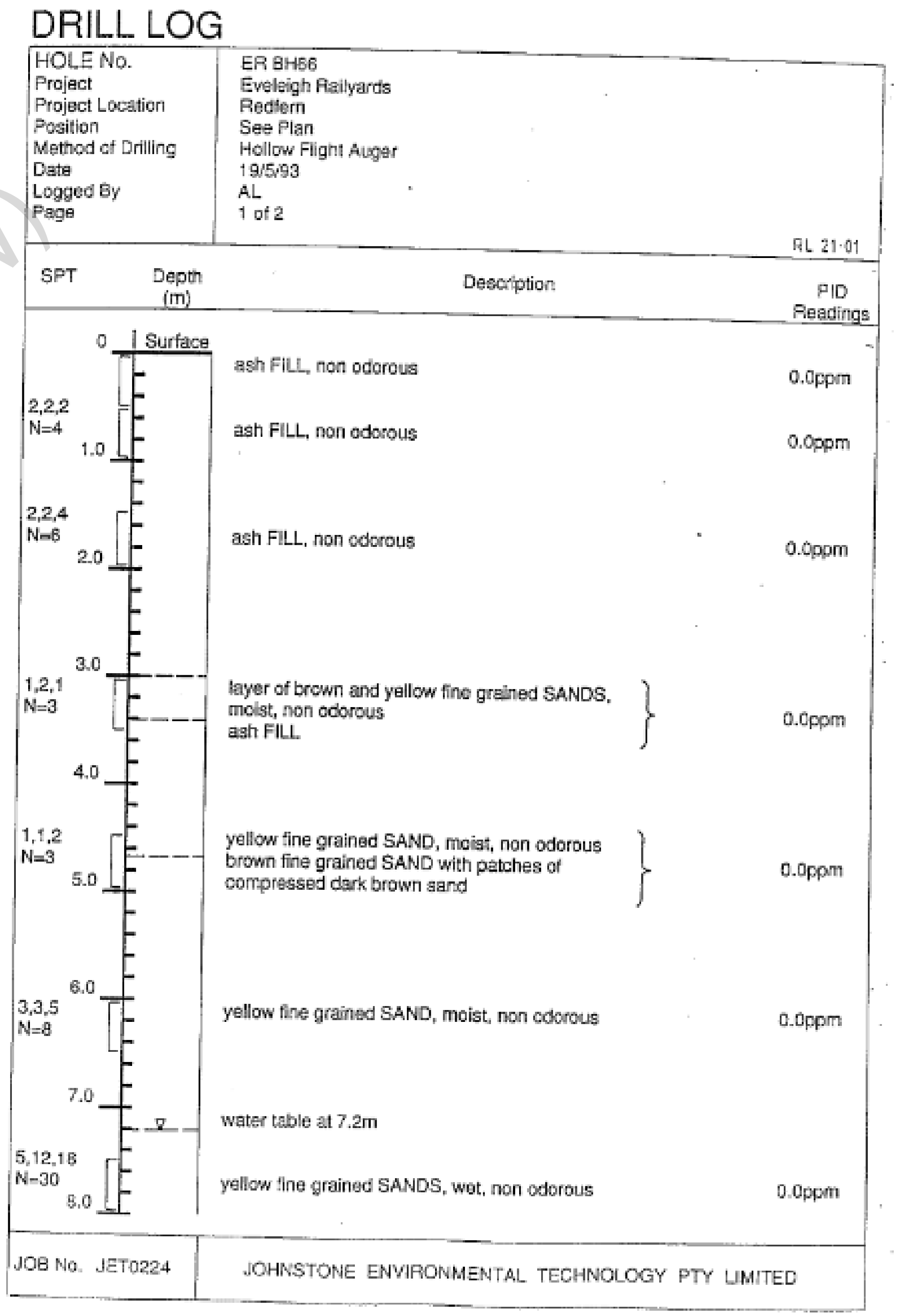
Contamination

The WSP Interim Audit Advice 1 in 2007 presented the Contamination study conducted in North Eveleigh Yard while contamination in South Eveleigh Yard was shown in the 1993 Johnstone Environmental Technology Report.

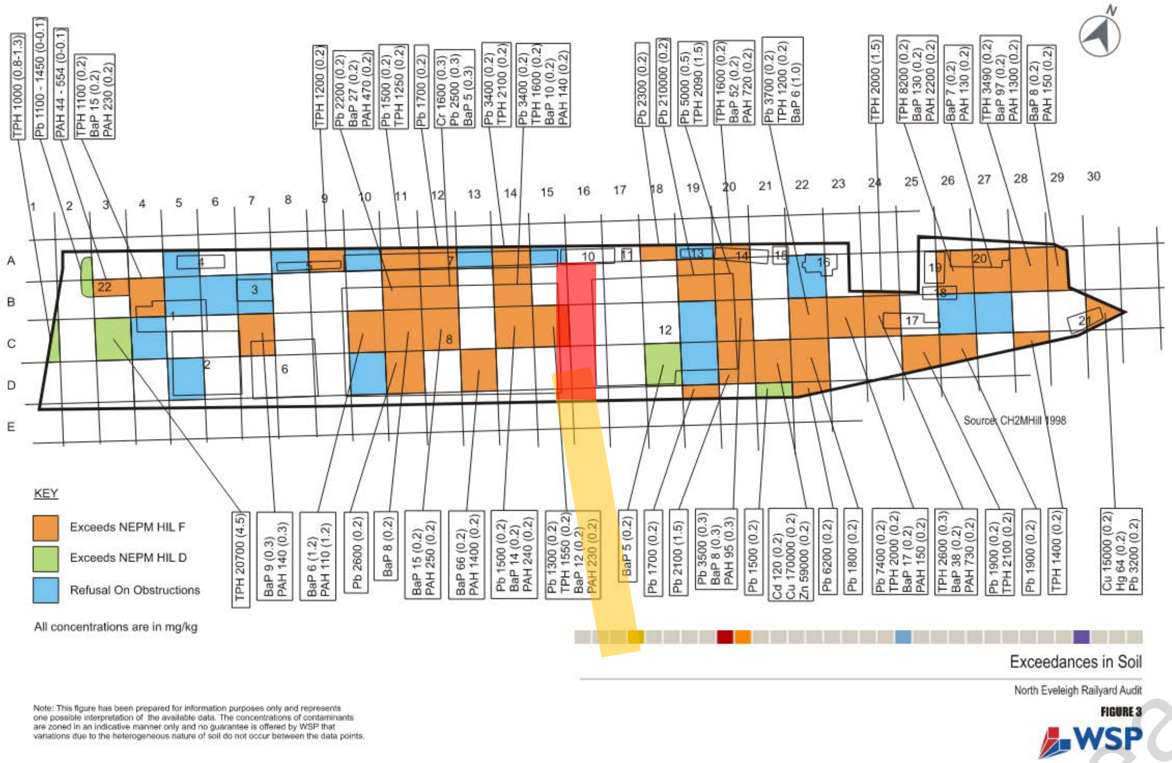


SURFACE HEAVY METALS
CORNWALLIS STREET
ENGINE SHOP
LOCOMOTIVE WORKSHOP
ERECTING SHOP
HYDROCARBON OIL TO 2-3m DEPTH
HYDROCARBON OIL AT 5-6m DEPTH
SURFACE HEAVY METALS TO 1m DEPTH
GARDEN STREET
HEAVY METALS AT 0.5-1.0m DEPTH
HENDERSON ROAD
METRES

Johnstone Environmental Technology Report (1993)
South Eveleigh Yard – pointing at BH66



DRILL LOG
HOLE No. ER BH66
Project Eveleigh Railyards
Project Location Redfern
Position See Plan
Method of Drilling Hollow Flight Auger
Date 19/5/93
Logged By AL
Page 1 of 2
RL 21·01
SPT
Depth (m)
Description
PID Readings
0 Surface
ash FILL, non odorous 0.0ppm
2,2,2 N=4
1.0
ash FILL, non odorous 0.0ppm
2,2,4 N=6
2.0
ash FILL, non odorous 0.0ppm
3.0
1,2,1 N=3
layer of brown and yellow fine grained SANDS, moist, non odorous
ash FILL 0.0ppm
4.0
1,1,2 N=3
yellow fine grained SAND, moist, non odorous
brown fine grained SAND with patches of compressed dark brown sand 0.0ppm
5.0
6.0
3,3,5 N=8
yellow fine grained SAND, moist, non odorous 0.0ppm
7.0
water table at 7.2m
5,12,18 N=30
yellow fine grained SANDS, wet, non odorous 0.0ppm
8.0
JOB No. JET0224
JOHNSTONE ENVIRONMENTAL TECHNOLOGY PTY LIMITED



WSP Interim Audit Advice 1 (2007)
North Eveleigh - Contaminant Exceedances in Soil

WSP Interim Audit Advice 1 (2007)
North Eveleigh - Depth to Base of Fill

Johnstone Environmental Technology Report (1993)
Drill log from BH66

Traverser

Proposed bridge location

Constraints Overview

Historical Contamination Studies

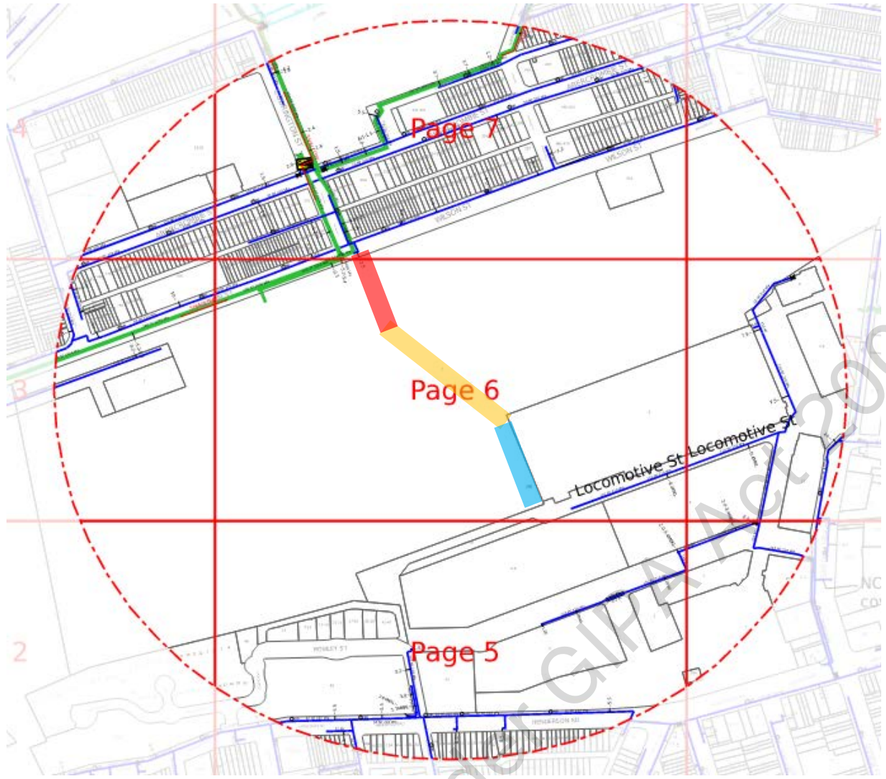
Third Party Utilities

The following assets are identified with the DBYD search in the area, including the vicinity of potential north and south landings as envisaged in the 2017 study. Assets are generally located near Yaama Dhiyaan building on Wilson Street at the north of Traverser (north landing) and near Locomotive Street on the south of the corridor between the Locomotive Workshop and the LES Building (south landing).

- Jemena
- Sydney Water
- Ausgrid
- City of Sydney
- NBN
- Potential for other underground services

Constraints

- Works may not be undertaken within the clearance set by the asset owner



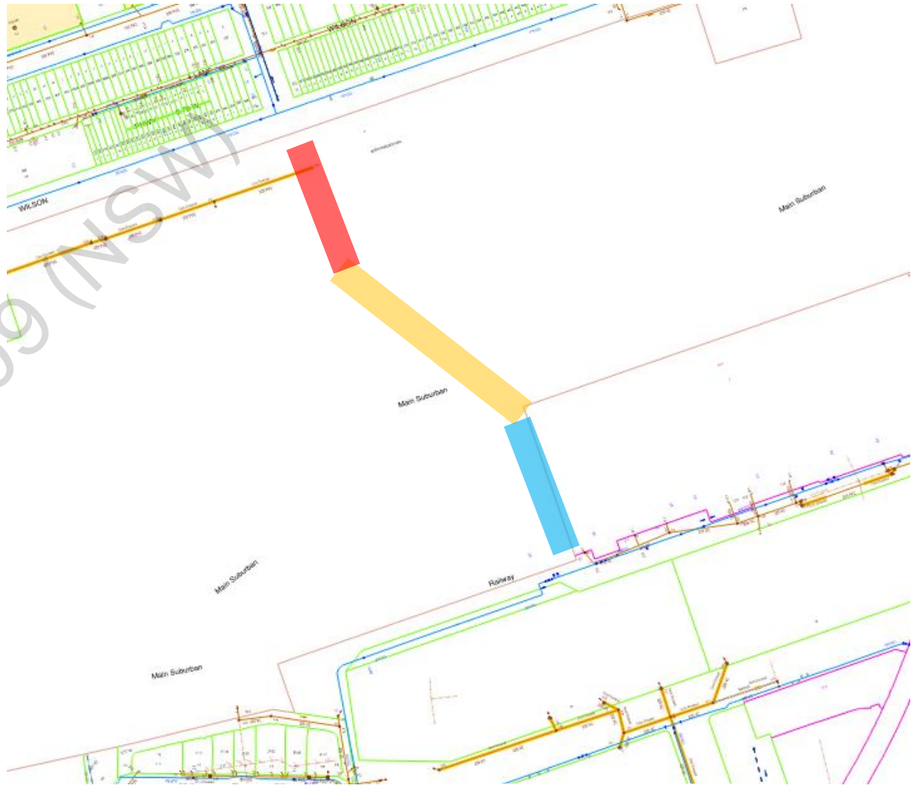
210kPa Medium Pressure gas main

300kPa Medium Pressure gas main

400kPa Medium Pressure gas main

1050kPa High Pressure gas main

Jemena DBYD



Sewer property connection point
With chainage to downstream maintenance hole.

Sewer concrete encased section

Sewer Rehabilitation

Sewer terminal maintenance shaft

Stormwater gully

Stormwater maintenance hole

Watermain – potable drinking water
With size type text.

Disconnected watermain potable drinking water
This means the watermain has been disused but remains in the ground.

Recycled watermain

Sydney Water DBYD

Traverser

Proposed bridge location

Corridor between the Locomotive Workshop and the LES Building

Constraints Overview

Third Party Utilities

ARUP

Heritage

Adjacent paint shop and annex is exceptional or high level of heritage significance.

Traverser machine must be preserved, either at the northern or southern end of the Traverser carriageway.

Ideally no structures obstructing the view from the heritage.

Paint shop and annex are heritage items.

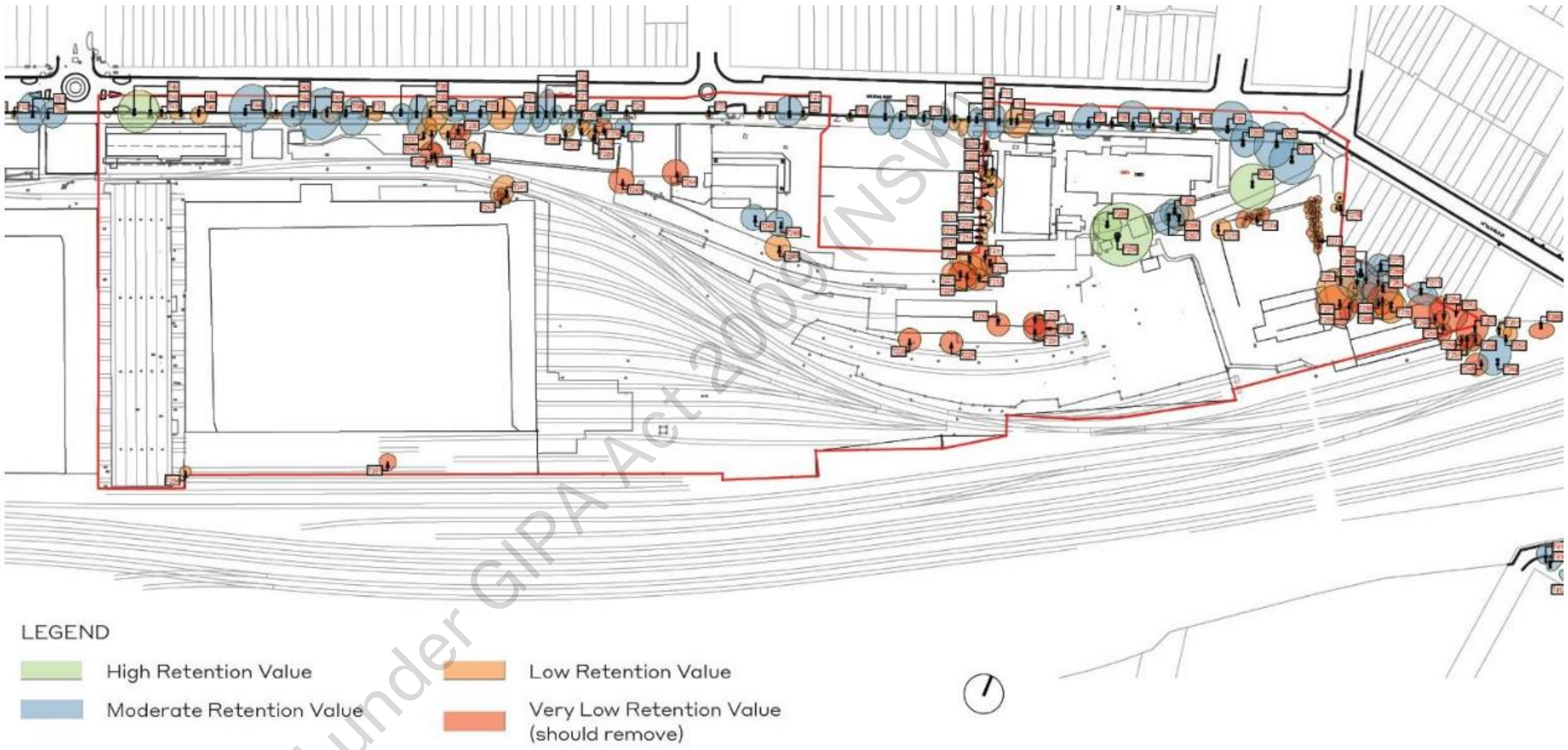
DPE, July 2022, Design Guidelines, Figure 2: Urban Strategy Map

Constraints Overview

Known Heritage Constraints

Environmental

Moderate retention value trees along Wilson Street



DRAFT Paint Shop Sub Precinct Design Guide (July 2022)
Figure 35: Significant Tree Retention

Constraints Overview

Known Environmental Constraints

Topography | Property

Landform – Elevation changes are substantial. Assuming 9m clearance and 0.7m bridge deck, then approximately:

- 10.8m rise/fall from north landing to ground
- 7m rise/fall from north landing to Wilson Street
- 14.6m rise/fall from south landing to ground

9m clearance to be challenged

Carriage Works

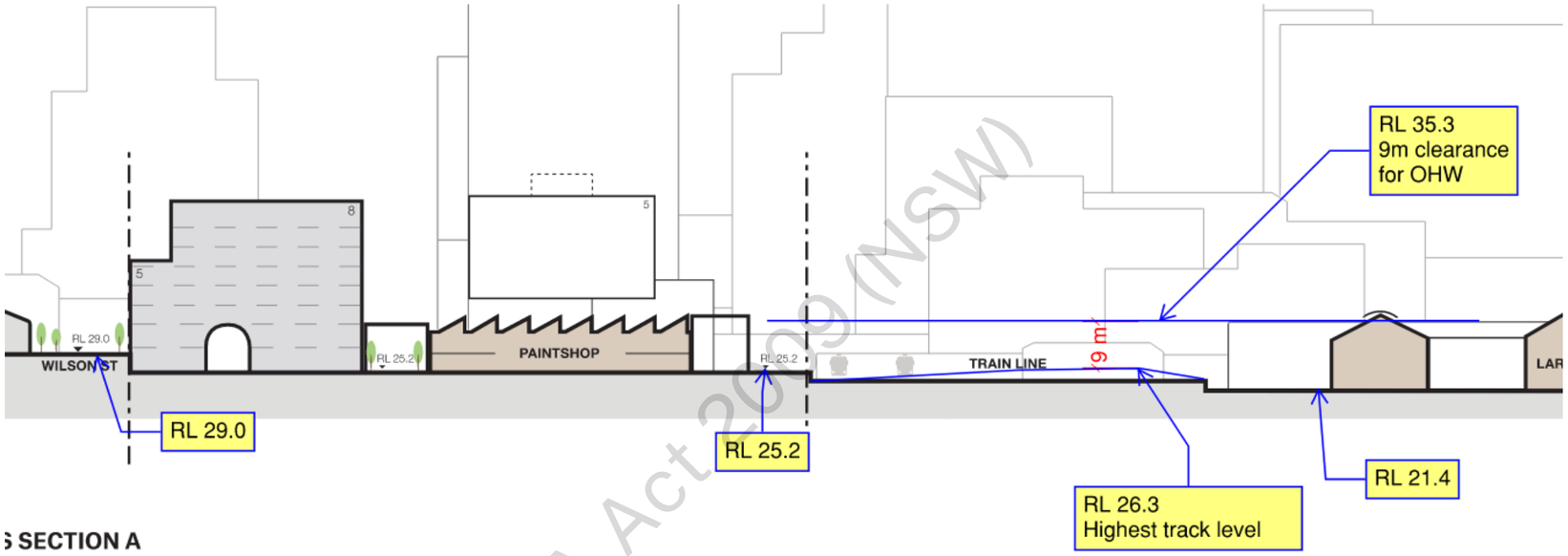
- Vehicle loading access along traverser

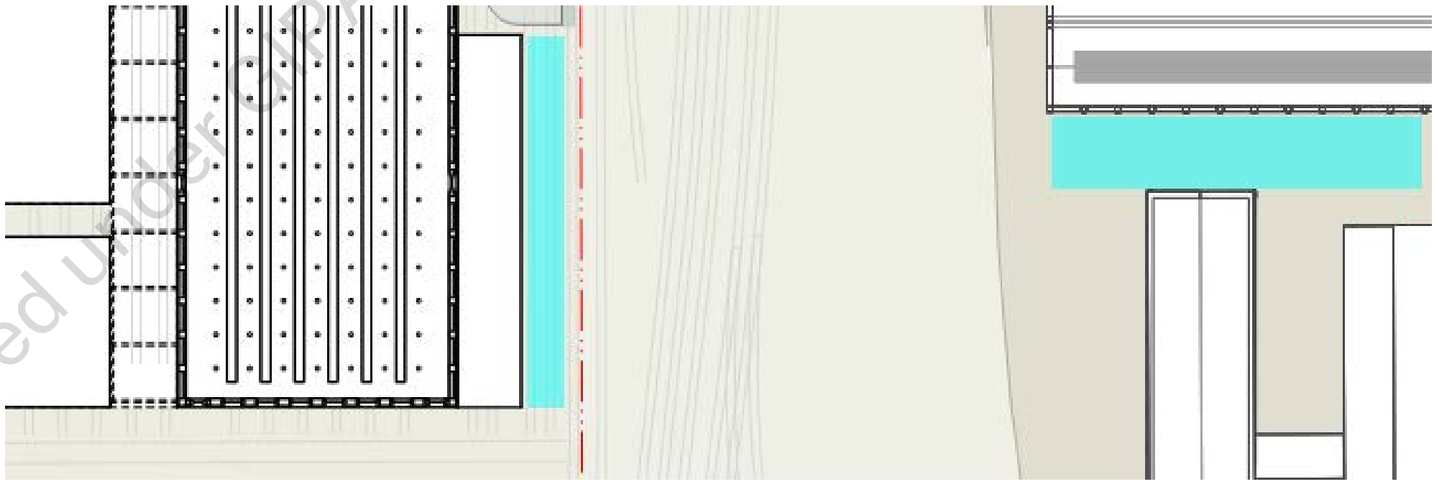
South Eveleigh landing zone

- Easement has been set aside, but the specific location is TBD. This is under an unsolicited proposal.

North Eveleigh landing zone

- Landing zone nominated as south of the paint shop. This may be amended. Traverser is to remain in-situ.



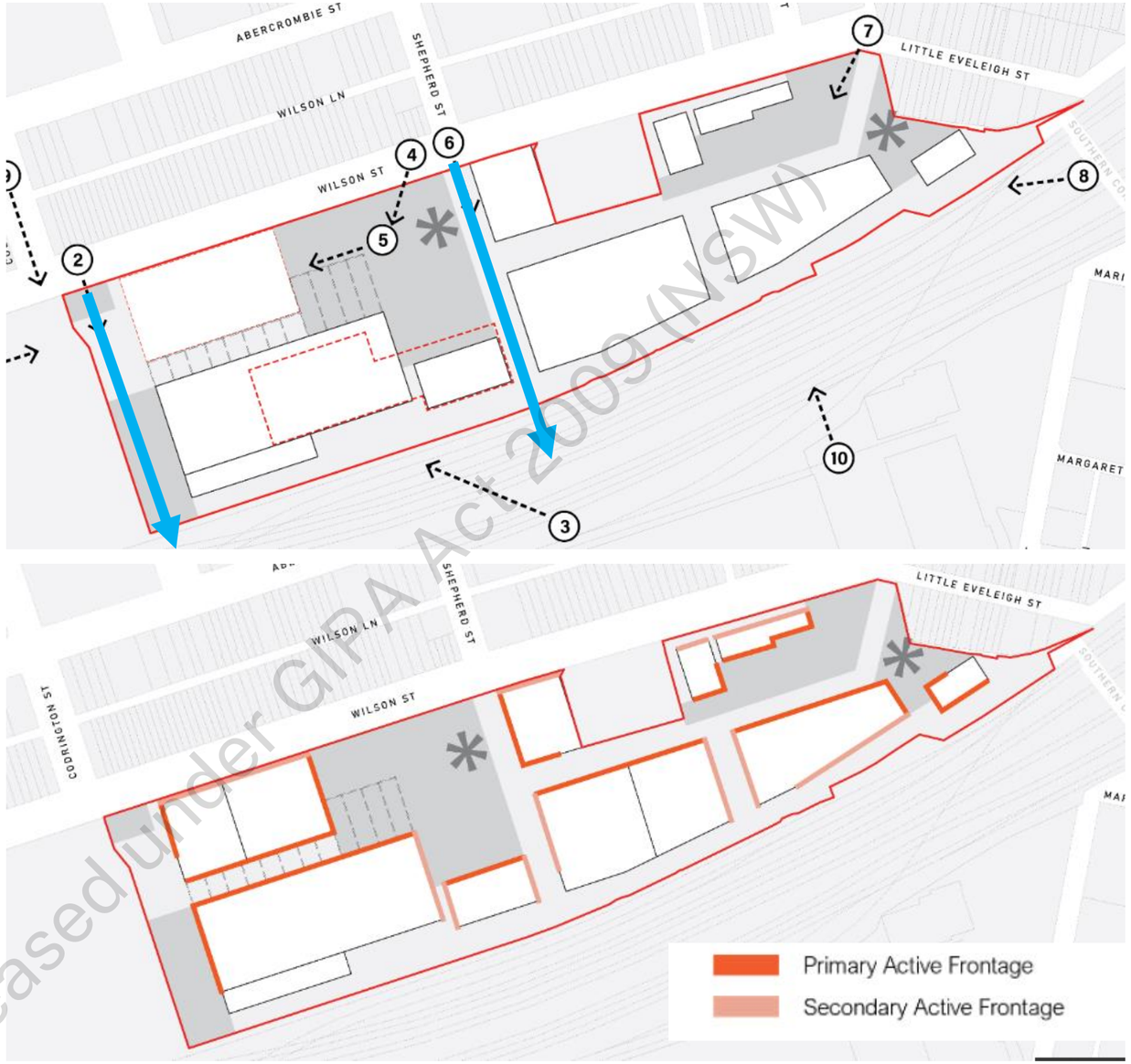


Constraints

Topography | Property

Urban Planning

- Key sightlines from various entry points along Wilson St to south Eveleigh (Design Guidelines Figure 24, Key views map)
- Site saddles two catchments – Blackwattle Bay and Botany Bay
- Most north-south corridors are intended as activated frontages. Any impacts from piers would need to be carefully considered and/or used as an opportunity.
- Traverser planned for use as a creative space



DPE, July 2022, Design Guidelines Figure 24: Key Views Map and Figure 25: Active Frontages Map

Constraints

2022 Urban Planning

Constructability

Constructability was assessed in 2008 study based on the use of a 400-tonne crane.

- Proposed 400 tonne crane requires a 3 m width clearance for travel and access. The dimensions of the crane are 17.5 m long by 3.0 m wide, but it needs to stand on 4 outriggers at 10 m by 10 m.
- No launching or lifting a bridge over live rail line.
- Launching or lifting a bridge in night time rail possession is possible, acceptance is subject to a risk analysis
- Decks (precast concrete slabs or steel decks) cannot be installed over live rail lines - unless a catch deck was preinstalled.

Bridge construction options were investigated in 2017 study:

- Lifted by crane
- Launched with lateral slide
- Rotation of segments
- Segmental Construction

Constructability requires revisit due to current constraints.

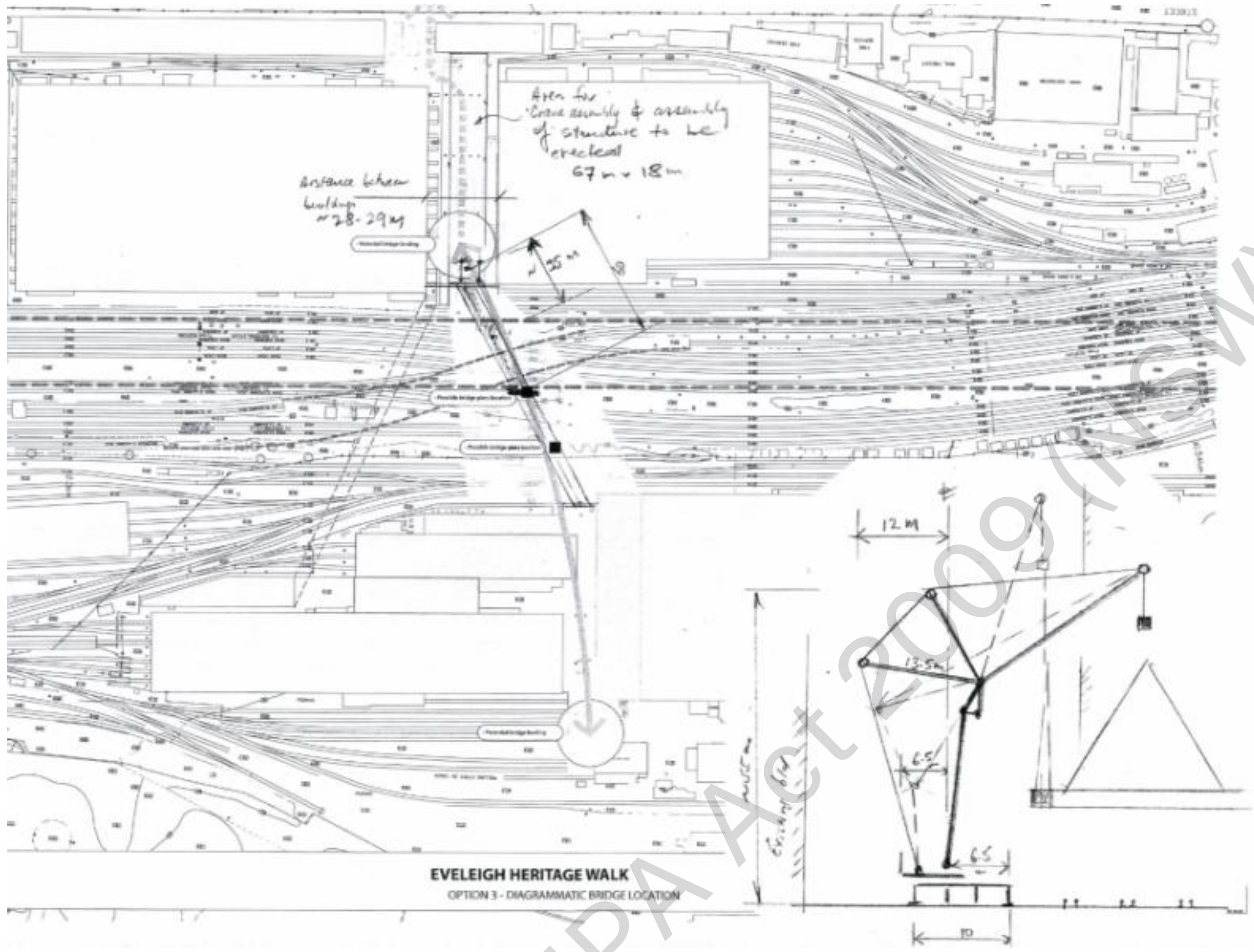
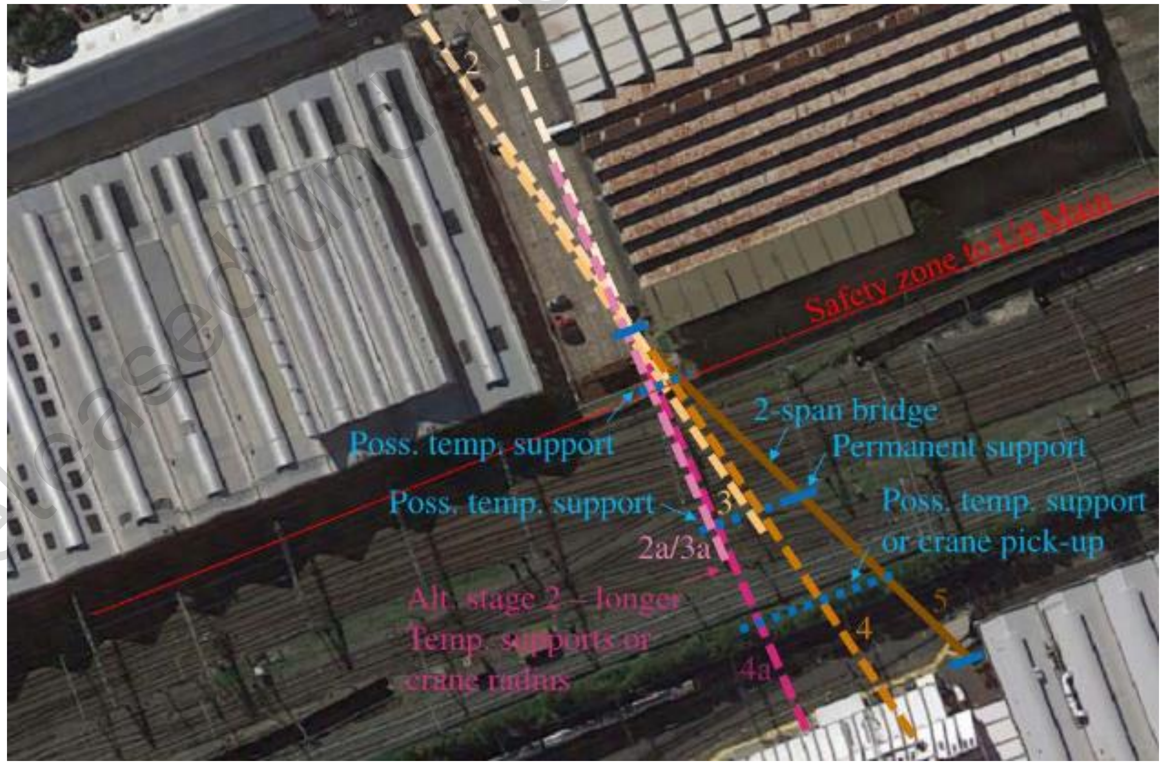
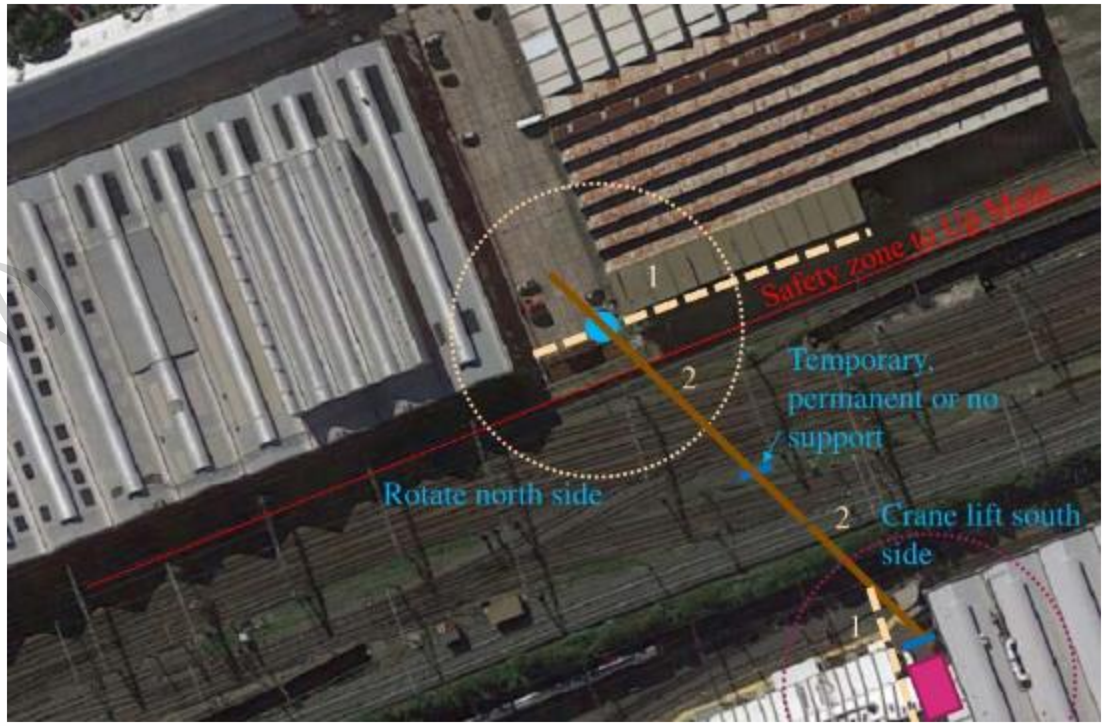


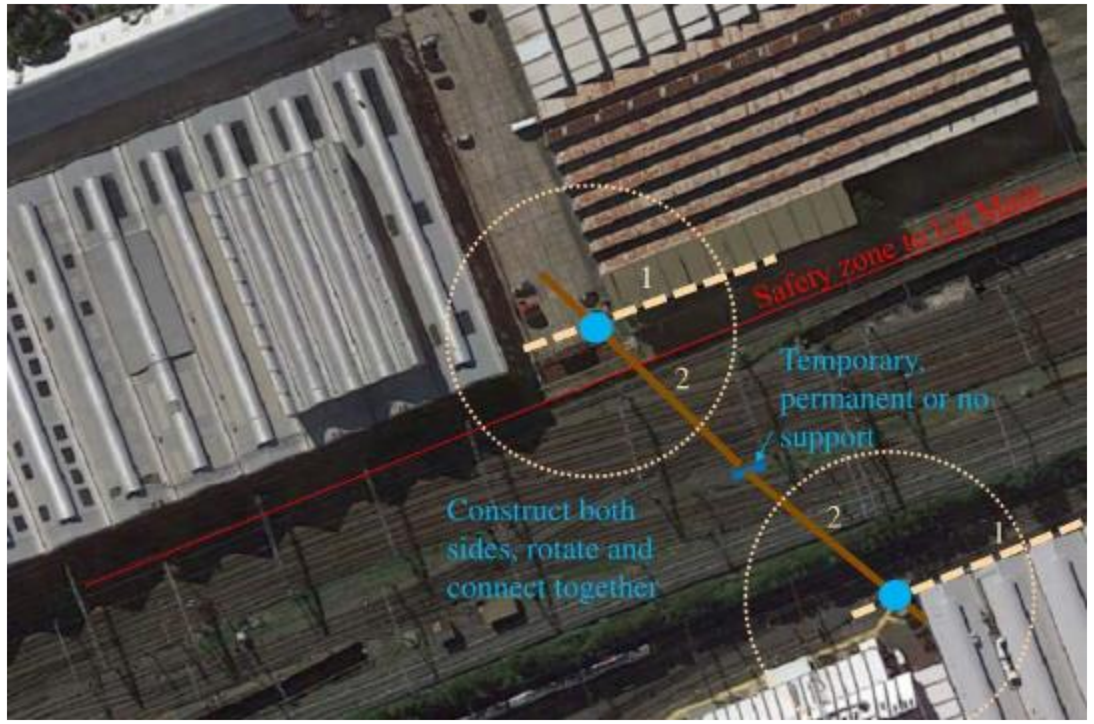
Diagram showing the 400-tonne crane placed on the traverser, Cox Sketch (2007)



Launched with lateral side



Rotation of first segment, crane lift of second segment



Rotation of both segments

Constraints

Constructability

Design requirements

Clearances

Deck Width

Grades

Protection Screens

Piers

Loading

Geometry | Clearances

AS5100 CL13.8

Vertical and horizontal clearances for bridges over rail shall be as required by the rail authority.

ESC215

Horizontal

Abutments 4300 from centerline of track

Piers 3500 from centerline of track

Footings 2150 from centerline of track

Vertical

6500 from low rail height

EP 08 00 00 01 S

For bridge > 8m in order to replacement OHW masts

RailCorp Engineering Standard — Track
Transit Space

ESC 215

Dimension	Structure
2 150mm	Minimum horizontal clearance to structures and structure footings to one metre below design rail level to allow for operation of ballast cleaners. No allowance is required for curve effects.
2 400mm	Signals and associated equipment to enable visibility of signals
3 000mm	OHWS masts and signal bridge masts **adjacent** to a track Temporary construction works adjacent to a track
3 500mm	Piers, columns, deflection walls between tracks
4 300mm	Bridge substructures and deflection walls (except between tracks) Cuttings without road access Station buildings Columns, footbridges OHWS masts and signal bridge masts on platforms Other structures located adjacent to non-electrified tracks and where road access is not required.
5 000mm	Other structures located adjacent to electrified tracks and where road access is not required
5 500mm	Other Structures and cuttings located adjacent to non-electrified tracks and where road access is required between the structure and the track (Note 1)
6 200mm	Other structures and cuttings located adjacent to electrified tracks and where road access is required between the structure and the track (Note 1) Bridges or air-space developments where an overhead wiring or signal mast is required within the structure limits

ESC215 **Table 1 – Mainline service requirements**

For all track in **electrified** areas the minimum vertical dimension between the underside face of non-energised equipment and the design **maximum** height of the low rail shall be as detailed in Table 5.

Dimension	Overhead Wiring Configuration
5 900mm	Wiring Attached
6 500mm	Wiring Not Attached

Table 5 - Vertical clearance requirements to structures in electrified areas

ESC215

Minimum Clearance to Under-side of OLB – OHW Unattached.	Both the bridge height and its width (along the track) influence whether OHW can pass unattached under a bridge (the preferred outcome), or whether the OHW needs to be attached (undesirable). As a guide, if the under-side of bridge is > 8m above track, then generally the OHW should be capable of being installed from standard OHW masts or portals, independent of the bridge, and therefore not attached to the bridge. For bridges lower than 8m, an OHW concept design is required to establish that the bridge height and width can allow the OHW to pass through unattached beneath the bridge, which is the preferred outcome (due to electrolysis corrosion considerations & ongoing maintenance). Alternatively, OHW may only be attached to the bridge if the OHW concept design can demonstrate that there are no other options because the bridge is too low and / or too wide (an undesirable outcome). In this case the concept design must identify how the OHW is to be supported & registered under the bridge, and how minimum electrical clearances are to be met.

EP 08 00 00 01 SP

Design Requirements

Geometry | Clearances

Geometry | Deck Width

Minimum widths of Pedestrian Bridge (AS5100.1 Cl 13.11)

Geometric requirements:

- Minimum 1.8m clear width between handrails
- Refer to Table 13.11

Cyclist and shared paths (AS5100.1 Cl 13.13)

Geometric requirements:

- Refer Austroads Guide to Road Design, Part 6A
- **Disability Discrimination Act, and AS1428.1**

T HR Cl 12030 ST

The width of footbridges shall be the greatest of the widths specified in AS 5100, the TfNSW stations and buildings standards specified in Section 9, and project and stakeholder requirements.

Geometry | Clearance Over

Pedestrian Bridge (AS5100.1 Table 13.7)

Geometric requirements:

- Vertical clearances *over* 2.4m

Cyclist and shared paths (AS5100.1 Table 13.7)

Geometric requirements:

- Vertical clearances *over* 2.7m

Geometry Grades

Pedestrian bridges (AS5100.1 Cl 13.11)

Table 13.11 requirements

TABLE 13.11

GEOMETRIC REQUIREMENTS FOR PEDESTRIAN BRIDGES

Clear width between handrails	1.8 m min.
Ramp gradient	As specified by the relevant authority, but not steeper than 1 in 8
Stairway gradient	As specified by the relevant authority, but not steeper than 1 in 1.6

Cyclist and shared paths (AS5100.1 Cl 13.13)

Geometric requirements:

- Austroads Guide to Road Design, Part 6A
- **Disability Discrimination Act, and AS1428.1**

Design Requirements

Geometry | Approach Grades

Protection Screens

Provided to prevent objects being thrown from the bridge.

AS5100.1 16.4

Geometric requirements:

- 3000mm min high
- 25x25mm aperture for screen
- 9000mm min from centreline of track

T HR Cl 12030 ST

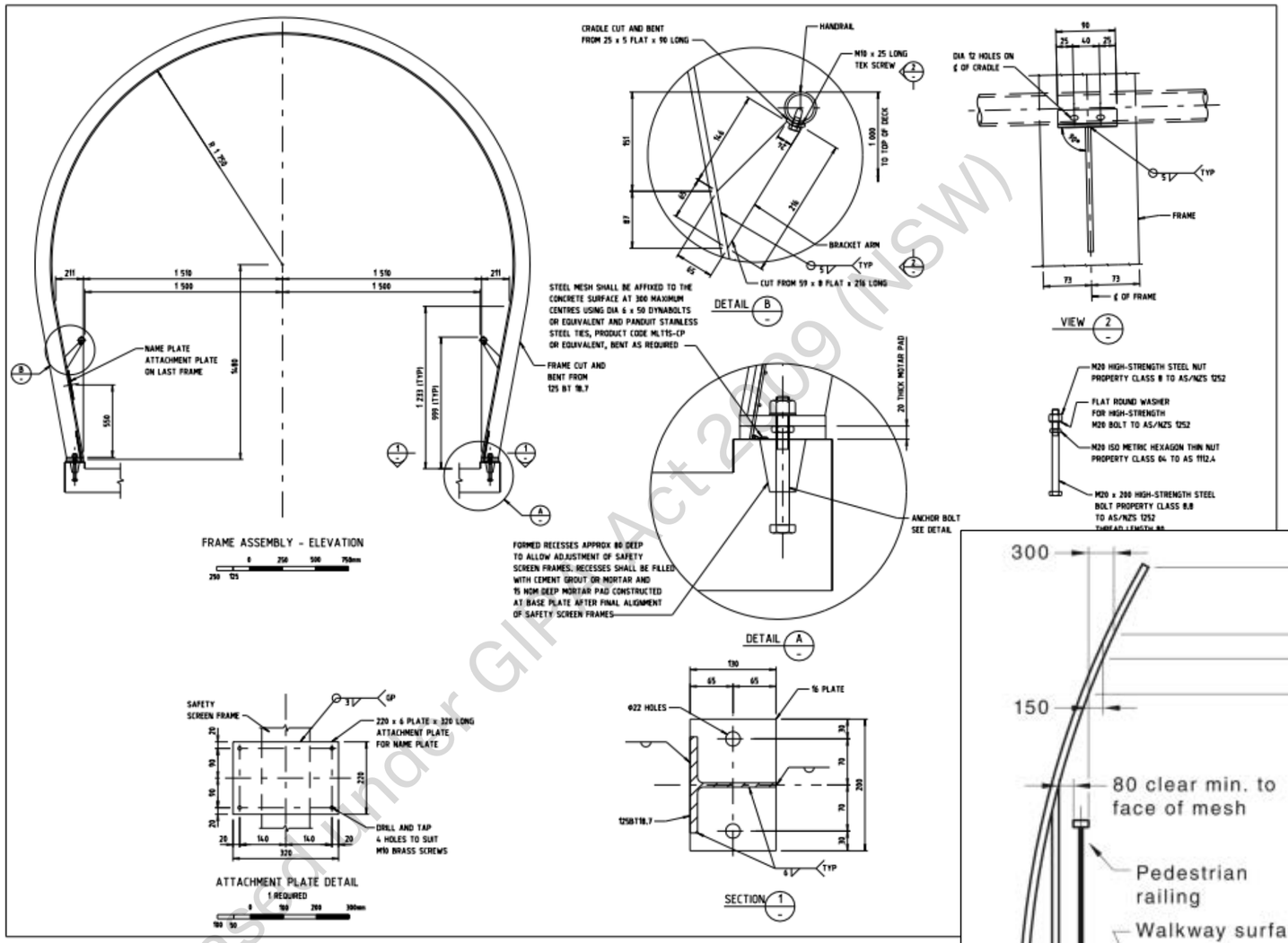
Cl 9.2 indicates preference for TfNSW Standard arrangements where possible

Protection Screens - curve inwards

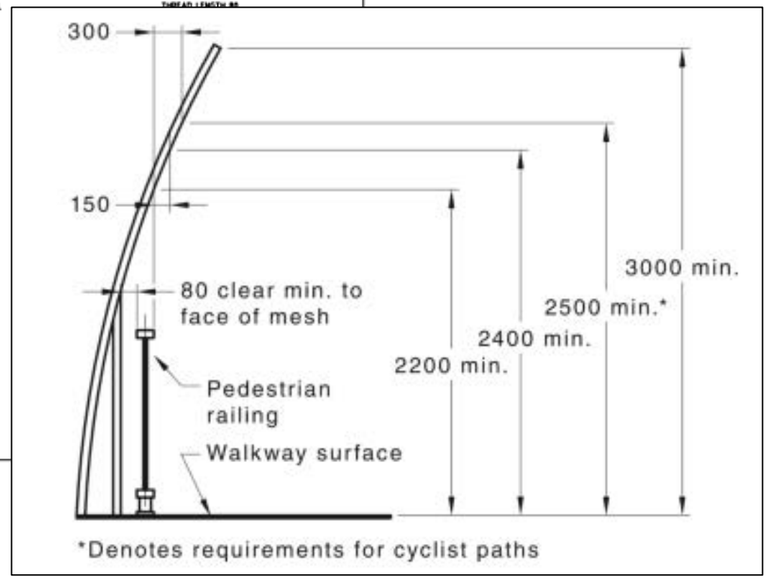
Safety Screens, vertical solid element, polycarbonate possible

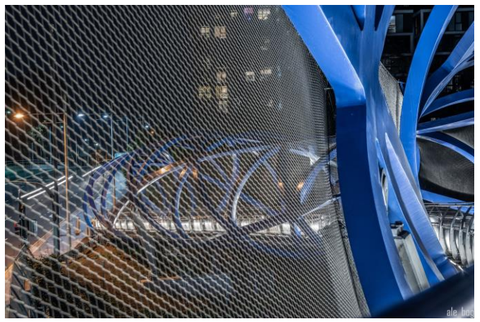
BTD 2012/01

Minimum 2.0 m above the top rail or top surface of any adjacent pedestrian or traffic barrier, whichever is the greater



Potential screen arrangements





Example of mesh for safety screen

Design Requirements

Protection Screen Requirements

Piers

AS5100.1 Cl 15.3

Horizontal clear spans shall be provided, unless piers in corridor are approved by relevant authority.

If clearance to pier face:

- 0m to 10m, relevant authority approval is required.
- 10m to 20m, risk assessment to be undertaken

AS5100.1 Cl 15.4.3

Pier thickness to be minimum 800mm

AS5100.1 Cl 15.3.6

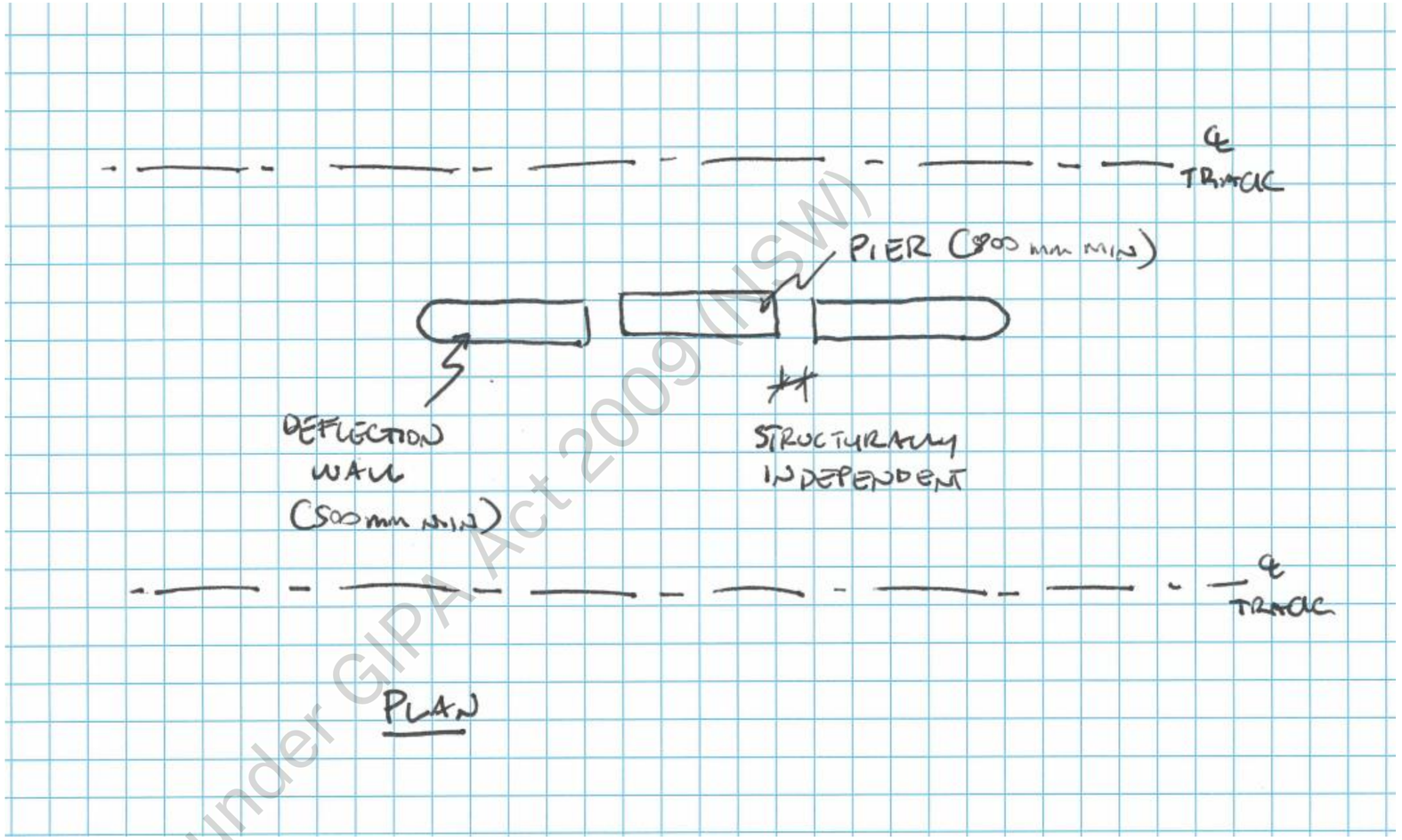
Deflection walls to be provided to protect pier

(introduced from 2017 revision of AS5100.1)

Deflection walls to be 500mm thick

T HR Cl 12030 ST

- Footbridges shall comprise a clear span between abutments, except as permitted in this standard.
- Abutments that comply with the requirements of this standard and AS 5100 are permitted within the rail corridor.
- Footbridges without abutments shall comprise a clear span between outer piers.
- Intermediate piers are permissible when they are located on platforms that have the characteristics defined in Section 18.2.
- Frangible piers for footbridges shall not be used unless approved by the Lead Civil Engineer, ASA.



Sketch showing potential arrangement of piers

ASSUMPTIONS

Design Requirements

Pier Design Requirements

ARUP

Miscellaneous

T HR CI 12030 ST

Painting to be in accordance with SPC301. Colors shall not be red, orange or green. Paint shall not be intumescent

Surface drainage run-off water shall not discharge into the rail corridor.

T HR EL 10001 ST

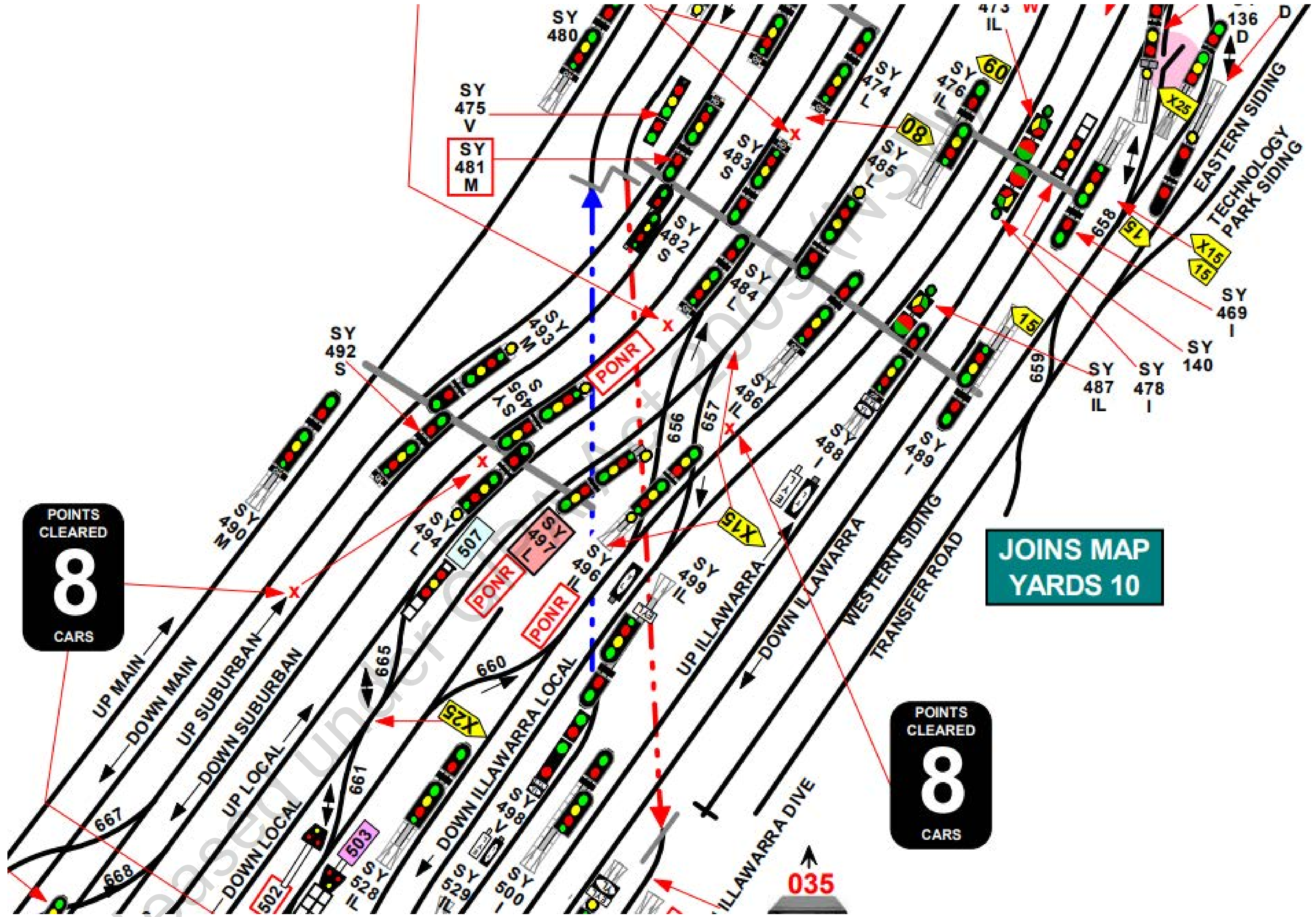
Clearances to HV electrical services

T HR CI 12030 ST

Earthing and bonding requirements

T HR SC 10001 ST

Signal sighting distances (6 seconds minimum)



Driver Route Knowledge Diagram indicating signal position

Design Requirements

Miscellaneous design requirements

Loading

Vertical Loading (AS5100.2 Cl 11.4.3)

Between 0m to 5m

- loading 500kN

Between 5m to 10m

- loading 500kN to 0kN

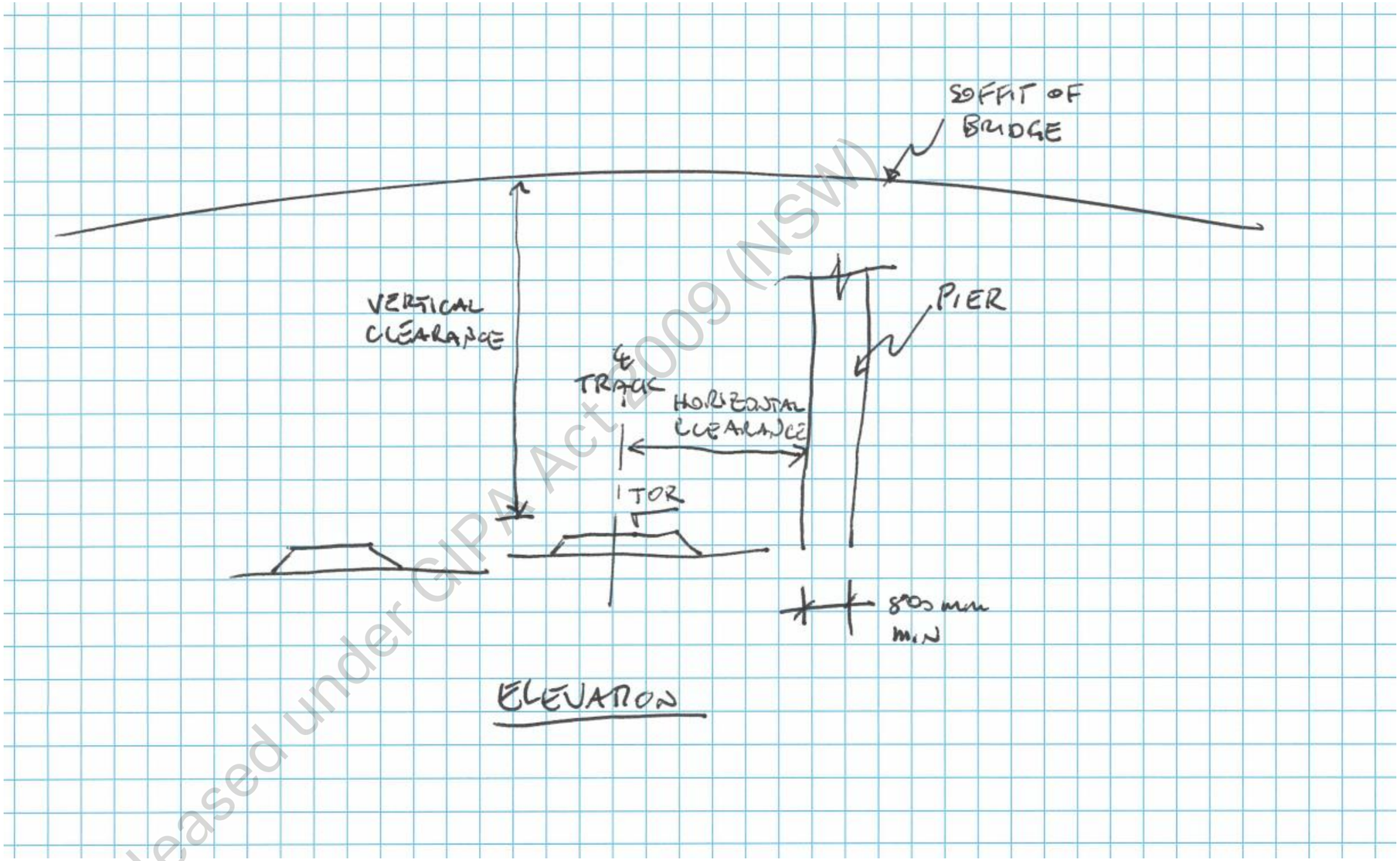
Horizontal Loading (AS5100.1 Cl 15.3)

Between 0m to 10m loading

- 4000 kN parallel to rails.
- 1500 kN normal to rails.

10m to 20m loading

- 1500 kN



Sketch indicating clearances from rail

Design Requirements

Loading Requirements

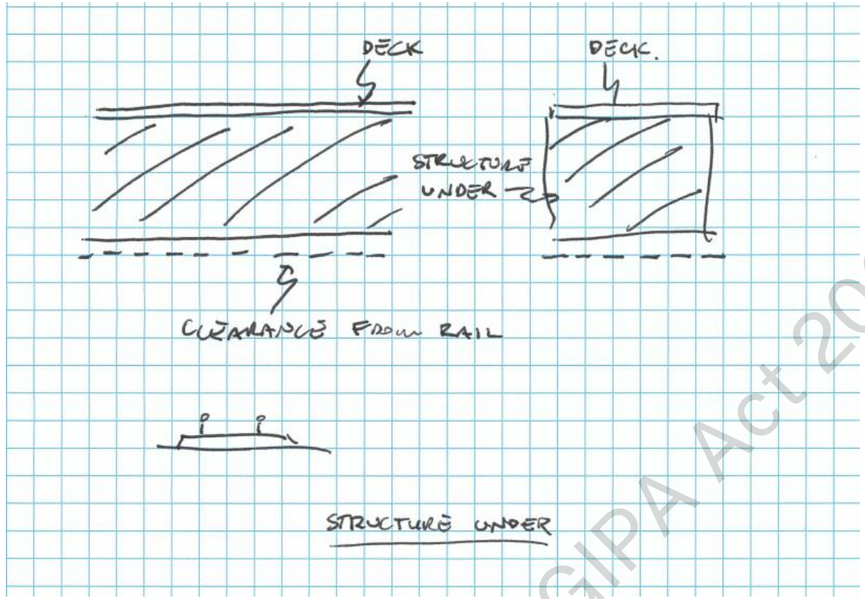
Structural Forms

Superstructure Form

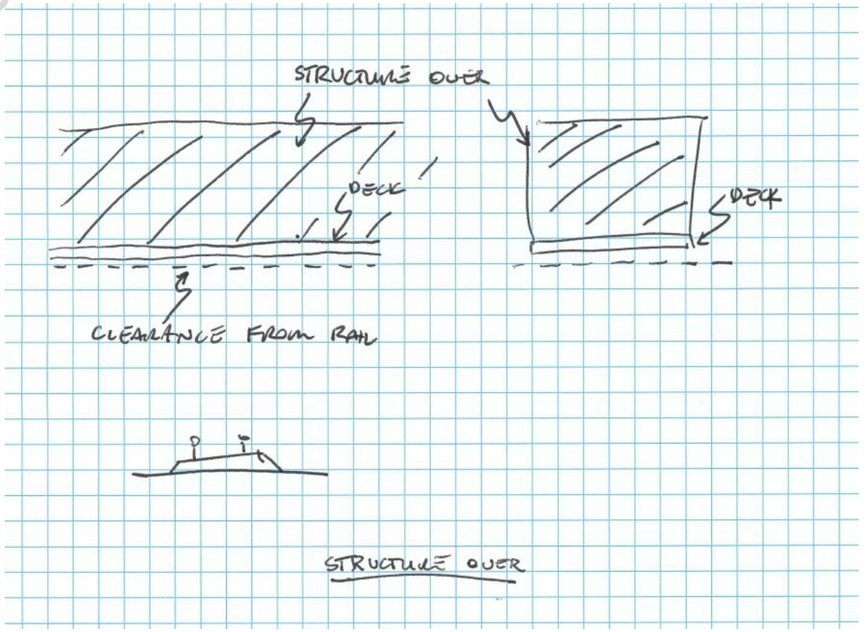
Substructure Form

Superstructure Form

- "Structure over" or cable supported structures preferrable to minimise deck elevation
- Steel work preferrable to facilitate lifting
- Truss form and tied-arch likely to facilitate "structure over"
- Cable supported options (cable stayed or suspension bridge), which enable a slender deck and the ability to span across the rail corridor without an intermediate pier. Some potential challenges should also be addressed, such as planning approval for tall pylons, maintenance and whole of life.



Sketch showing "structure under deck"



Sketch showing "structure over deck"

Structural Forms

Superstructure

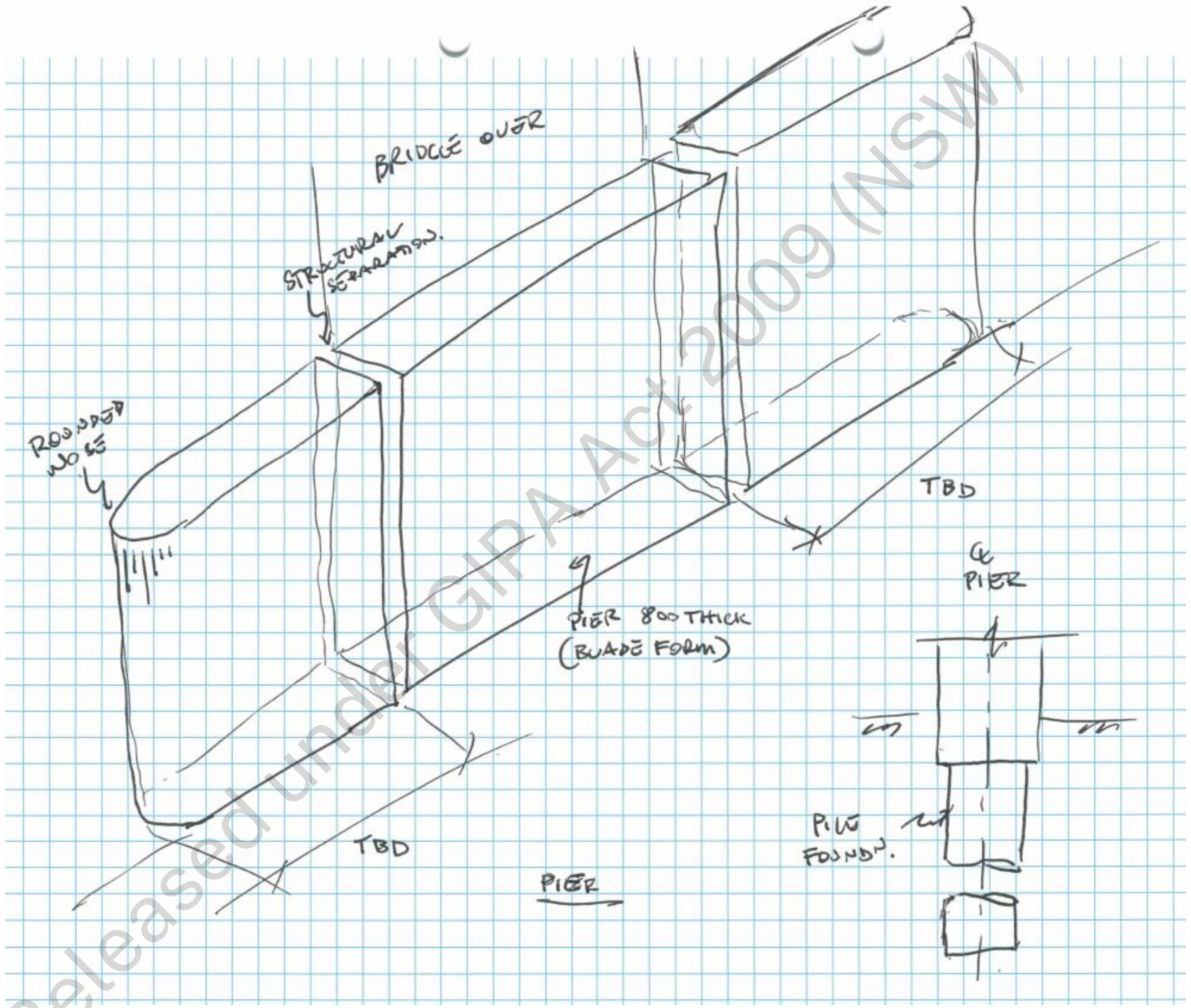
Substructure Form

Pier

- Blade form, 800mm thick
- Piled foundations
- Precast/Cast-in-situ TBD

Deflection walls

- "In front" of pier
- Structurally independent
- Rounded nose
- Length to TBD,
- Height presented may be optimized
- Precast/Cast-in-situ TBD
- Piled foundations



Sketch showing pier or pile foundation

Structural Forms

Substructure

Next Steps

Augmentation Options

Assumptions

Inputs

Risks

Opportunities

Further Design Development

Augmentation Options

Move Overhead Wiring

Move Signals

Attach Overhead to bridge

Change easement location

Bridge columns through the Paintshop to traverse over the Paintshop to Wilson street

Assumptions

Possession scheduling is assumed to be as per information nominated in 2017 report.

Given piers were shown in the 2017 report, we are currently assuming these can placed in corridor – Relevant Authority approval is required (TfNSW/Sydney Trains)

Easement on south side is assumed to available for landing (Mirvac easement)

Inputs

Bates Smart

- DDA access requirements including widths, stairs details and minimum / maximum grades.
- Connectivity
- Urban design treatment, pier shape, cladding, handrails
- Security requirements
- Lighting
- Lift size

Balarinji

- Connection with Country input

Curio

- Confirmation of heritage requirements / interface

Turf

- Landscape interface

Ethos Urban

- Property boundary constraints

Next Steps

Augmentation Options | Assumptions | Inputs

Risks

Approval from other asset owners and stakeholders

Constructability – safe access and space to build a bridge

Lack of information (survey, GI, rail possessions)

Coordination and integration of masterplan

Property boundaries

Opportunities

New alignment options – e.g. span over paintshop

Tunnelling

Further Design Development

SESA

Connectivity

Urban design

Whole of life

Wind and vibration design

Deck drainage

Constructability

Material

Maintenance consideration

Next Steps

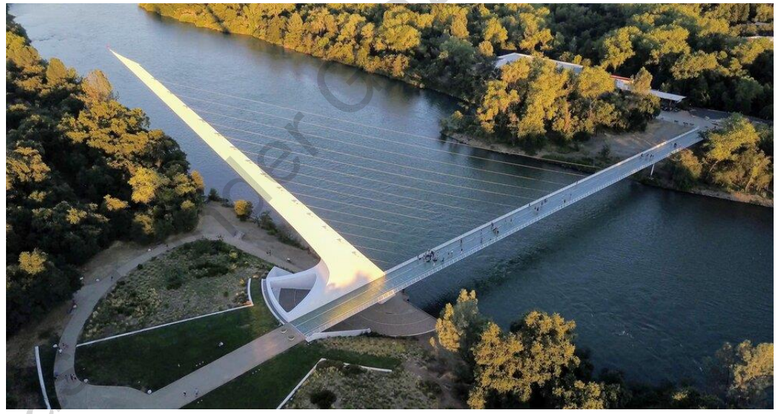
Risks | Opportunities | Further Design Development

Yandhai Bridge, Nepean River

Lachlan's Line, North Ryde

Helix Bridge, Singapore

Kingsgate Footbridge, Durham



Sundial Bridge, California

Dafne Schippers Bridge, Utrecht

Inspiration

About Us

The analysis and report for this project was undertaken by Arup who have significant experience with analysing the design and performance of bridges and rail infrastructure.

References + Standards

To complete the analysis and reporting, a series of standards and documents were reviewed and considered as part of the process.

The following standards were used as references:

- AS5100-2017 - Bridge Design
- BTD 2012/01 - Provision of Safety Screens on Bridges
- ESC215 – Transit Space
- EP 08 00 00 01 S - Overhead Wiring Standards for the Electrification of New Routes
- T HR Cl 12030 ST - Overbridges and Footbridges
- T HR EL 10001 ST - HV Aerial Line Standards for Design and Construction
- T HR SC 10001 ST – Signalling Design Principle

Documents from the following projects were referred to:

- Eveleigh Heritage Walk *for Redfern Waterloo Authority* [2008 study]
- Carriageworks to Australian Technology Park – North-South Pedestrian Link *for Urban Growth* [2017 study]

ARUP

For further information, please contact:

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Level 5 151 Clarence Street

Sydney NSW

2000

Redfern North Eveleigh Bridge

Transport for New South Wales

Feasibility Study & Concept Options Report

Rev 1

25 November 2022

Contents

Objectives of the Study

Arup has been commissioned to investigate the feasibility of a bridge that connects RNE to South Eveleigh and enables pedestrian and cyclist patronage by considering constraints, design requirements, bridge constructability, risks, opportunities and future design development.

A conceptual sketch produced as part of this feasibility study was used to inform a high level cost estimate.

Executive Summary

The Redfern North Eveleigh bridge will be a very challenging, expensive bridge to build and does not provide outstanding time savings or convenience for users.

The evaluation of possible alignments for the bridge and possible time savings are addressed in the following slides.

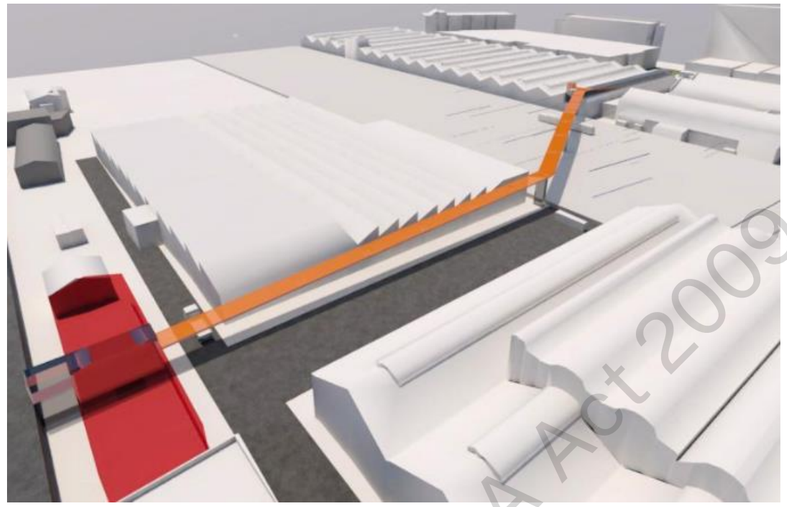
Further, due to the elevation of the site, and the significant interface with train operations, there will be substantial cost required to build the bridge

Previous Studies

Arup was previously commissioned in 2008 and 2017 to review the site constraints including constructability, and to develop sketches of bridge concepts for preliminary costing.

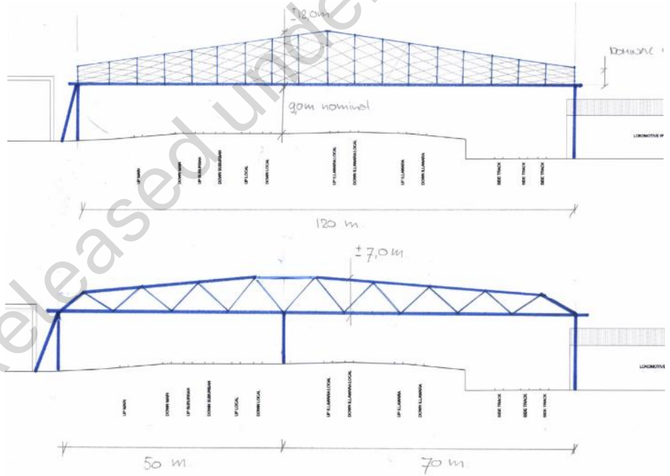
During the early studies, sites to the east were favoured over the western alignments because the bridge length could be minimized. In addition the siting provided space for a pier approximately at its midspan when considering the constraints of available space in the rail corridor. As the 2008 study was undertaken prior to the installation of the new Redfern Station crossing, ‘duplication’ of an existing alignment was not a reason to discount these options at the time. The second platform access bridge at Redfern Station is currently under construction and due for completion in Q1 2023.

Early studies also featured a ramped landing direct from the bridge to Wilson Street. The previous design brief included the requirement for DDA ramps (grade 1 in 20). Due to the topology and level differences, it was more efficient to extend the ramp directly to Wilson Steet instead of ramping down to the traverser, then ramping back up to street level.

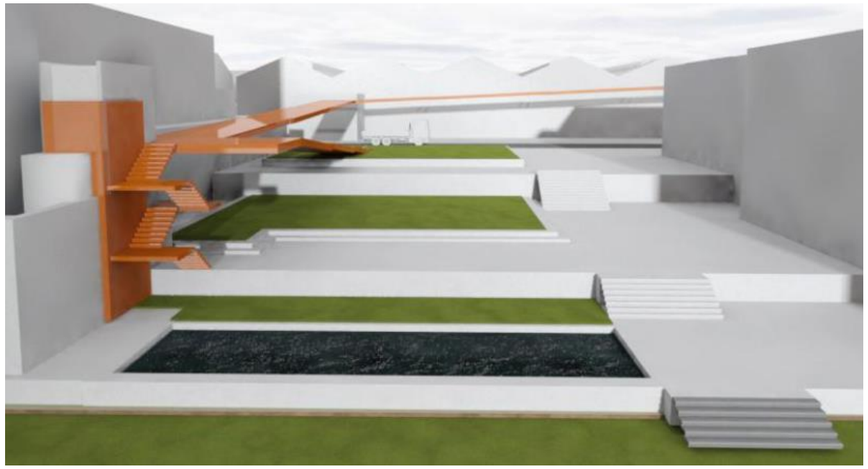


North landing to Wilson Street

South landing option in Locomotive Shed bay



Truss options with pier, clear spans are ~50-120m



South landing option along village square (Between Channel 7 and CBA)

What characteristics should a bridge have?

The RNE bridge should be a connection across the impenetrable rail corridor, saving time, encouraging permeability, and generally be a convenient, safe and accessible piece of infrastructure.

Connect the North and South Eveleigh communities

Provide local permeability across the rail corridor

Safe

Comfortable

Convenient

Provide time savings for pedestrians and cyclists

Accessible

Sustainable

Sympathetic to the industrial heritage of the area

Connection to Country

Value for Money

Potential Time Savings

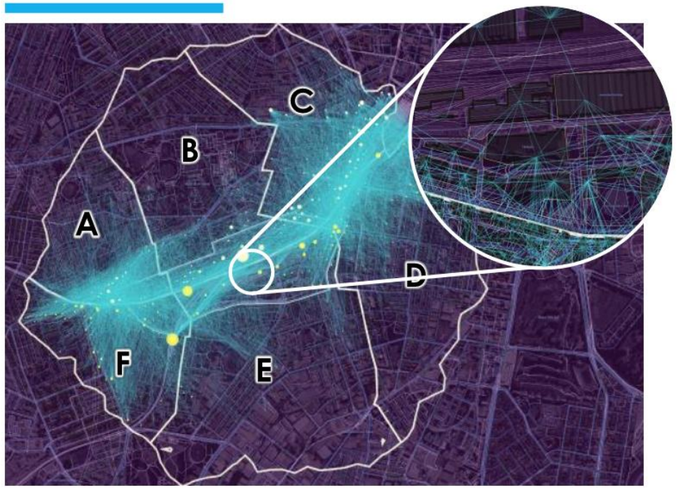
This section explores the potential connectivity benefits of a bridge.

Current and Future Demand

From Bridge Catchment Analysis, SCT Consulting, 2021

Current demand

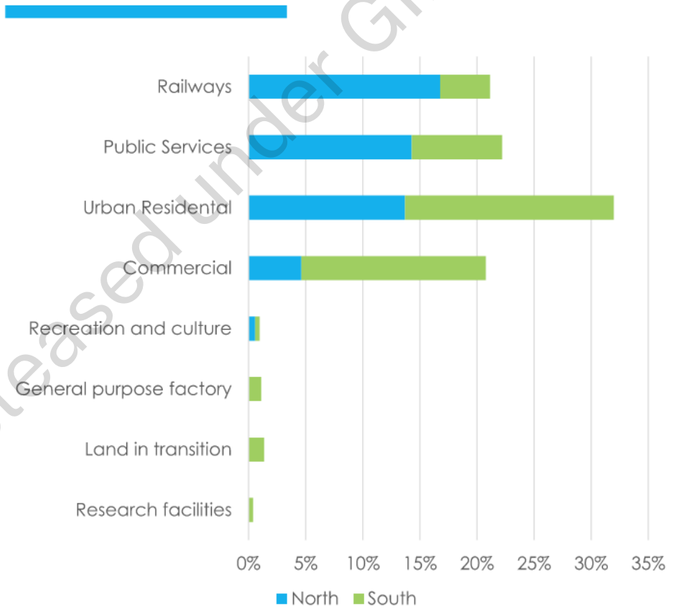
340-420 journeys per weekday, 53% are less than 1000m in length.



Cross-corridor trips by land-use

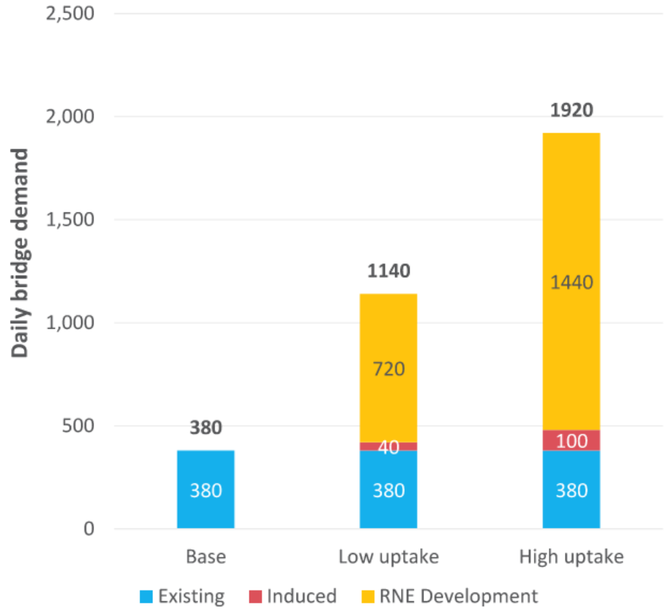
Main beneficiaries of the additional bridge are cross-rail corridor journeys to/from:

- Urban residential
- Public services (University of Sydney)
- Commercial (North and South Eveleigh precincts).
- Light industrial and commercial (Waterloo and Green Square)



Future demand

1140 – 1920 crossings per day



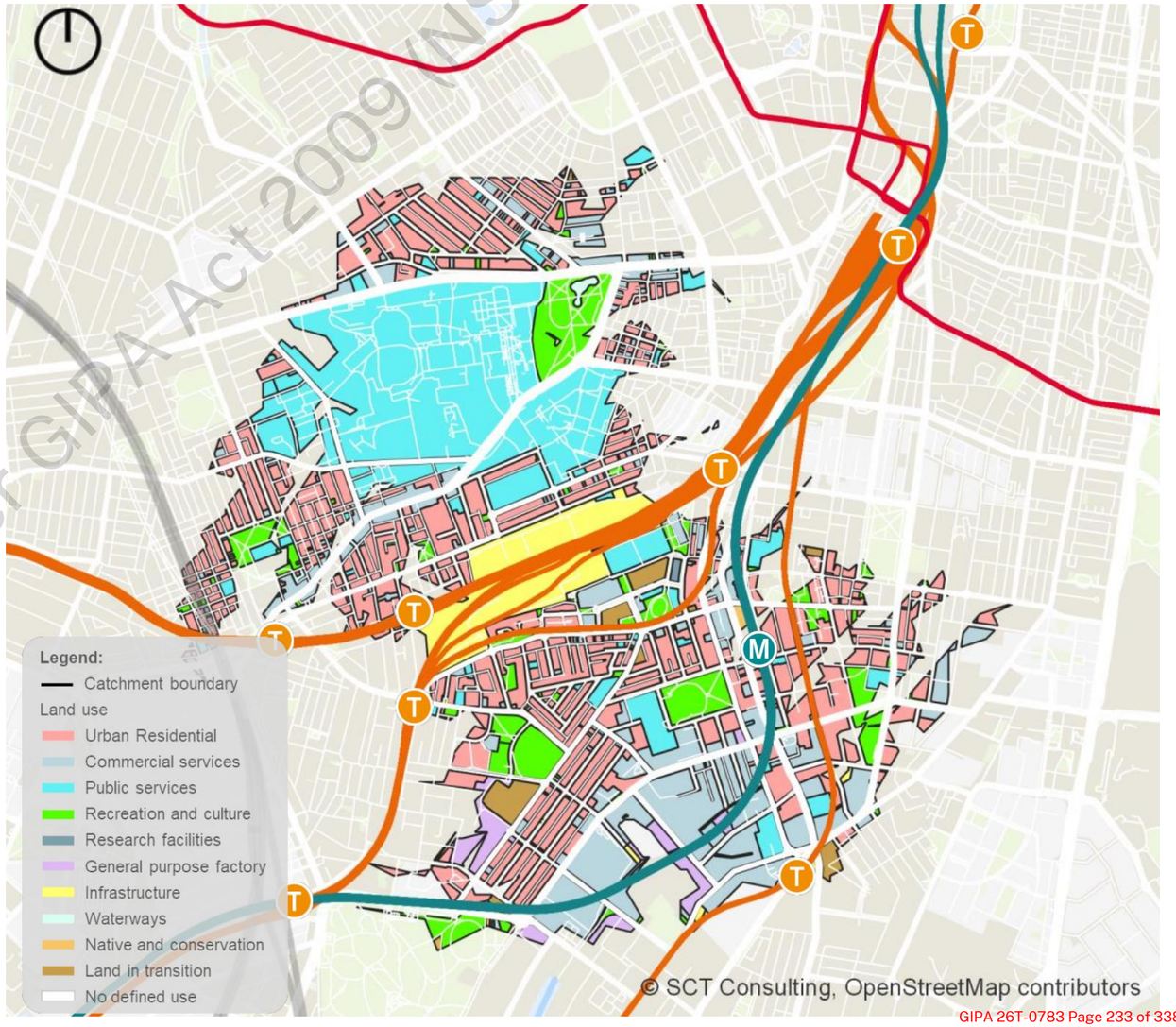
Expected patronage is **1140-1920 people per day,** which is very small. In comparison George street between Albert Street and Philip Street (Redfern) sees about 2000 journeys per day, during both weekdays and the weekend.

Travel Time Savings

From Bridge Catchment Analysis, SCT Consulting, 2021

SCT Consulting (021) estimated the average travel time savings as 5-8 minutes for cross corridor journeys in the highlighted regions. However, as you need to climb up the stairs or take the elevator up to cross over the rail lines, this is reduced to an **overall estimated time saving of 3–6 minutes per trip**.

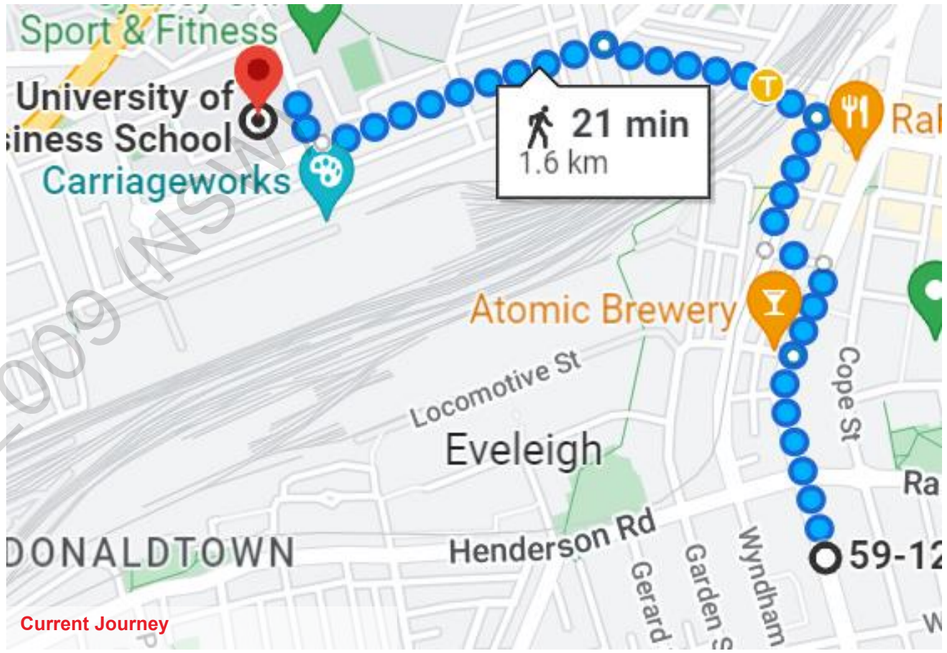
Savings also become less pronounced for origins and destinations further away from the bridge.

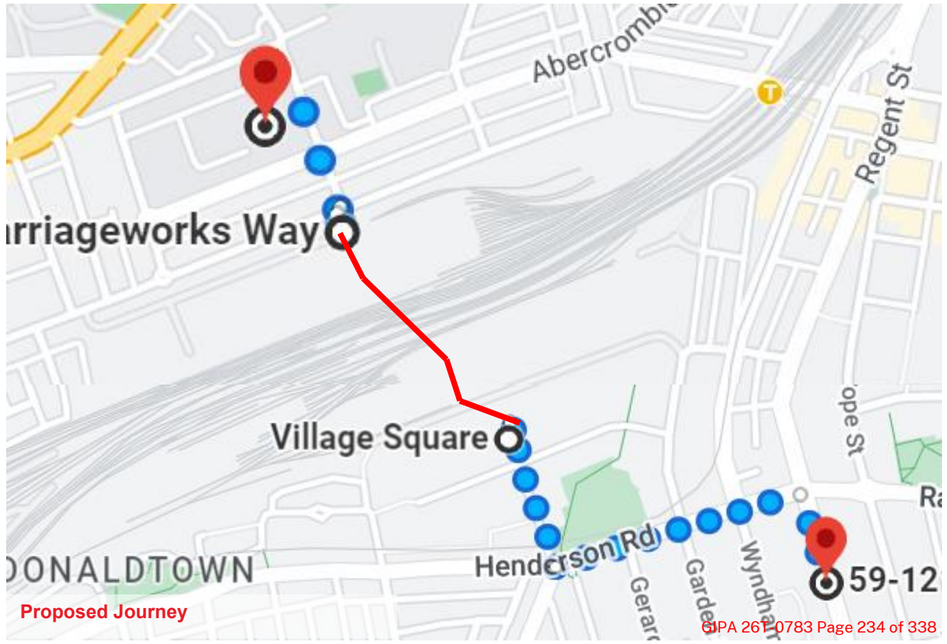


Example pedestrian journey from ABS to Waterloo Metro Station

From University of Sydney Abercrombie Business School (ABS)
To Waterloo Metro Station

Current journey time:	**21 min**
Proposed journey time:	**17 min**
• ABS to Carriageworks	3 min
• Carriageworks to Village Green via bridge	3 min
• Stairs/Lifts at each end	2 min
• Village Green to Waterloo Station	9 min
Approximate time saving:	**4 min**





Bridge Siting Commentary

Alignments for bridge sites are explored under different design considerations.

This section selects two of the alignments to be considered further.

Bridge Siting Commentary – Challenges associated with the options

Minimum 10m clearance height above rail corridor; HV cable, drainage at rail corridor

Illawarra Dive (tunnel)

Eveleigh Maintenance Centre

Heritage

A: Minor benefit to permeability

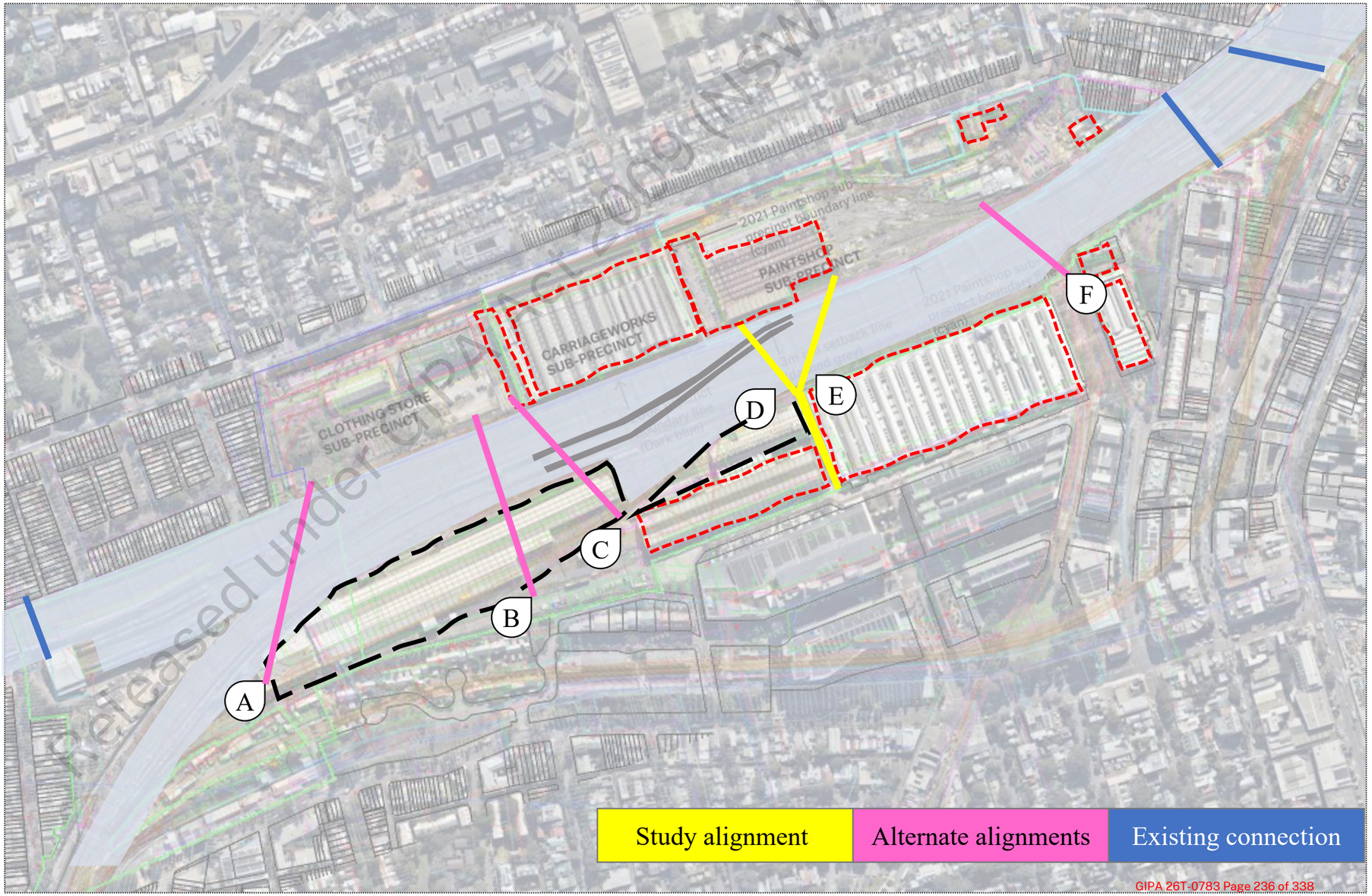
B: No immediately obvious space for piers and deflection walls. Needs to extend over Maintenance facility.

C: Limited space to position pier in rail corridor

D: Work in proximity to heritage listed assets

E: Work in proximity to heritage listed assets and new development

F: Too close to the second pedestrian crossing at Redfern Station. Minimal additional benefit to permeability.



ARUP

Description of Options

Six alignment options are listed and compared in different parameters.

	A	B	C	D	E	F
						
Alignment	East of Clothing Store Precinct to east end of Eveleigh	Connection from Clothing Store Precinct perpendicular to the tracks	West corner of Carriageworks to west of Large Erecting Shed (LES).	West corner of Paint Shop to west of Locomotive Shed (the Loco).	East corner of Paint Shop to west of the Loco.	Far east end of the Redfern North Eveleigh (RNE) development to Innovation Plaza.
Assumptions	Eveleigh Maintenance Centre is operational.	Depends on approval to span over the operational Eveleigh Maintenance Centre.	Eveleigh Maintenance Centre is operational. Easement for landing needs to be provided by Sydney Trains.	Easement for the south landing can be secured within the access corridor for the current Eveleigh Rail Workshops.	Easement for the south landing can be secured within the access corridor for the current Eveleigh Rail Workshops.	Easement will be secured for the north and south landings.

Connections to the RNE development

The bridge should provide connectivity from the proposed development at the North Eveleigh Site to surrounding areas of interest.

	A	B	C	D	E	F
						
	Low connectivity	Low-moderate connectivity	Moderate connectivity	Moderate-high connectivity	Moderate-high connectivity	Low connectivity
Comments	Flow to Erskineville town centre, primarily residential connection	May connect to the Australian Technology Precinct (ATP)	Connection to ATP	Connection to ATP	Connection to ATP. Path of travel visible from Fan of Tracks.	Landing located closer to the development, but minimal additional benefit compared to the new Redfern concourse.
Distance*	~1000m, 10-15 min walk from east of paint shop to south landing	~700m, 5-10 min walk from east of paint shop to south landing	~700m, ~10 min walk from east of paint shop to south landing	~300m, ~5 min walk from east of paint shop to south landing	~200m, ~5 min walk from east of paint shop to south landing	~300m, ~5 min walk from east of paint shop to south landing

* Assuming 10 min per km walking speed and 3 minutes to get up and down from the deck to ground.

Local Connections - Permeability across the rail corridor

The bridge should better connect North and South Eveleigh.

Proximity to existing crossings diminish the permeability benefit.

	A	B	C	D	E	F
						
	Minor increase to permeability	Nil or undetermined increase to permeability	Moderate increase to permeability	High increase to permeability	Moderate to high increase to permeability	Minor increase to permeability
Comments	Primarily residential to residential. No benefit to South / North RNE developments	Minimal benefit if Maintenance Centre remains. Local benefits depends on future development of the Maintenance Centre.	Connection to ATP, Carriageworks and to Sydney University. May facilitate connection to Waterloo.	Near linear connection from University of Sydney Business School, Codrington St, Carriageworks, and to ATP. May facilitate connection to Waterloo.	Connection from University of Sydney via Shepherd St, RNE precinct, and to ATP. May facilitate connection to Waterloo.	Too close to the second pedestrian crossing at Redfern Station.
Nearest existing crossing	300m west at Burren Street	500m west at Burren Street	600m west at Burren Street	600m east at Redfern station	500m east at Redfern station	150m east at Redfern station

Bridge Design – Piers and Spans

Too long a clear span increases the size of the structure and complexity of construction.

	A	B	C	D	E	F
						
Piers	Potential location for two piers in the rail corridor.	Very congested tracks. No immediately obvious space for piers and deflection walls.	Very congested tracks. One potentl candidate location for pier.	Potential location for one pier in the rail corridor.	Potential location for one pier in the rail corridor.	Potential location, but in tight space, for one pier in the rail corridor.
Clear span	Assumed clear span of 50m.	Need to span the full 100m in a clear span and 100m span over the facility	Assumed clear span of 80 or 150m.	Assumed clear span of 50m.	Assumed clear span of 60m.	Assumed clear span of 50m.
Minimum length	250m	200m	150m	100m + 50m walkway	120m + 50m walkway	130m
Likely Superstructure	Truss	Cable stayed	Cable stayed	Truss	Truss	Truss

Bridge Design – Landing Zones

Landing zone are where the bridges touch the ground to the north and south of the rail corridor.

Existing users, heritage, masterplan, and other constraints will restrict suitability of the landing zones.

	A	B	C	D	E	F
						
North landing	May need to land adjacent to, or span over, what appears to be a traction substation.	Suitable landing areas contingent on changes to maintenance facility.	Minimal space south of Carriageworks. Piers will need to be located at the end of the Traverser. Heritage impact may unacceptable.	Grassed area behind paint shop annex.	Grassed area behind paint shop. Spatial coordination required with Block K.	Assume area can be accommodated in RNE development.
South landing	Approval required from Sydney Trains to utilise maintenance facility for landing.	Approval required from Sydney trains to span over maintenance facility.	Landing at accessway to maintenance sheds. approval required from Sydney Trains.	Assumption easement has been set-aside for the landing as part of the unsolicited proposal. Approval required from Sydney trains to land in maintenance facility access.	Assumption easement has been set-aside for the landing as part of the unsolicited proposal. Approval required from Sydney trains to land in maintenance facility access.	Possible landing zone area north of the Innovation Plaza, but adjacent to maintenance dive. Impact on main pedestrian entry from Redfern Station to South Eveleigh.

Stakeholder Impacts

The site of the bridge is a live rail corridor, very close to central station and a critical artery for the train network. Any design will require close cooperation with Sydney Trains; from the pier in the rail corridor to abutments in the operations and maintenance facility.

There will be additional design requirements on the structure because of the rail corridor (e.g. deflection walls in case of train collision).

All designs will need to be approved by Sydney Trains.

Certain alignments may also impact local residents.

	A	B	C	D	E	F
						
Sydney Trains	Need approval to construct piers in rail corridor. Need approval to land abutment in maintenance facility and access areas Need approval to interface with power substation.	Need approval to span over maintenance facility.	Need approval to construct piers in rail corridor. Need approval to span over maintenance facility.	Need approval to construct piers in rail corridor. Need approval to land abutment and access in maintenance facility circulation area.	Need approval to construct piers in rail corridor. Need approval to land abutment and access in maintenance facility circulation area.	Need approval to construct piers in rail corridor. Need approval to land abutment adjacent to maintenance dive
Local Residents	Bridge will impact on easterly sun for Iverys Lane residents.		If landing is at Locomotive Street, may cast shade along Rowley Lane.			
ATP	No direct connection	No direct connection	No direct connection	Connectivity	Connectivity	Minimal increase to connectivity.

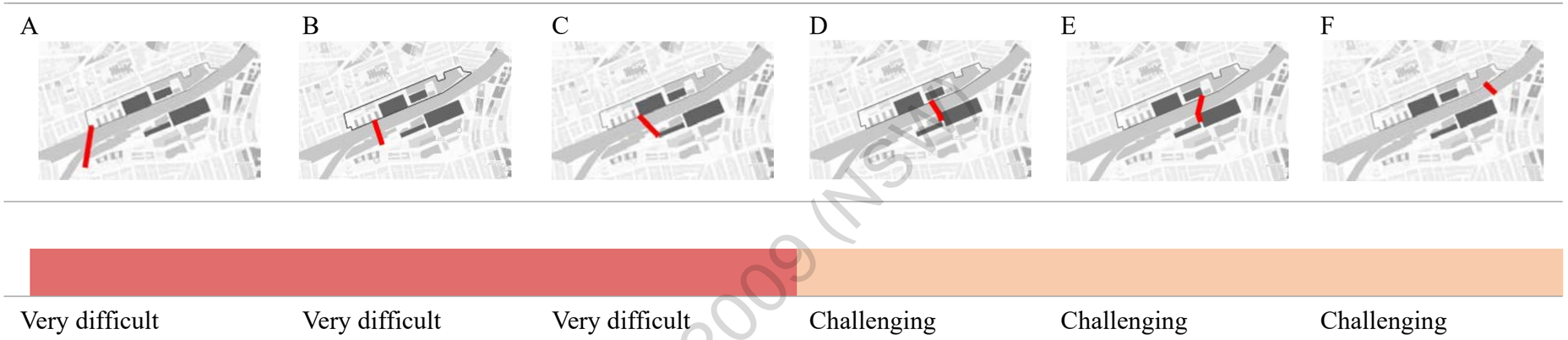
Constructability

Construction in the rail corridor is very challenging, expensive, risky, and will take several years.

Piling, pile caps, pier and deflection wall works will need to constructed during possessions. That is in circumstances where constraints permit construction of structural supports

The bridge will likely be launched or lifted in segments. This too will need to occur during possessions as lifting or launching over a live rail line is not permitted.

As an optimistic assumption, there may be up to two 36- or 48-hour possessions per year, and thi would indicate a construction duration of 3.5 years for the D & E options.



High Level Summary

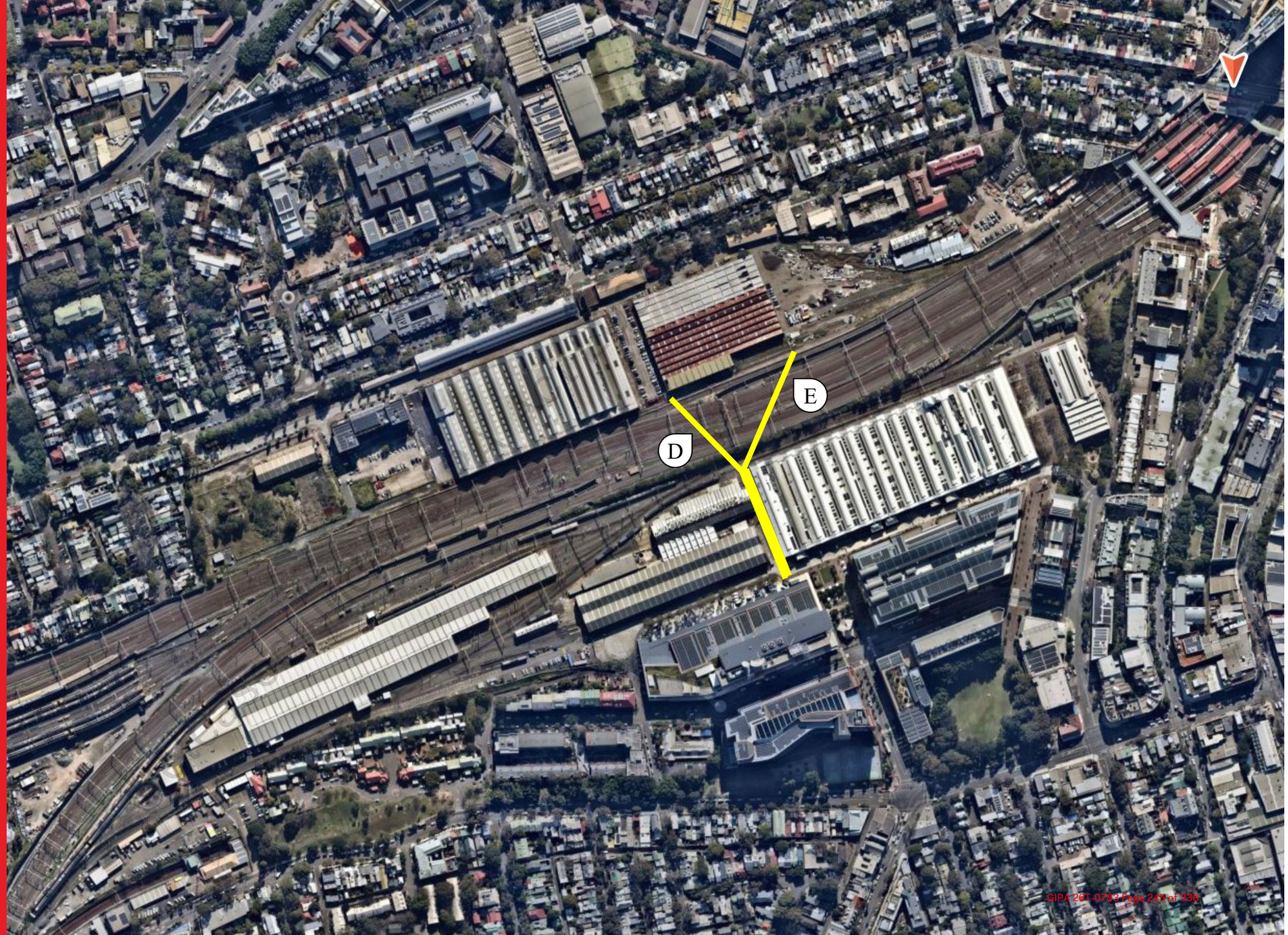
Connections to RNE		Connections near the Paint Shop precinct and/or Carriageworks are more central to the proposed development.
Local Permeability		Alignments adjacent to the Paint Shop suit desired lines to USyd, ATP, and potentially to Waterloo. New crossings too close to existing crossings provide less opportunity for enhanced permeability.
Bridge Design – Piers and spans		Longer spans increase complexity. Minimum span for any option is ~50m. Piers in the rail corridor and maintenance areas requires Sydney Trains approval.
Bridge Design – Landing Zones		Existing users, heritage, masterplan, and other constraints restrict suitability of landing zones.
Stakeholder Impacts		The bridge must seek Sydney Trains engagement and approval. Some alignments may impact local residents (e.g. shading).
Constructability		Construction in the rail corridor is possession dependent. Design and construction is expensive, risky, and will take several years to build (minimum 3.5-4 years) for a pier in a single config.
	Considered further Considered further	

Bridge Form Options

This section does not present the final forms of the bridge.

The models shown are the 3D equivalent of ‘back of envelope’ sketches to inform high level design, construction and cost estimation.

This report does not seek to define the urban design outcomes for the area. It only considers how the engineering design may interact with the masterplan, feasibility and site constraints.



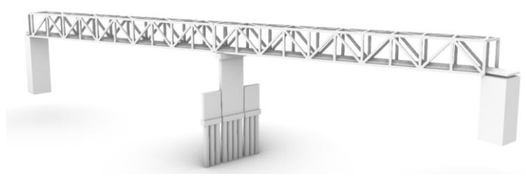
Superstructure - General Forms

The images presented are generic bridge forms to suggest the typologies of possible bridges.

Throughout the iterative design process, the design principles for the site would be integrated with structurally feasible solutions.

It should be noted that all bridge forms must satisfy minimum clearance of 10m above railway track to avoid clashing with the existing OHW and signal gantries.

A **truss form** was identified as the least obtrusive form and was taken forward for the purpose of this study. Weathering steel could be used for the construction, which would also eliminate maintenance requirements for painting.

	Truss	**Tied Arch**	**Cable-Stayed**
			
Height of spanning structure	5 – 6.5m tall	10 – 15m tall (from tying chord to highest point at arch)	Pylon height ~25 – 30m
Span length	50 – 65m	50 – 65m	100 – 130m
Other requirements	Central pier required	Central pier required	Need space for the back stay (image shown is a comparatively compact arrangement) Needs very tall pylons of ~ 25-30m high
	Considered further Form is sympathetic to industrial character of the surrounds.		

Pier in the Rail Corridor

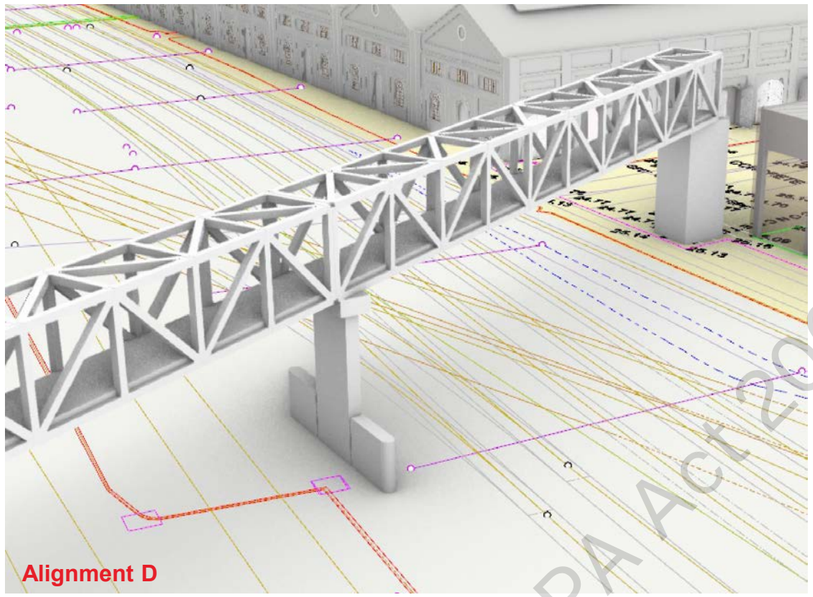
A pier within the rail corridor is required for superstructure options that are efficient and can be lifted into the rail corridor.

Removing the pier is not possible as it would:

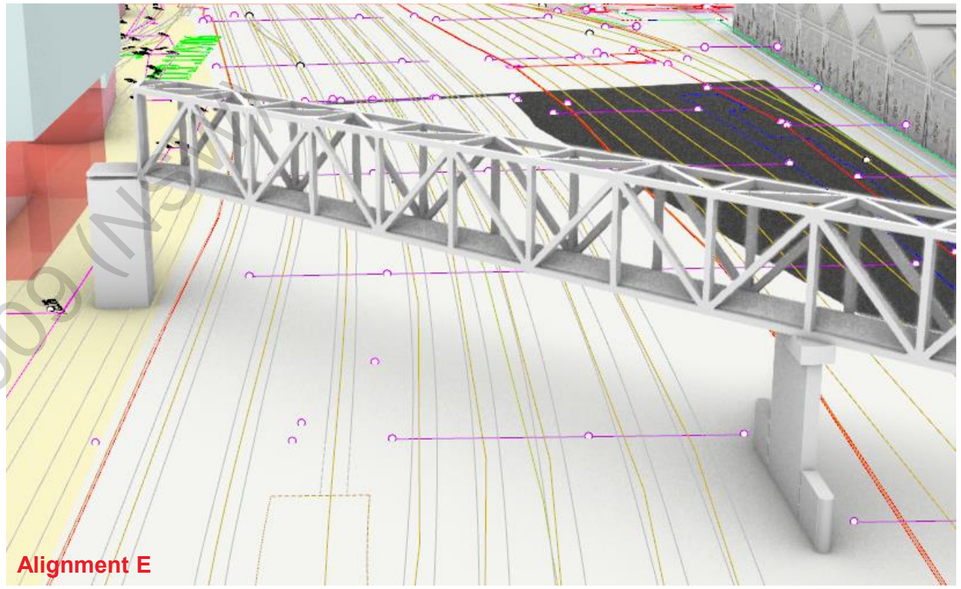
- Increase the size of the bridge truss such that access to the full width of the rail corridor itself is required to construct it (not possible).
- Require a cable supported bridge form. However this will require modules to be lifted from the tracks (not possible) and introduces pylons and backstays (not compatible with physical constraints).

Construction of the pier will be challenging and the design will be heavily influenced by the Sydney Trains maintenance regime. The construction duration will be 3.5 years minimum under ideal possession schedules.

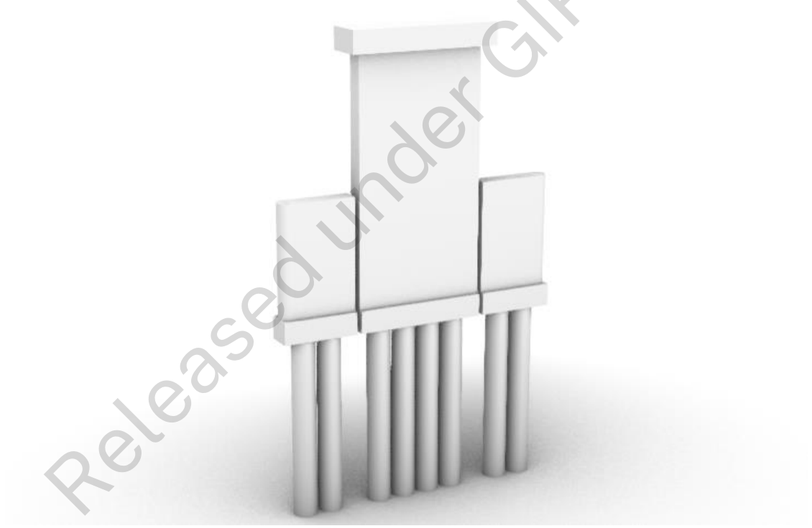
Approval from Sydney Trains and AMB is required for any proposed pier.



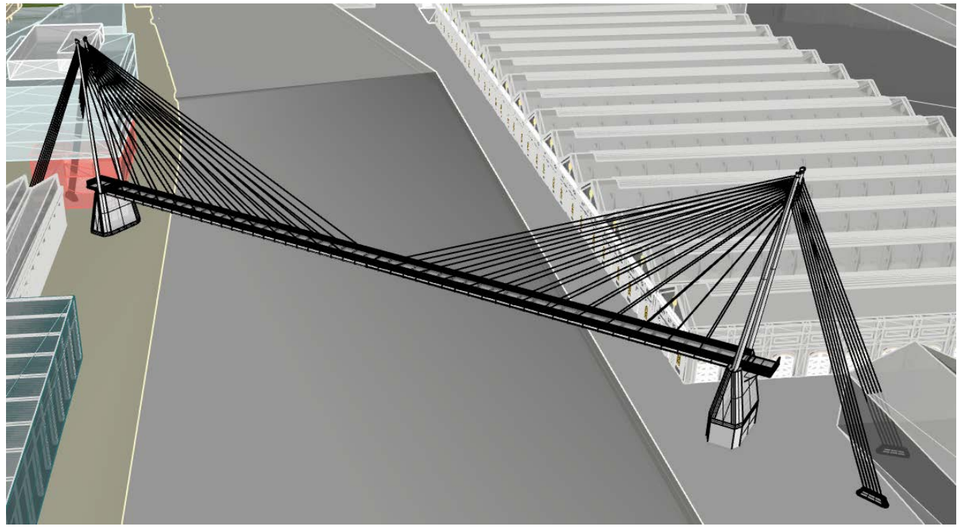
Alignment D



Alignment E



Piles, pile cap, deflection walls and pier



Cable supported bridge in mass model illustrates back stay clashing with the buildings – not a viable option

** Models are indicative only and do not represent the final forms. The model is intended to provide a visual impression of the structure spatial sizing relative to the site.*

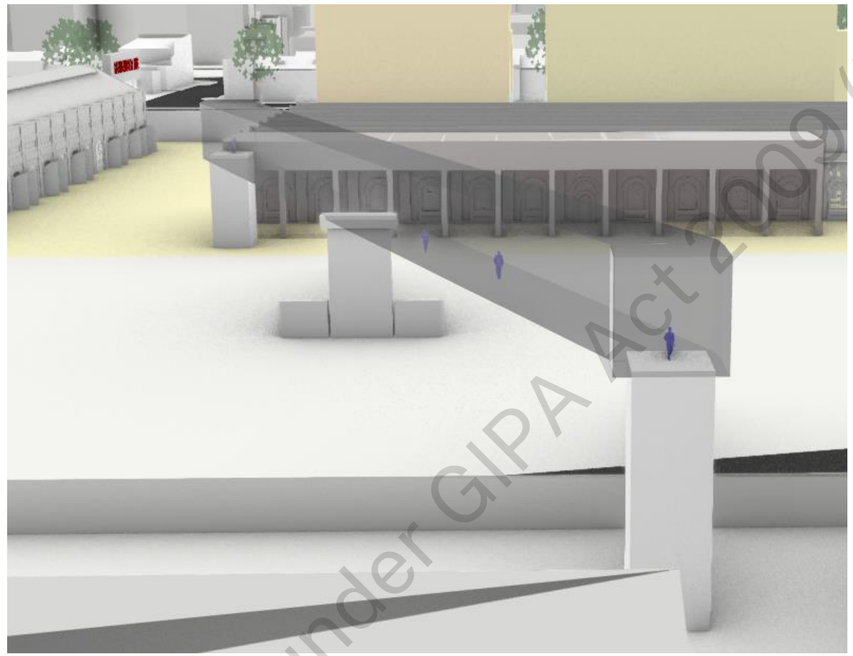
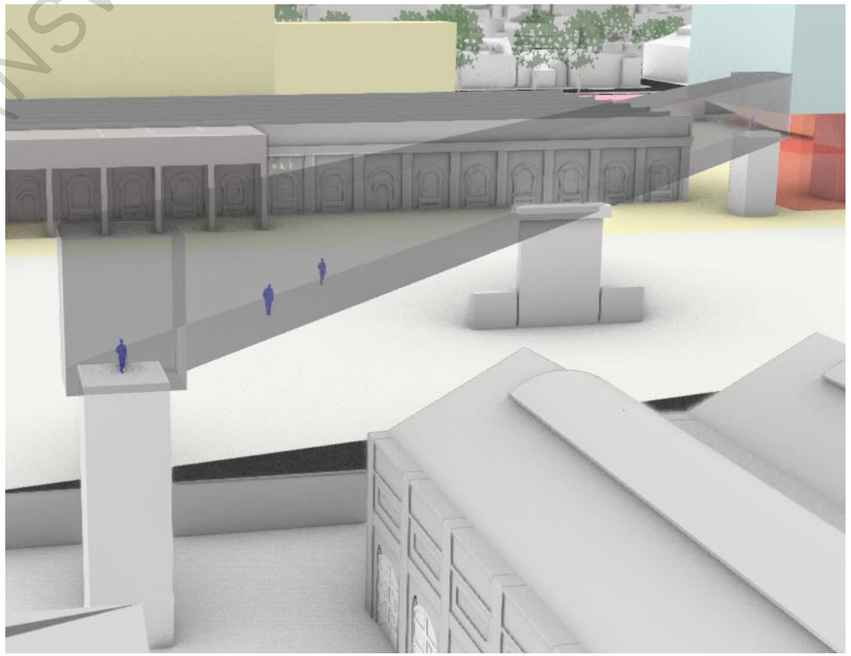
Superstructure - Bridge Volume

The size of the superstructure is influenced by considerations such as:

- Span
- Self-weight
- Requirement to protect against train stacking

Due the clear spans required, even with the central pier, the bridge will have a substantial structural volume.

It is noted that at this stage, we have focused on practicality, rather than aesthetic appeal. However aesthetics would be an important consideration, particularly in regards to complementing the existing heritage buildings surrounding the bridge.

	Alignment D	**Alignment E**
		
Indicative dimensions	5m (W) x 5.5m (H)	5m (W) x 7m (H)

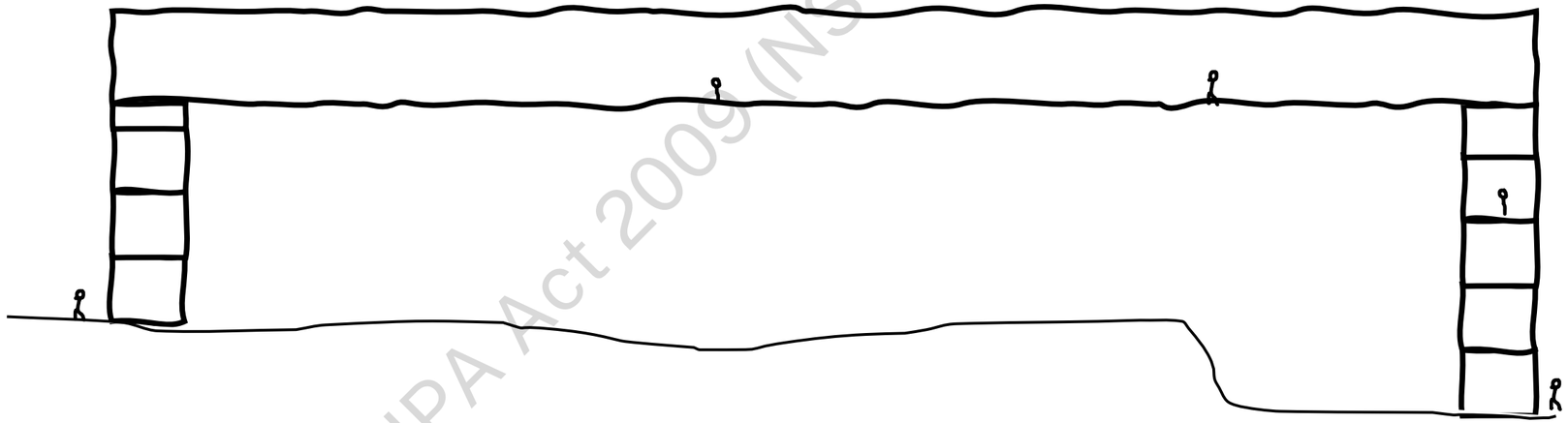
Access will primarily be via lifts

The rise on the north side is approximately 10.5m. This is about 3.5 storeys. (~55 steps/risers)
The rise on the south side is approximately 14.5m. This is about 5 storeys. (~75 steps/risers)
For reference a typical residential storey is 3m.

The bridge alignment provides connectivity for the community. But the stairs also present a cost to pedestrians. At this elevation, the stairs will not be a comfortable or accessible route for many customers. As a guide, stairs are typically used for level changes of up to 5m train stations before they are replaced by escalators and lifts.

The lifts (required for DDA) will be the primary option for access. **Two or more lifts on each end will be required** to meet demand, and multiple lifts will be required so there is backup during breakdown or maintenance. A staircase will still be required in the case of lift breakdowns.

Ramps are not preferred as the elevation and associated horizontal runs present a less-attractive route for pedestrians and cyclists. Refer to future pages for more detail.



North
10.5m level difference
Approx 3.5 storeys

South
14.5m level difference
Approx 5 storeys

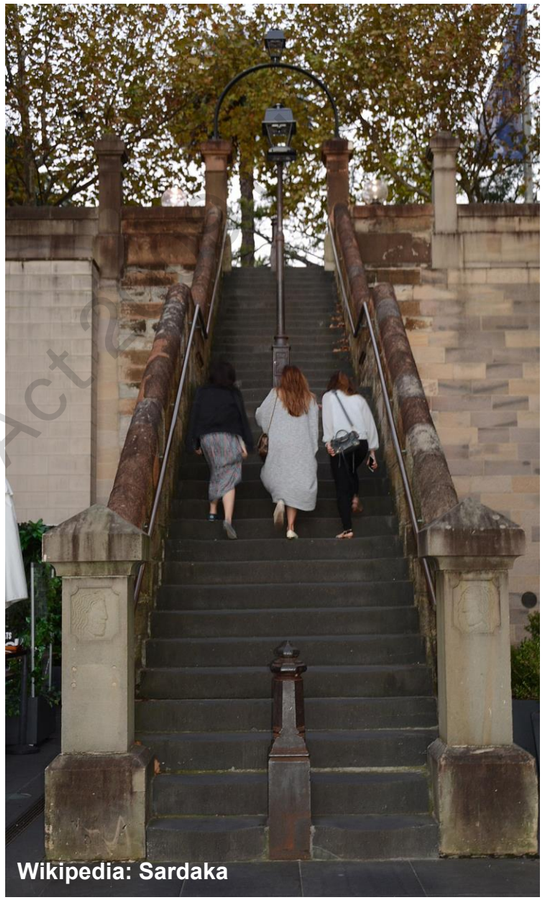
The rise is driven by:

- *Clearance required for rail assets*
- *Clearance for potential train stacking*
- *Level difference - ~3.7m retaining wall*
- *Deck and bottom chord of superstructure*

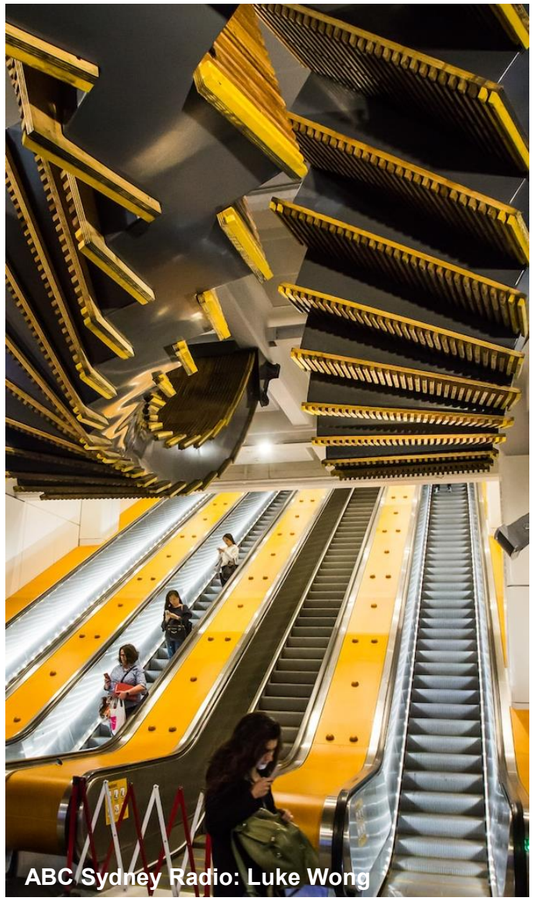
Local Comparisons

Butler Stairs - connecting the Domain to Woolloomooloo (~19m, 103 steps)

Argyle stairs - access from Argyle Street to Cahill Expressway and Sydney Harbour bridge (~10m)



Moore Steps - connecting East Circular Quay with Macquarie Street (~8m, 38 steps)



Wynyard Station Escalators (~13m)

Note, the general rule of thumb is to use lifts or escalators above 5m.
North: approx. 10.5m, 3.5 storeys, ~55 steps*, 45 seconds#
South: approx. 14.5m, 5 storeys, ~75 steps*, 60 seconds #
*Variable. Depends on step height. Intermediate landings not included.
Highly variable. Depends on individual fitness

South Landing Zone

Both alignments D and E assume a landing zone between the LES and maintenance facility.

The design in the south landing area will require approval from Sydney Trains.

The abutment location has been pushed as close as possible to the rail corridor to:

- Reduce the clear spans
- Maintain a straight alignment
- Avoid clashing with adjacent buildings

NW Route - Access over operational areas

The pier landing is within the Sydney Trains maintenance facility. Extensive engagement and permission will need to be sought from Sydney Trains to secure this location.

Due to the mixed security and safety requirements, an extended deck is needed over the maintenance area so that the lift and stairs can be placed in a publicly accessible zone.

Extended deck over maintenance area

E-W Pedestrian Route

The E-W pedestrian pathway is narrow, and the pier placement will reduce the width of the emergency pedestrian access route. Further, the alignment is not along a major desire line.

The N-S alignment has been considered instead of the E-W alignment.

Impacts for consideration

- Visual impact to adjacent frontage of Locomotive Sheds. The walkway will be visible above the Locomotive Shed roofline.
- Synergies with LES repurposing
- Operational impact to Sydney Trains
- Preserve area under the extended deck alignment for emergency access to the rail corridor
- Refer to next slide for operational impacts

Rail area
Publicly accessible area
Abutment

Pedestrian access
Lift/stairs/deck

ARUP

South Landing – Operational Constraints

The maintenance shed will remain operational. Construction of the south landing becomes challenging with the following operational constraints and requirement at each location, ***if endorsement is granted.***

1) Access for staff is to remain. Assume the need for emergency exit from Locomotive building for pedestrian access is adjacent to rail corridor.
2) Removal of shed is not possible without impacting maintenance operations
3) Access to gate is required to be maintained.
4) The equipment and shed serve the Locomotive building. Mirvac have easement rights and TfNSW is not in control. Assume no relocation.
5) No Parking Zone in front of shed.
6) Consideration for turning circles and emergency access to rail corridor.

(1) Staff access

(1) Staff access and area immediately beyond

(2) Shed is used for maintenance

(2) Shed is used for maintenance
(3) Corridor acts as emergency access to rail corridor

(4) Plant for the Locomotive Sheds

(5) Shed access

South Landing - Ramps

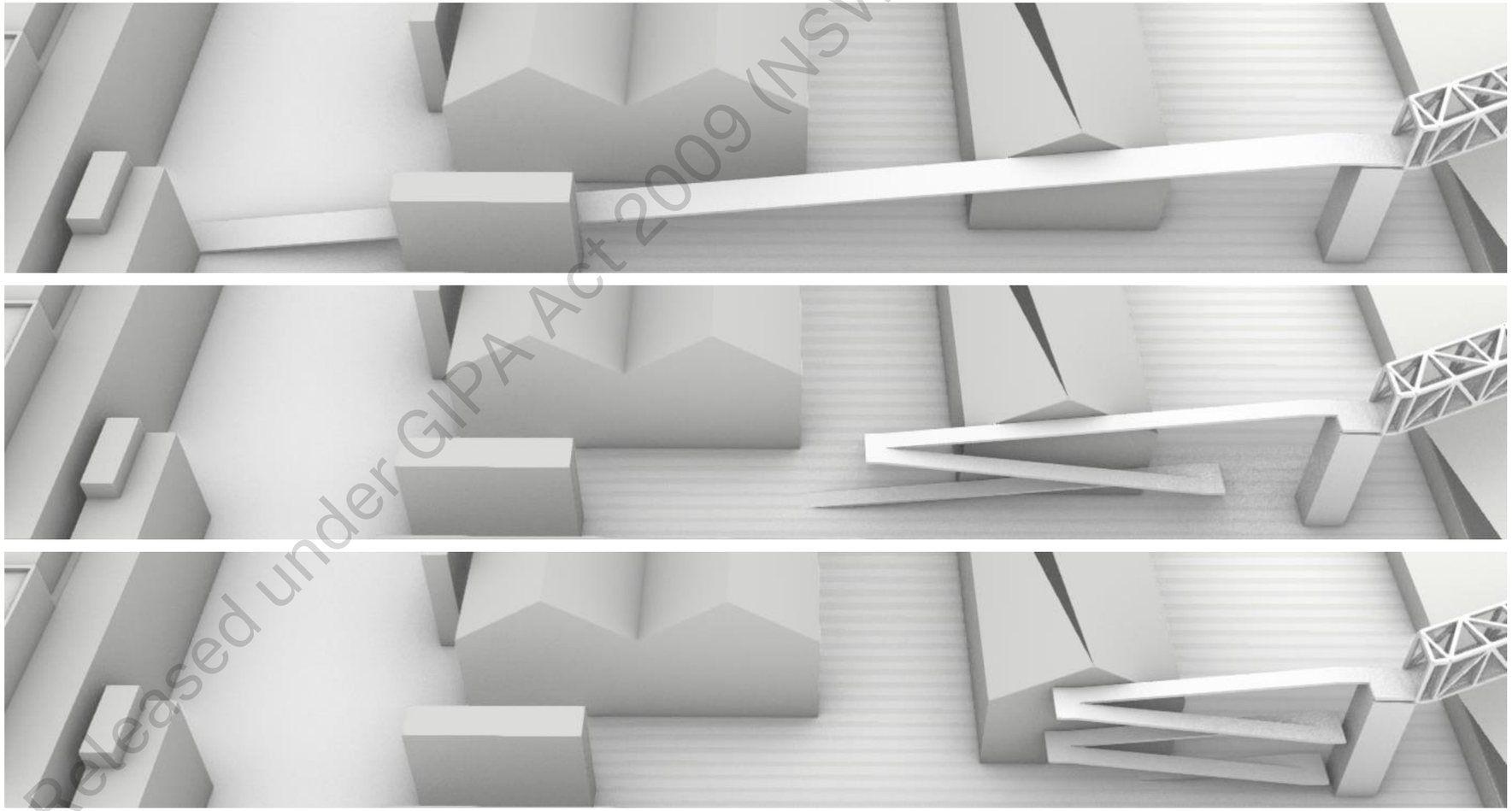
A ramp is not feasible or appropriate for the south landing due to the space required to accommodate the horizontal length given the difference in level.

The steepest grade permissible (Grade 1 in 8 cyclist ramp) without rest zones (not compliant) results in a run to the base of the Channel 7 building. DDA compliant ramps (grade 1 in 20) would be longer still.

For pedestrians, the additional distance increases the walking time and further reduces any potential travel time benefits. For cyclists, the large number of switchbacks reduces the appeal in comparison to a more roundabout but direct route.

A ‘winding’ run with the large space requirements will also block access to the rail corridor and will present a challenge to an open ground-plane.

Similar typologies would be applied if ramps were used on the north.

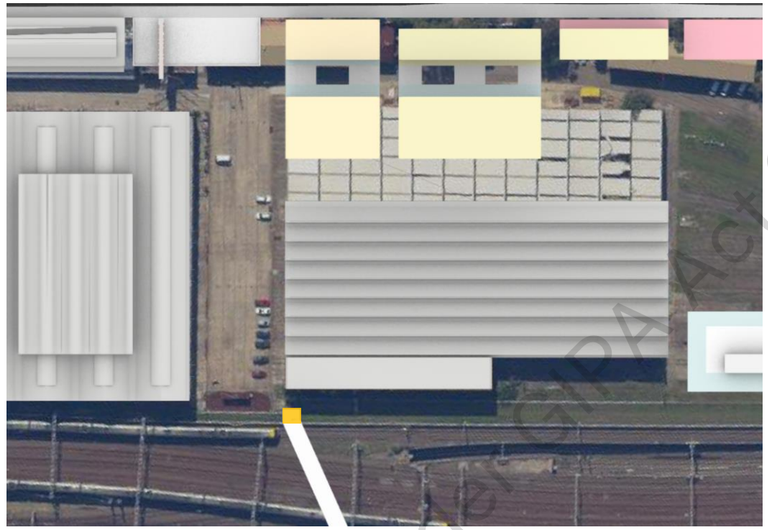


** Models are indicative only and do not represent the final forms. The model is intended to provide a visual impression of the structure spatial sizing relative to the site.*

North Landing Zone

The north landing is slightly less complex than the south, and stairs and lifts will generally fit in the space available. Ramps have not been proposed as a complementary ramp on the south side is unlikely to be accommodated.

A minimum 4m x 4m footprint will need to be reserved for the abutment.

	Alignment D **West of Paintshop - Behind Paintshop annex**	**Alignment E** **East of Paintshop**
		
Design outcomes	Respects sight-line along the Traverser. Potential to direct people into the Paintshop. May be sited outside the Paintshop precinct boundary.	Potential to direct people into the main square
Constructability	Rail possession or protection will be required to construct the piers. Proximity to the Traverser gives more storage and lifting space. Construction will restrict operations of the Carriageworks, and timing of works will need to be coordinated with the availability of the area.	Limited space for access between the Paintshop and K1 building in the new development Works to be constructed under rail protection. Very constrained access, will be difficult to maneuver cranes and material if built after the new development.

** Abutment locations are indicative only and do not represent the final forms. The model is intended to provide a visual impression of the structure spatial sizing relative to the site.*

North Landing Ramps

Digital maquettes of the ramps are shown.

As can be seen from the images, a ramp is not ideal as the run required will be a substantial visual impact across heritage frontages.

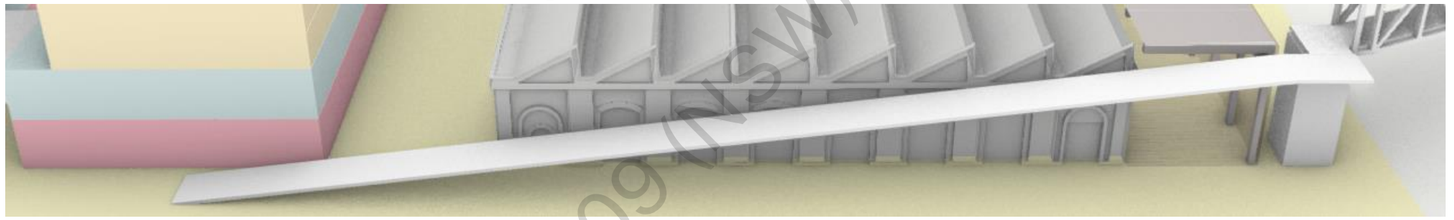
The scheme shown considers a cyclist ramp (grade of 1 in 8), which has less onerous constraints than a DDA ramp (grade of 1 in 20).

The ramped distance will increase if a DDA ramp is required.

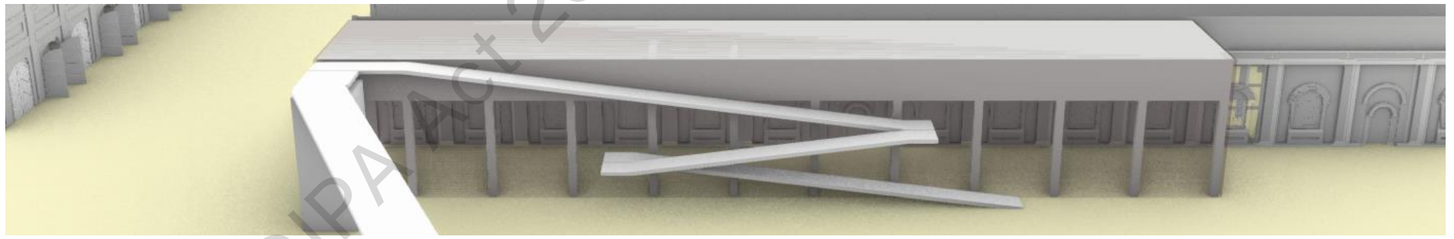
The north landing requires a level drop of approx. 10.5m.

Alignment D West of Paintshop

N-S alignment — Will cut across the frontage of the paint shop and along the Traverser, and thus is not desirable heritage outcome

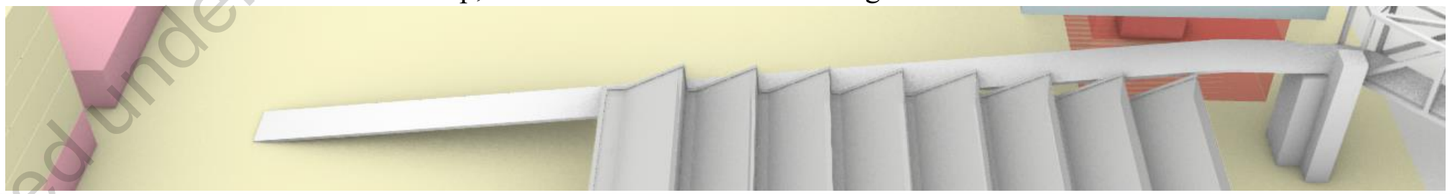


E-W alignment — Coordination required with drainage

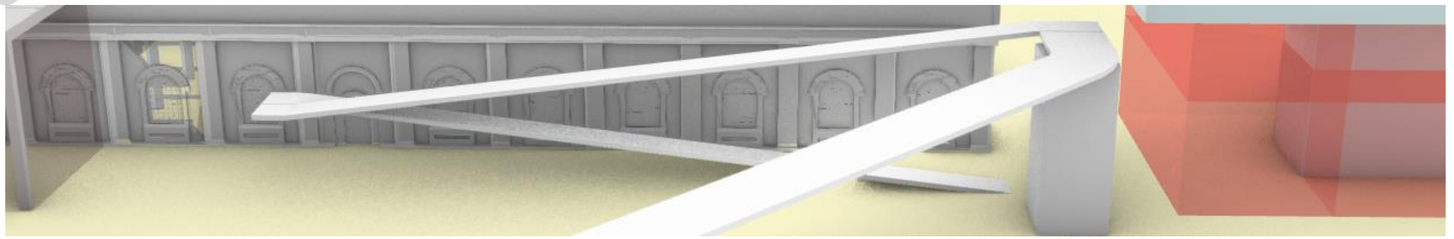


Alignment E East of Paintshop

N-S alignment — Will cut across the frontage of the Paintshop and K1 building obstruct the space between Paintshop, and thus is not desirable heritage outcome



E-W alignment — Coordination required with drainage



** The location of the ramp is indicative only and do not represent the final forms. The model is intended to provide a visual impression of the structure spatial sizing relative to the site.*

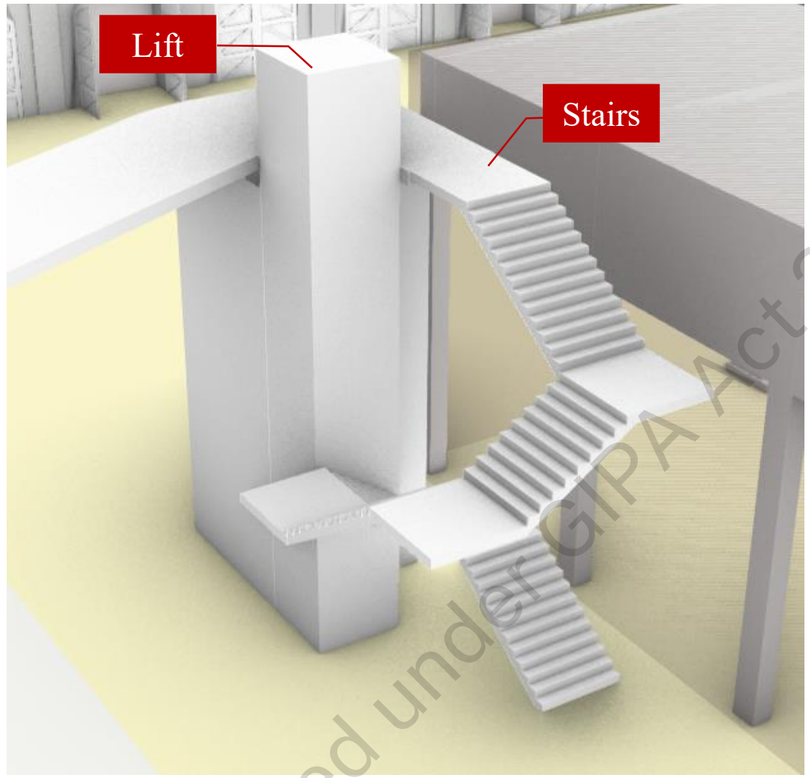
Stairs and Lifts

The configuration and location of the stairs and lifts are TBC at this stage of ideation.

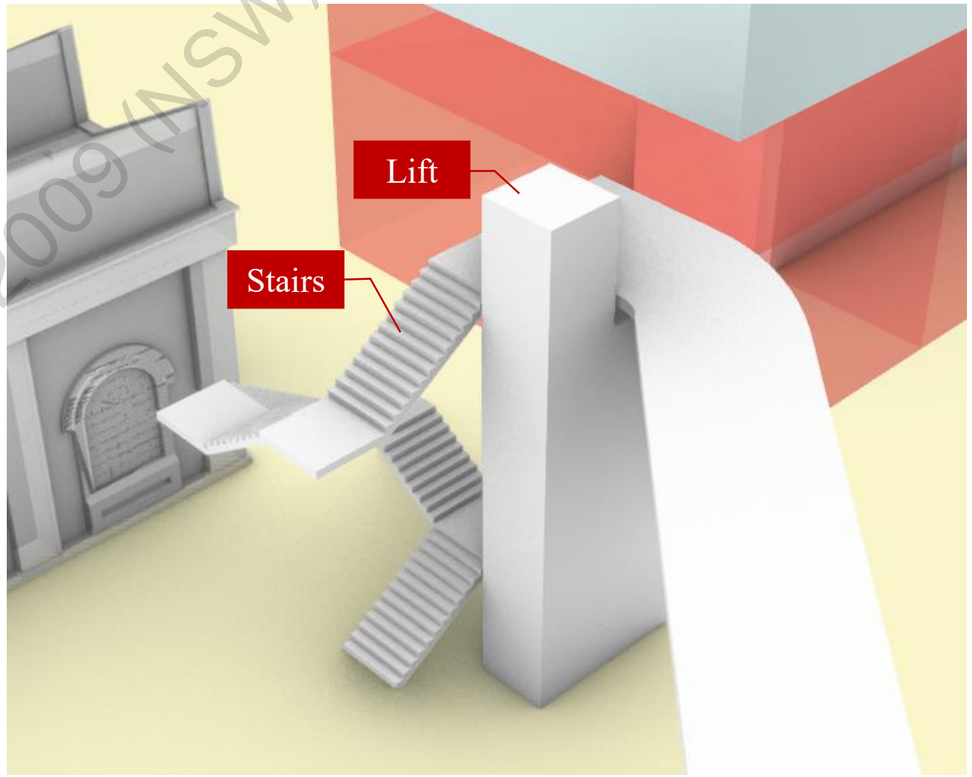
There are multiple feasible configurations available.

It is highly likely they can be accommodated within the landing zones.

Note, the stair is not a mandatory requirement if sufficient lift access can be provided.



Alignment D



Alignment E

** The location of the stairs and lifts is indicative only and do not represent the final forms. The model is intended to provide a visual impression of the structure spatial sizing relative to the site.*

Other Design Considerations

For the bridge to be a safe, comfortable and desirable route for pedestrians and cyclists, multiple other design elements will need to be considered.

A non-exhaustive list of considerations is provided.

	Example Design Considerations
Safe	CCTV, safety screens/throw screens, Crime Prevention through Environmental Design (CPTED), lighting design above and beyond compliance. Earthing, bonding and electrolysis, consider sightlines for train drivers, risk of train collisions (deflection walls).
Comfortable	Quality of finishes, maintenance regimes (e.g. cleaning, lift maintenance)
Convenient	Pedestrian modelling and lift queue times, lift sizing to fit bicycles
Time Saving	-
Accessible	DDA
Sustainability	Embodied carbon, durability and obsolescence.
Heritage	To be advised, compromise is required.
Connection to Country	Quality of architectural design, opportunities to tell the story through structural form or non-structural art (e.g. opportunities on throw screens)
Value for Money	Durability, prefabricated construction
General Bridge Engineering	Structural design, geotechnical design, utilities (e.g. power connection to service lifts and lighting), drainage, constructability, approvals process through Sydney Trains and AMB

Construction Overview

Constructing the bridge will be difficult, expensive, and take many years.

Due to the location over multiple live rail lines, constructability is a major driving constraint.

Further, due to the proximity of Redfern Station to Central Station, any construction activity will be akin to ‘open heart surgery’.

One high-level and optimistic construction sequence has been outlined.

Construction Considerations

Constructing the bridge will be challenging, expensive, and take many years. Refer to the next page for an indicative construction program.

As the bridge is positioned over a live rail corridor, the construction methodology and sequence will need to be undertaken in alignment with shut-downs or possessions. Each possession typically ranges from 36-48 hours in duration and there are a limited number of possessions granted for each configuration each year. In the ideal scenario, a maximum of 2 possessions will be scheduled for each configuration each year.

Construction activities, including lifts or launch of the bridge, cannot be conducted over live rail, so the majority of construction work will need to be undertaken during possessions. Further, it is extraordinarily unlikely for the entire width of the rail corridor to be shutdown simultaneously, especially for a central artery such as Redfern Station. Staging will need to 'piggy back' off larger projects.

All construction plans will need to be approved by Sydney Trains.

Concessions required

Some elements will explicitly require concessions from Sydney trains. This is a non-exhaustive list.

- Piles and piers in the rail corridor, which would be in proximity to HV assets and the Illawarra Dive.
- A bolted construction project would need to be approved by Sydney trains.

Risks and uncertainties

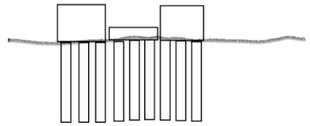
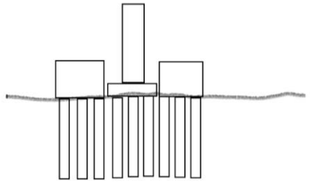
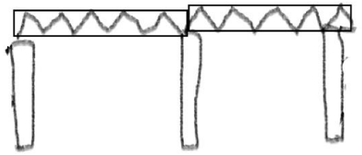
- Possession schedule lookahead is only ~1 year (i.e. no visibility of possessions beyond June 2023)
- Coordination with possession schedule for access and construction.
- Access from the south side is very challenging given that this will cause disruption to the local maintenance facility. If go ahead is granted scheduled work time would still be limited to possession schedules. Access is also required to lift the southern span into place.

Optimistic Construction Program

Under the assumption that up to 2 x 48 hour possessions are granted each year, the bridge has a very optimistic construction duration of 3.5 years. It is highly unlikely that this duration will be reduced, and a more realistic duration would be 4-5 years construction duration. A further 1-2 years needs to be added to account for the design and approvals process.

Risks and uncertainties

- The number of possessions is unconfirmed and may be reduced. The current schedule lookahead is only for 1 year and there is no visibility of possessions beyond June 2023.
- Access from the south side is very challenging given disruption to the maintenance facility. Works within the maintenance facility will also be limited to possession schedules. Access is required to lift the southern span into place.

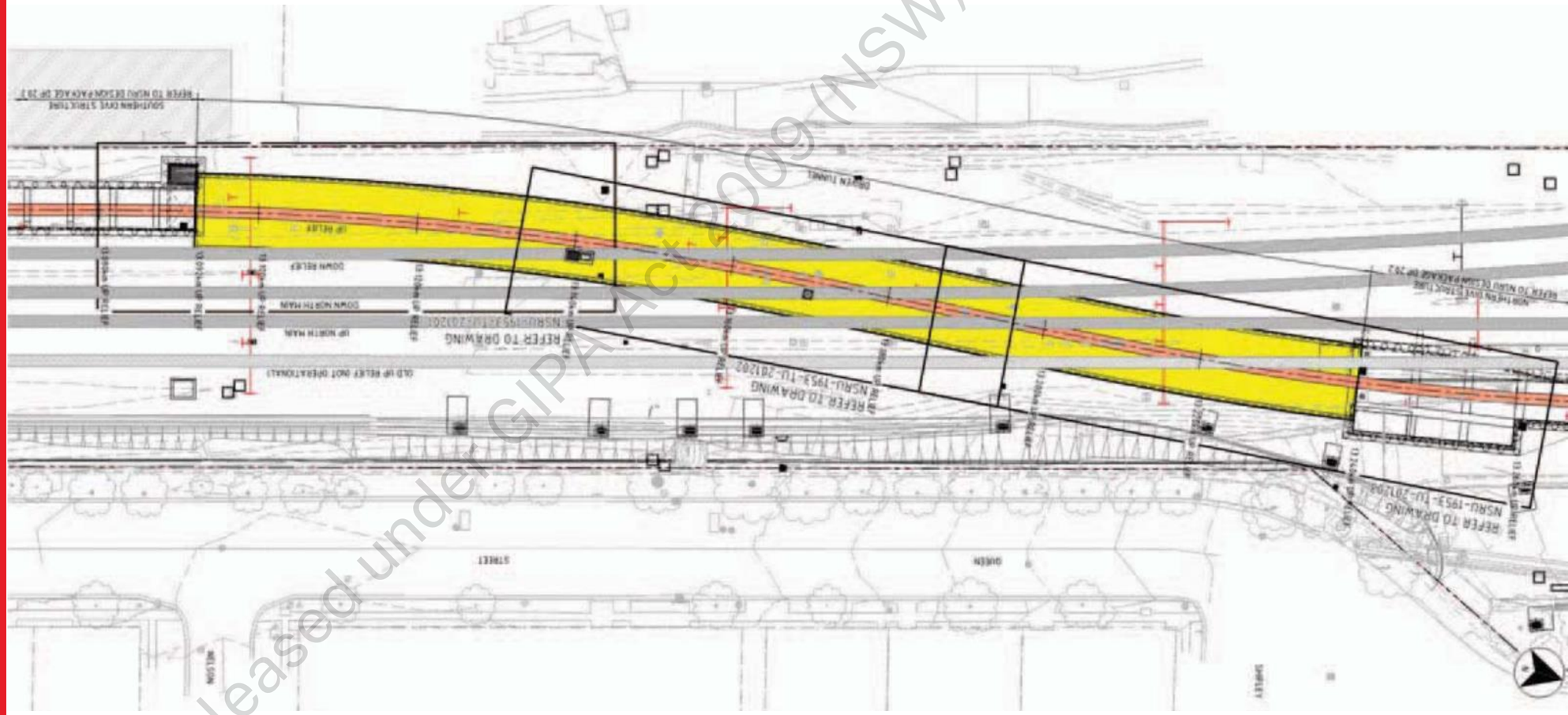
Bridge element	**Possible Min. no of possessions**	**Min. no of years required for possessions**
Piles in rail corridor 	2	1
Pile cap install and cast, and set formwork deflection wall 	1	0.5
Install pier, deflection wall, concrete pour and strip 	1	0.5
Bridge: - Lift and bolt north span - Lift and bolt south span 	2	1
Fitout and miscellaneous	1	0.5
Total:	**7 possessions *minimum***	**3.5 years *minimum***

Tunnel Case Study

A tunnel case study is described here for consideration.

The North Strathfield Rail Underpass was built as a rail tunnel, rather than a pedestrian tunnel. However it provides insights for constructing under live rail.

Gonzalez, M. et al., 2014, *The North Strathfield rail Underpass – Driven Tunnel Design and Construction,* 15th Australasian Tunnelling Conference 2014, Sydney, NSW, 17-19 September 2014.



Case Study – North Strathfield Rail Underpass

This case study is provided for consideration only, and a full feasibility study has not been undertaken. At a high-level, a tunnel would be have similar constraints on the landing (portal) zones and level differences required as for a bridge. Therefore it would not be a simple and cost effective alternative.

Further, given the foot-traffic and tunnelling distances required (100-150m), a tunnel is unlikely to be perceived as safe. Dimensions, lighting, ventilation finishes and other design elements will need to be of a very high quality/specification if the inherent CPTED challenges of a long tunnel with low volumes of usage is to be overcome.

Overview

- Rail tunnel to grade separate freight trains from suburban trains.
- 148m long
- 8m high x 9m wide
- 2.5 – 3.5m ground cover

Other features

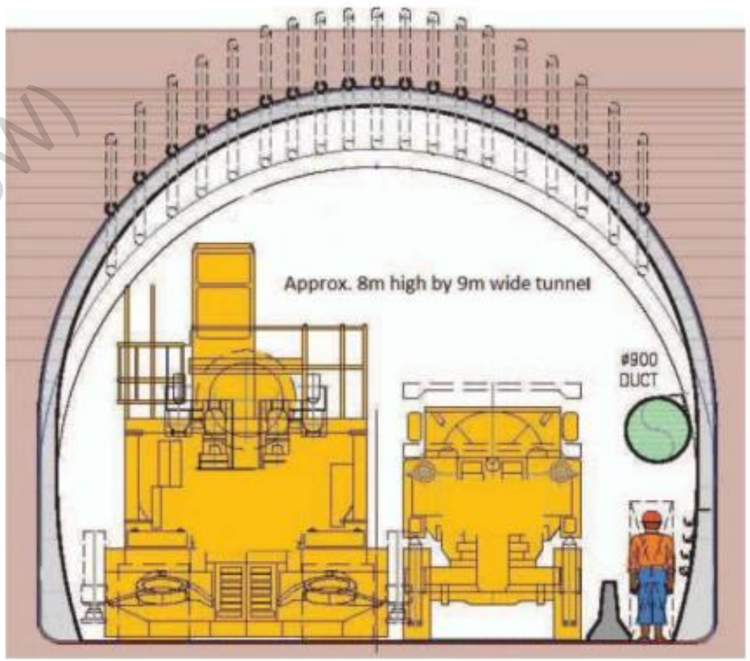
- Geotechnical investigations during track possession regime.
- Excavation cycle - Canopy tube, road header excavation, shotcrete lining.
- Synthetic fibre reinforced shotcrete without steel sets or lattice girders.
- 24-7 monitoring of rail for settlement

Outcomes

- ~6 month tunnelling period
- Limited disruption to rail operations
- Construction adjacent to and under live rail.

Considerations for a pedestrian tunnel at RNE

- Safety and security. Due to length, the end of the tunnel may not be visible.
- Footprint for dive sites
- Interface with existing tunnels or dive structures
- Depth of tunnel and downward ramps



Summary

Summary: Assessment of bridge feasibility

There is a high degree of difficulty in siting and constructing a pedestrian bridge from the RNE development.

The feasibility of the landing zones is questionable, especially on the southern side where the abutments are in operational rail maintenance areas.

The need for possessions and work under protection significantly impacts on cost and programme. Engineering solutions can be found if enough money, time and effort is dedicated to the problem.

However, there is a task for TfNSW to consider whether the cost required to build this bridge is balanced by the use case and benefit it brings to the Redfern North Eveleigh community.

Connect the North and South Eveleigh communities	✓
Provide local permeability across the rail corridor	✓
Safe	✓
Comfortable	?
Convenient	?
Provide time savings for pedestrians and cyclists	?

Accessible	✓
Sustainable	!
Sympathetic to the industrial heritage of the area	!
Connection to Country	✓
Value for Money	!

ARUP

Conclusion and Next Steps

The Redfern North Eveleigh Bridge will be a very challenging and expensive bridge to build and does not provide outstanding time savings or convenience for users.

Next steps:

Internal TfNSW benefits and value assessment.

Business case preparation and funding submission (subject to passing value and benefits assessment).

If the bridge is built:

There will be a high cost and long program due to physical and operational constraints.

Design Costing Notes

The following sections provide further detail to inform cost estimation by the quantity surveyor.

ARUP

Alignment D *[Alignment E]*

- From North landing – At west of Paintshop behind the annex *[At East of Paintshop]*
- To South landing – At zone between maintenance facility and Locomotive Shed

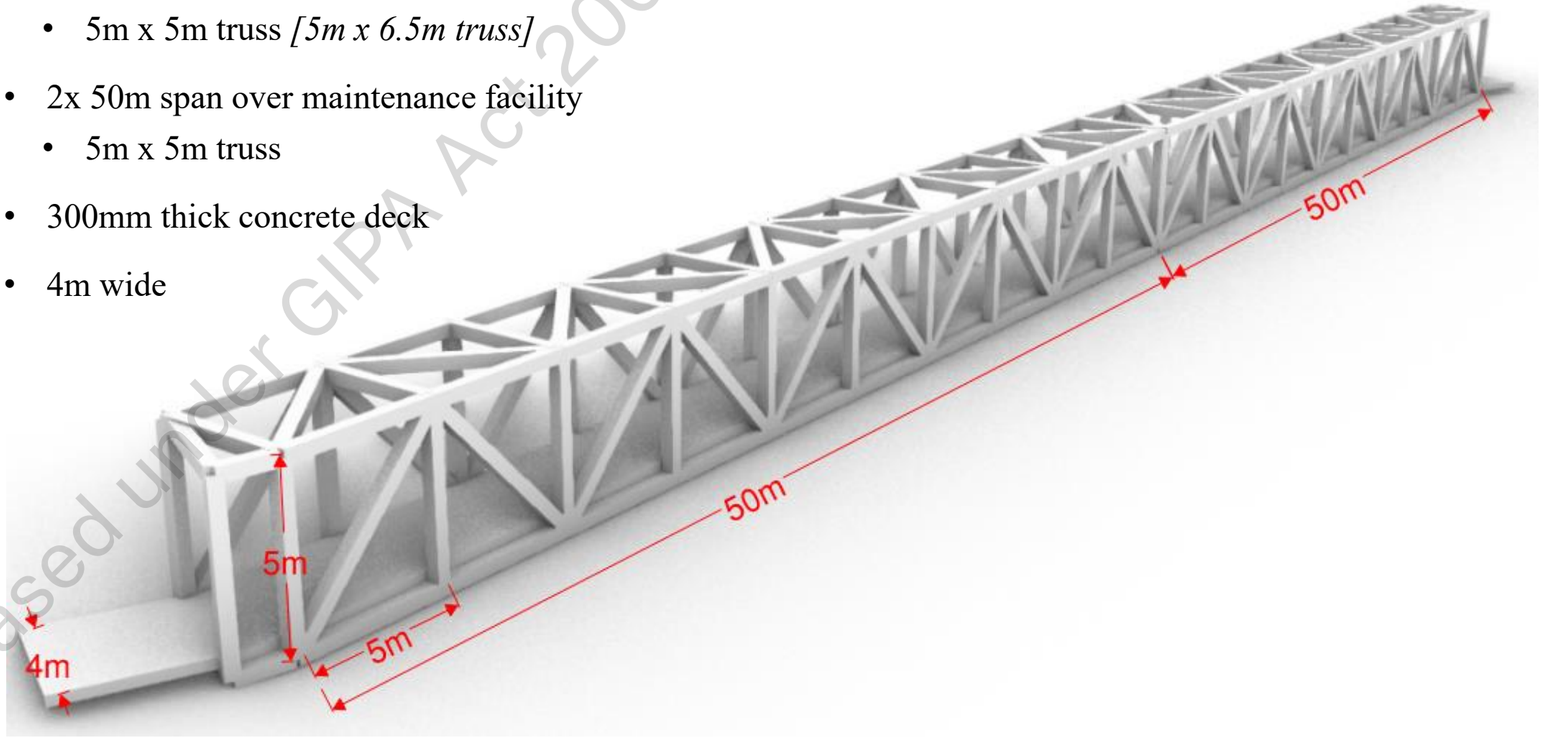
Alignment D

Alignment E

Superstructure Example - Truss

Assumed for alignment D *[specific for alignment E]*

- Weathering steel for durability and low maintenance preference
- Bolted construction (No site welding)
- 2x 50m *[2x 65m]* spans over rail
  - 5m x 5m truss *[5m x 6.5m truss]*
- 2x 50m span over maintenance facility
  - 5m x 5m truss
- 300mm thick concrete deck
- 4m wide
- Access from both the north and the south
- Sloped deck to remove need for drainage
- Skew bridge - 30 degrees *[45 degrees]*



Truss in Alignment D and for spans over maintenance facility in both alignments

Bridge Detail

Notes on Scheme Design for Costing

Substructure

Assume for alignment D
[specific for alignment E]

- 2x Abutments
  - Minimum 4m x 4m footprint
  - Abutment foundation
  - From top of deck to ground, approximately 10.5m at North and 14.5m at South
- 1x Headstock*
- 1x Pier in rail corridor*
  - Precast, post-tension
- 2x Deflection wall
- Pile caps*
  - Separate pile cap under pier and deflection walls
- 8x Piles *[9x Piles]*

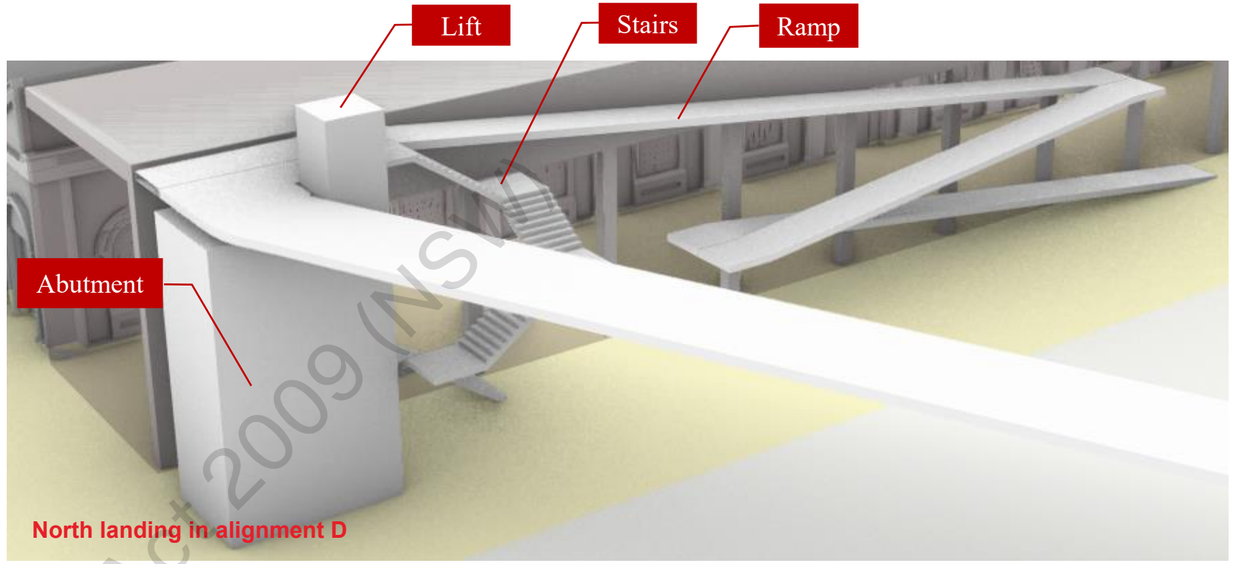
** Headstock, pier and pile caps will be larger in size for alignment E*

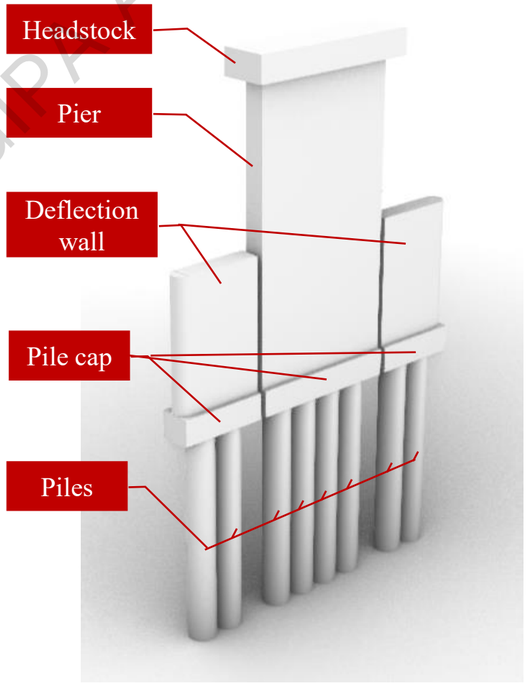
Access, Fittings and Others

- Access at each landing (See abutment for required level drop)
  - Lift (2x each side, assume 13p lift to fit a typical bike)
  - Stairs (Assume 1.6m wide)
  - Ramps (note as separate line item)
- Handrail
- Safety screen
- Lighting (assume specialist lighting over and above compliance requirements)
- Security (CCTV)
- Include additional allocation for Connection to Country piece.

Superstructure

- Needs to be of a very high aesthetic quality
  - E.g. similar to Lachlan's Line or Helix Bridge in Singapore





** The location of the ramps, stairs and lifts is indicative only and do not represent the final forms. The model is intended to provide a visual impression of the structure spatial sizing relative to the site.*

Bridge Detail

Notes on Scheme Design for Costing

Construction Costing Notes

The following sections provide further detail to inform cost estimation by the quantity surveyor.

Substructure

Construction of the substructure will require a combination of the following:

- Full rail possessions to construct the central pier
- Approval to perform construction work close to HV asset and Illawarra Dive
- Work under protection to construct the abutments
- Substructure design is possession-driven, hence time-efficient solutions are proposed that can be constructed within the available possession.
- Work in the rail corridor will require temporary rail access by flooding the track with ballast to allow access for a piling rig and trucks from the northern side of the site.

Substructure	Construction method	Other risk and assumption
Pile	• Bored with temp casing. Remove soil • Install pile reo cage with crane • Cast concrete pile in place	• Assumed cased bored pile • Unknown rock level. Founding level to be determined from GI • Potential contaminated material in bore • Piling rig must achieve clearance underneath de-energised OHL
Pile cap	• Precast concrete or steel shell casing as formwork – temp shoring • Lift in place • Prefabricated reo cage • Concrete pour from long reach pump on the northern side or along tracks via Mcdonaldtown	• Steel shell can be used as a sacrificial formwork • Assumed the shell can be transported to site
Pier / Deflection wall	• Precast segments lifted in place • Tie to pile cap with Macalloy bar • Grout OR • Formwork / Transvent tube left in corridor • Prefabricated reo cage on site • Concrete pour	• Precast unit would be the time-efficient option. However, the size of the unit can pose an issue for transportation, and it is a heavy lift. • Risk of clashing with OHW and gantry during lifting and working at top of pier
Headstock	• Precast concrete or steel headstock lift in place • Install bearings	• Risk of clashing with OHW and gantry during lifting
Abutment	For foundation • Excavate the desired footprint • Form reo cage/ steel fixing on site • Concrete pour • Construct abutment structing once concrete is cured and other fitout, including cladding	• Approval to construct adjacent to the Paint Shop Precinct boundary for north abutment • May require rail possession as the abutment location is close to the railway track, subject to coordination with Sydney Train. Alternatively, the work must be performed under protection.

Crane and Access

- Mobile crane is preferred due to limited space and relative ease of mobilization. Constructability is assessed based on the use of 450-tonne mobile crane.
- Load capacity is approximately 30t for 30m and 20t for 40m reach.
- Requires a 3.1m width clearance for travel and access.
- Requires approximately 20m long x 10m wide area for crane setup with outriggers

Bridge design requirement

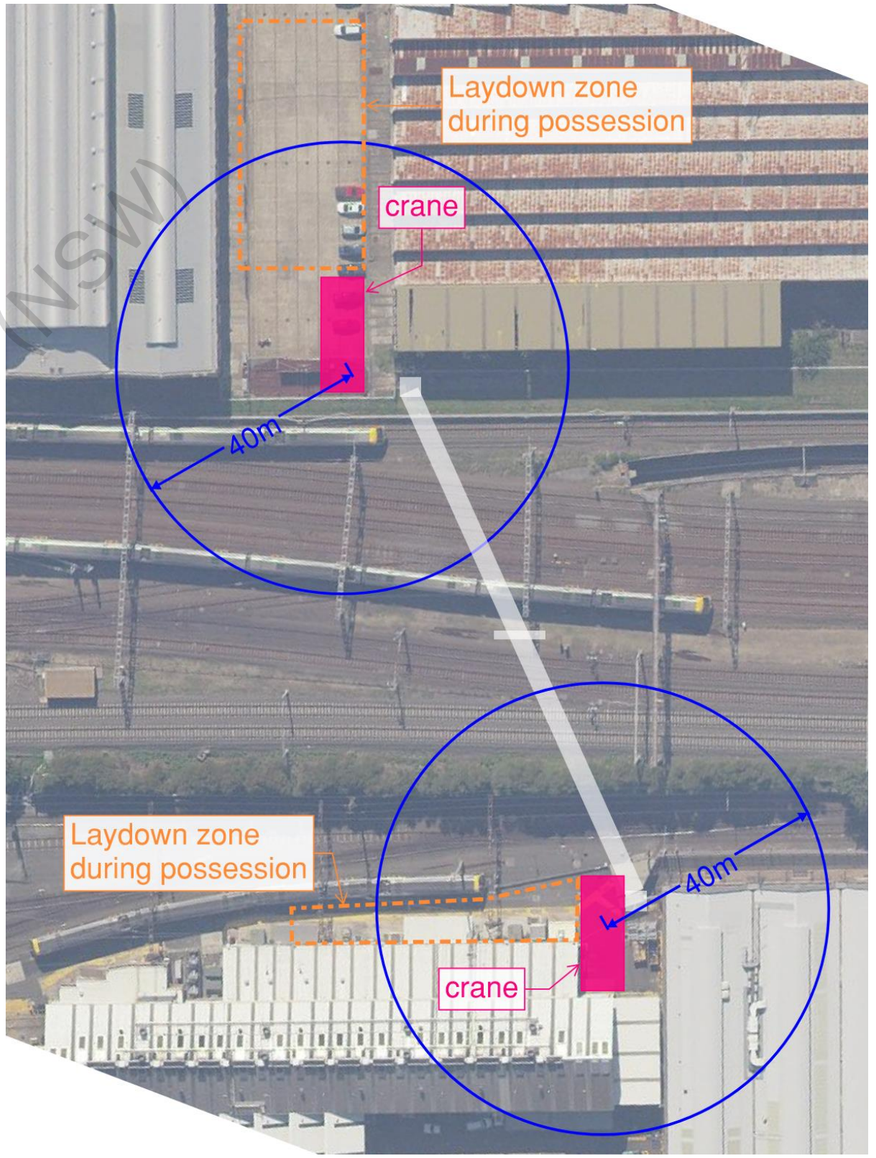
- Weathering steel
- Bolted design – no welding
- Subject to the final design, the bridge may be designed into smaller segment with bolted connection. This reduces the weight for the lift.
- Each segment can be designed in different size/length due to the allowable lift weight in the reach, say 20-35 tonnes each.

Lifting Process

1. Lift bridge in place in modules (2 x vertical trusses and cross members)
2. Modules are bolted.
3. Concrete deck poured on transfloor.
4. Once concrete is cured, fit out work can commence, including installing handrail, safety screen, lighting etc.

Risks and assumptions

- The Traverser can be utilised in the north as laydown and storage area
- Carriageworks access along the Traverser will be affected during construction (e.g. substantially during possessions, and partially affected between possessions).
- Heavily dependent on Sydney Trains approval for maintenance area access. Will need to temporarily remove shed and other obstacles for crane access and bridge parts assembly. Very tight laydown zone, constraint in space for access. Assumed that construction access in this area will be during possession regimes and not for the entire elapsed construction period.
- Lifting bridge segments over building.



Superstructure

Notes on Scheme Design for Costing

Possessions

Construction of the pier in the rail corridor and superstructure erection will require rail possessions.

The current possession schedule (issued on 23 Sept 2022) indicates plans up to 25 June 2023. There is no visibility on the future schedule .

Assuming the future schedule is comparable to the current possession schedule, we have assumed:

- 2 possessions a year
- 48 hours in each possession
- minimum 7 possessions is required, suggesting a **minimum 3.5 - 4 year construction period**

The construction of other bridge components (abutment, access) has not been considered as part of these rail possessions but will be constructed under possession.

Negotiation may be possible with Sydney Trains regarding whether the bridge construction schedule can be considered in the future possession schedule planning. An allowance may be made for additional possessions. However, it is unlikely that the project will be granted ‘ideal’ possession configurations and the project would likely need to "piggy-back" on other larger projects.

Construction sequence by element	Min. no of possessions	Remark
8x no. of piles	2	• 4 piles per possession • 2 rigs required
Pile cap	1	• Precast unit or steel shell can be used as a sacrificial formwork • Drop reo cage/ steel fixing on site • Concrete pour
Pier and Deflection wall	1	• Formwork for deflection wall shall be set in previous possession • Pier can utilise Transvent tube as the formwork • Drop reo cage/ steel fixing on site • Concrete pour
Headstock and Superstructure	2	• Crane required • Headstock and superstructure will be lifted in place • Including bearing installation • One possession per lift from north and south • Bolted design and no welding
Fitout and miscellaneous	1	• Cast deck slab, install safety screens, lighting etc
Total:	**7**	

Rail Possessions for Construction

Notes on Scheme Design for Costing

ARUP

Other notes for costing

- Replacement bus during rail possession may need to be allowed for
- Protection cost – protection officers
- Use of temporary access structure or to flood the track for piling rig and truck access on tracks
- To permanently/temporarily dismantle or relocate shed and entry access hub in the south landing
- Cost risk due to no future possession schedule for contractor planning
- Maintenance facility must remain operational. Assume construction under protection for south-side deck between LES and Loco.
- Ground investigation is required. Shallowest rock depth is 8m to 15m. With the shallower depth at the northern side. Rock is dipping towards the south based on desktop studies of the site. Pile lengths TBC. Rock sockets would be required.
- Assume contaminated fill throughout.

Other Notes

Notes on Scheme Design for Costing

About Us

The analysis and report for this project was undertaken by Arup who have significant experience with analysing the design and performance of bridges and rail infrastructure.

References + Standards

To complete the analysis and reporting, a series of standards and documents were reviewed and considered as part of the process.

The following standards were used as references:

- AS5100-2017 - Bridge Design
- BTD 2012/01 - Provision of Safety Screens on Bridges
- ESC215 – Transit Space
- EP 08 00 00 01 S - Overhead Wiring Standards for the Electrification of New Routes
- T HR Cl 12030 ST - Overbridges and Footbridges
- T HR EL 10001 ST - HV Aerial Line Standards for Design and Construction
- T HR SC 10001 ST – Signalling Design Principle

The following documents were referred to:

- Eveleigh Heritage Walk *for Redfern Waterloo Authority* [2008 study]
- Carriageworks to Australian Technology Park – North-South Pedestrian Link *for Urban Growth* [2017 study]

Redfern North Eveleigh

Transport for New South Wales

Tunnel Option Briefing Note

6 February 2023

Existing Maintenance Tunnel

There is an existing heritage maintenance tunnel crossing from the Carriageworks towards South Eveleigh.

However, it does not fully cross the rail corridor.

Northern tunnel portal is not easily made accessible to public, and inconveniently located with very restricited access between the Carriage works and the rail tracks, as indicated in image below.

Existing Maintenance Tunnel

A ‘tunnel’ was indicated diagrammatically and described briefly in various sources of drawing and reports.

The tunnel does not fully extend across the rail corridor. It runs from the south-side of the Carriageworks and towards the western end of the LES but emerges onto rail track. The northern tunnel entrance is not visually obvious and inconveniently located.

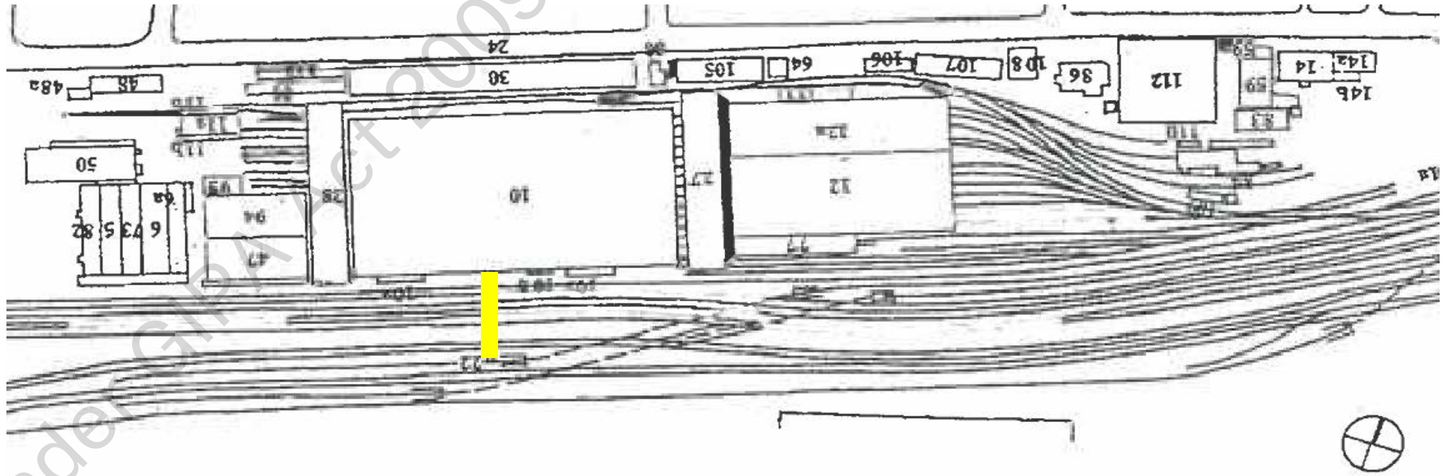
The ability for an extension of the tunnel beyond the southern boundary of the rail corridor will be limited as this will require major disruption to rail services given the presence of the Illawarra Dive and the operational nature of the tracks.

The NSW Office of Environment & Heritage provides the following description under Eveleigh Railway Workshops, listed under s.170 Register.

Heritage Description: S34: Eveleigh Yard Subway (1925-1927): The subway is a rectangular tunnel 80 metres in length, running below the rail tracks between the Carriage Workshops and the Loco Workshops at Eveleigh. Walls are brick lined and the floor and ceiling are concrete. Both ends are accessed by a flight of brick steps from ground level and there is one flight of steps within the tunnel, near the southern end.

Further the tunnel is also included in the Heritage Conservation Management Plan for the area resulting in potential difficulties and constraints.

As the tunnel has a low height and width, unlined and unventilated, additional investigation will be required to assess the current condition and internal dimensions of the tunnel to determine whether the tunnel is suitable to meet requirements of a modern pedestrian tunnel, which is not considered likely.

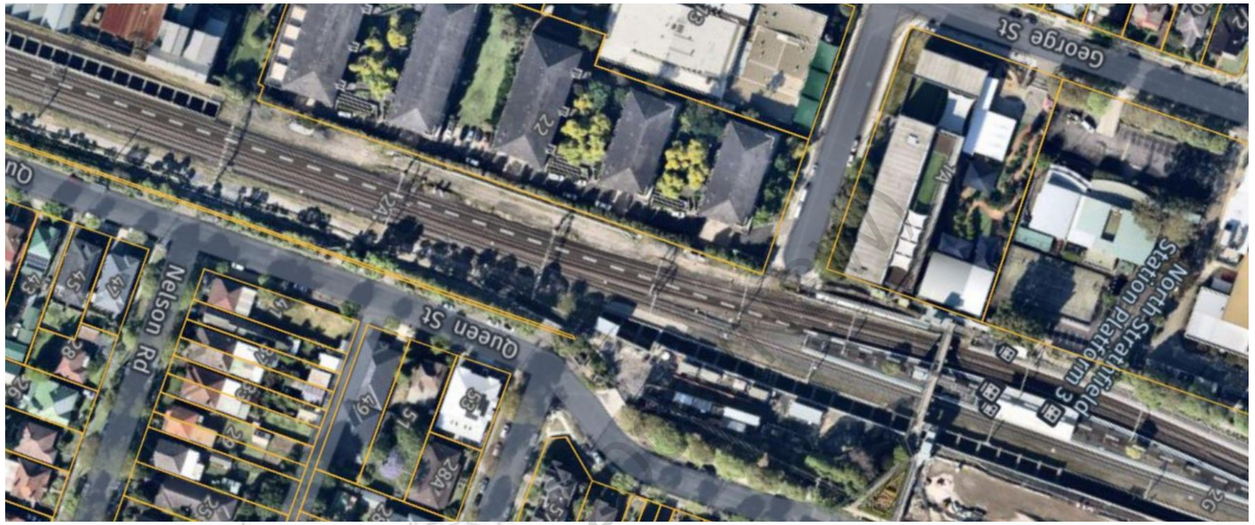


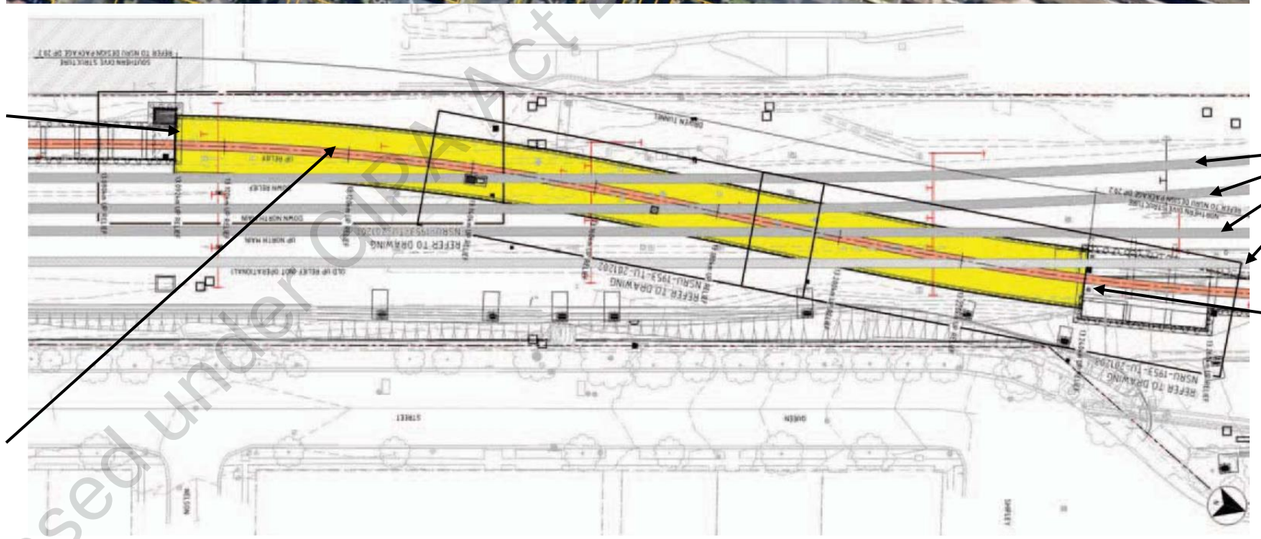
Statement of Heritage Impact - Carriageworks at Eveleigh Contemporary Performing Arts Centre (2003) Subway location in yellow

Tunnel Case Study

The North Strathfield Rail Underpass was built as a rail tunnel, rather than a pedestrian tunnel. However it provides insights for constructing under live rail.

Gonzalez, M. et al., 2014, *The North Strathfield rail Underpass – Driven Tunnel Design and Construction,* 15th Australasian Tunnelling Conference 2014, Sydney, NSW, 17-19 September 2014.





Case Study – North Strathfield Rail Underpass

This case study is provided for consideration only, and a full feasibility study has not been undertaken, and serves as an example for a tunnel being constructed immediately below a live rail environment. At a high-level, a tunnel would be have similar constraints on the landing (portal) zones and level differences required as for a bridge. Therefore it would not be a simple and cost effective alternative.

Further, given the foot-traffic and tunnelling distances required (~300m), a tunnel is unlikely to be perceived as safe. Dimensions, lighting, ventilation finishes and other design elements will need to be of a very high quality/specification if the inherent CPTED challenges of a long tunnel with low volumes of usage is to be overcome.

Overview

- Rail tunnel to grade separate freight trains from suburban trains.
- 148m long
- 8m high x 9m wide
- 2.5 – 3.5m ground cover

Other features

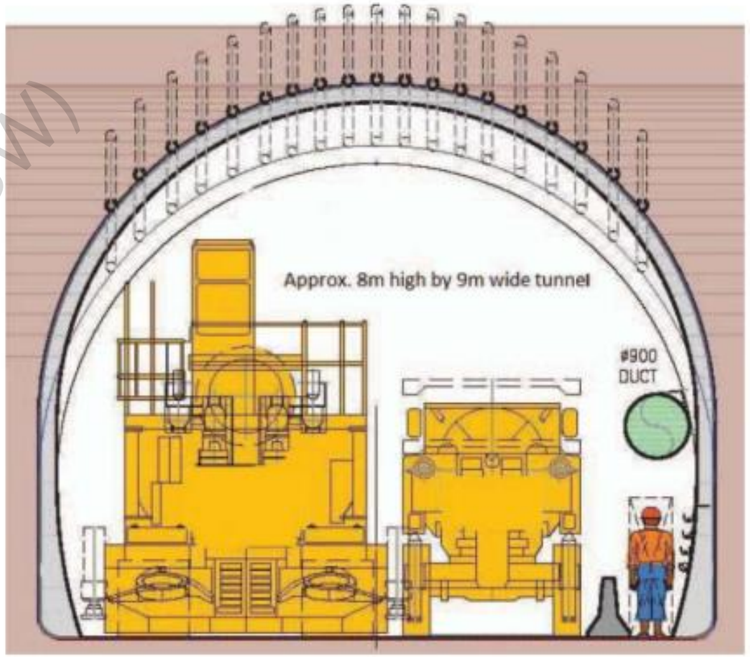
- Geotechnical investigations during track possession regime.
- Excavation cycle - Canopy tube, road header excavation, shotcrete lining.
- Synthetic fibre reinforced shotcrete without steel sets or lattice girders.
- 24-7 monitoring of rail for settlement

Outcomes

- ~6 month tunnelling period
- Limited disruption to rail operations
- Construction adjacent to and under live rail.

Considerations for a pedestrian tunnel at RNE

- Safety and security. Due to length, the end of the tunnel may not be visible.
- Footprint for dive sites are not available due to access constraints, heritage
- Interface with existing tunnels or dive structures
- Depth of tunnel and downward ramps



Tunnel Option

This section provides a high level description regarding the potential of a pedestrian connection below the rail corridor in lieu of a bridge crossing.

Consistent with the assessment undertaken for a potential new bridge crossing, the time benefit for crossing between north and south Eveleigh at this location in place of the new station crossing is minimal, being less than 3 minutes.

Existing Underground Structures

Study alignment below rail corridor as per preferred bridge alignment (tunnel invert 12 to 15m below existing track level)

DDA ramp length as radius (1 in 20 grade with landings) extending from tunnel invert

Illawarra Dive

Illawarra Tunnels (invert max 8m below existing track level

Eveleigh maintenance tunnel

Pedestrian crossings

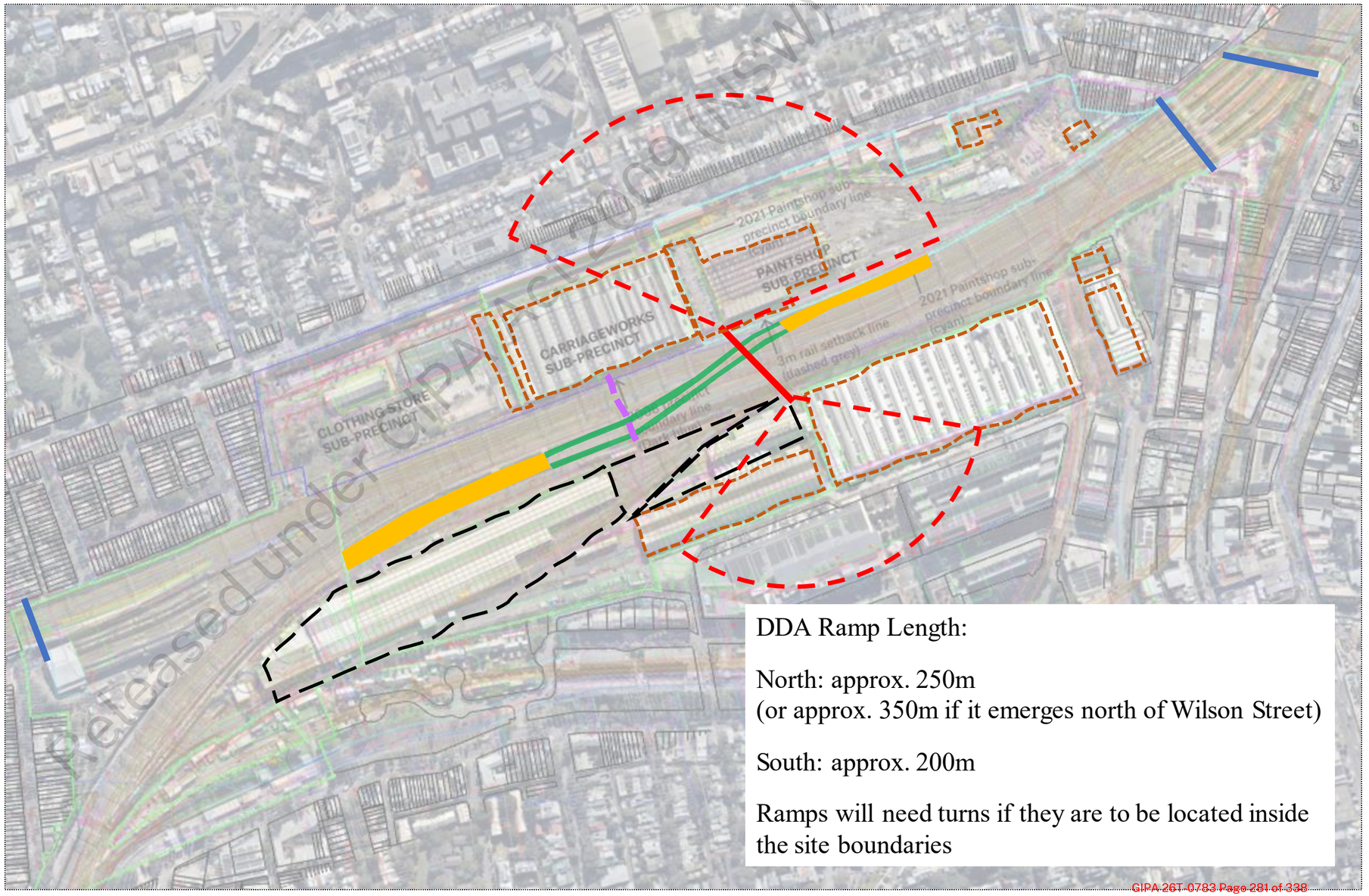
Eveleigh Maintenance Centre

Heritage

The substantial level difference means that any ramps will be very long.

Therefore Lifts and stairs will be required at tunnel entries.

There are limited to no locations to stage/launch tunnelling works



DDA Ramp Length:

North: approx. 250m
(or approx. 350m if it emerges north of Wilson Street)

South: approx. 200m

Ramps will need turns if they are to be located inside the site boundaries

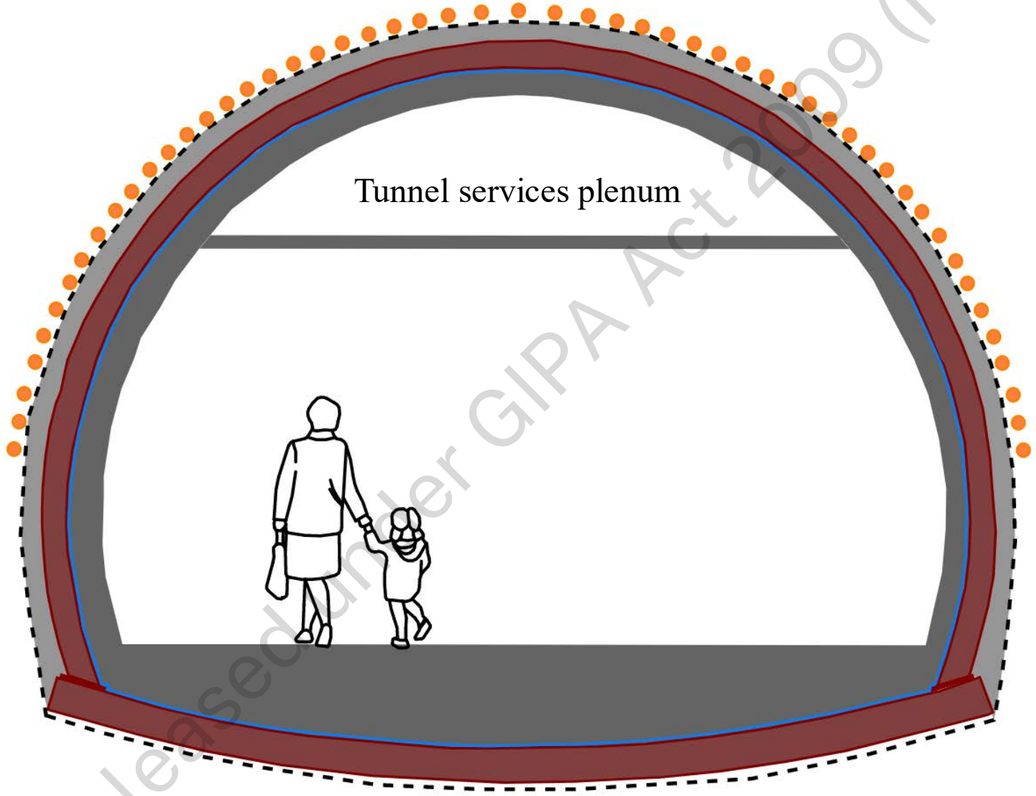
ARUP

Tunnel Typology

A progressively mined tunnel constructed using a traditional two pass support system (i.e. temporary support followed by permanent support) is considered to be the most appropriate tunnel typology for the anticipated subsurface ground profile and site constraints. The tunnelling methodology is similar to the case study presented earlier

Tunnel Support

- Excavation profile – achieved using small road header or excavator
- Spiles/canopy tube pre-support
- Primary shotcrete lining
- Temporary steel sets
- Waterproofing
- Permanent cast in situ lining



Tunnel Overview

- Limit tunnel to 5m high x 4m width. This size is based on dimensions adopted for previous pedestrian tunnels in Sydney.
- Able to achieve 2.5m ground cover to existing structures and running rail

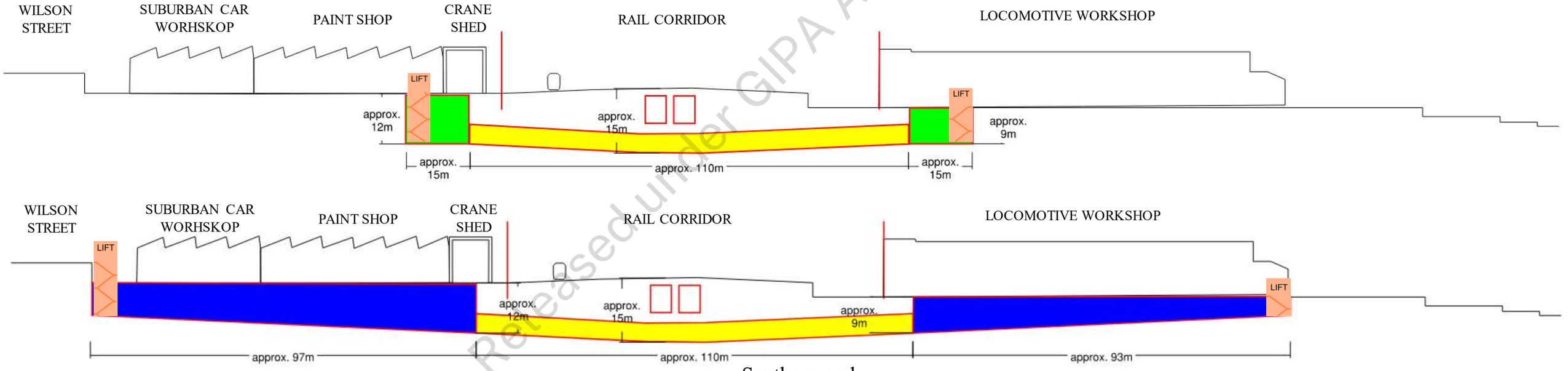
Image from the Arncliffe Pedestrian underpass, completed 2.5m below running rail

Tunnel Vertical Alignment

Due to the presence of the existing Illawarra tunnels a pedestrian underpass will need to be located below these tunnels with sufficient cover to minimise impact due to tunnelling. This would result in tunnel portals being 10-12m below existing surface levels at the northern (approx 3.5 storeys and 50 steps/risers) and southern northern (approx 4 storeys and 60 steps/risers) extents. The deepest point of the tunnel will be approximately 15m below the rail corridor in order to maintain a DDA compliant alignment.

Dive structures, or access shafts, will be required to provide access to the tunnel portal. Typically these can be achieved by traditional cut and cover methodologies, formed with bored contiguous or secant piled wall with a capping beam near ground surface, temporarily propped during construction, then reinstated with a plank roof at ground surface. *Note that the dives shown below are technically possible to construct, however are not practical and not available for construction due to heritage constraints and stakeholder requirements (ie. Maintenance facility cannot be interrupted as part of the operation of the rail network)*

- Existing Illawarra tunnels
- Mined tunnel – approximate length 110 m
- Cut and cover dive structures
  - North dive – approx. length 97m
  - South dive – approx. length 93m
- Cut and cover access shaft – approximately 15m square



Northern end:

The traverser alignment implicates that a shaft, not a dive structure, is required. There may be an opportunity to coordinate the tunnel entry with the proposed Paintshop development. Stairs and lifts are required for both dive and shaft access.

Southern end:

Entry via dive shaft, or longer mined tunnel and access shaft.

There may be an opportunity at the southern extent to incorporate the dive structure/access shaft with adjacent developments (e.g. LES). Ensuring access to the maintenance facility will be a major constraint. Stairs and lifts are required for both dive and shaft access.

Design and Construction Considerations

Design

In addition to the tunnel temporary and permanent support, the following elements will need to be considered as a minimum:

- Tunnel ventilation
- Lighting (higher requirements than a bridge)
- Fire suppression
- Flooding ingress potential (including pumped drainage)
- Crime Prevention Through Environmental Design (CPTED)
- CCTV
- Associated power requirements
- Maintenance requirements (e.g. cleaning)

Fire design and emergency egress points will need to be considered (including consultation with Fire and Rescue NSW) as there may be additional requirements due to the overall length of the tunnel and dive structures.

Real time monitoring of the running rail, at surface and within tunnels will be required, full instrumentation and monitoring plan to be co-ordinated and approved by Sydney Trains.

Construction

Constructing a tunnel below live rail corridor will be difficult, however can be achieved provided sufficient resources are dedicated to it.

The benefit of tunnelling across the corridor is that the construction program can be decoupled from Sydney train movements and track possessions. Interfacing with Sydney Trains during construction will be limited to survey monitoring during tunnelling.

However it is likely that the tunnel crown will be formed within soil, and this will reduce the overall production rate for tunnelling. It is anticipated that excavation of the tunnel will be limited to a maximum of 1m full face advances. This will need to be incorporated into construction programs appropriately.

The dive structures will involve a greater impact to the existing tenants and structure at the northern and southern entrance structures. *In practicality, the area required for the dive structures are not available for construction.*

Design and Construction Considerations

Risks

- Ground conditions along the alignment are unknown. It is likely that the tunnel crown will be formed within soil or fill, specifically over the southern extent.
- Risk of contaminated material being encountered is very high based on previous experience within rail corridors and existing investigations within the Carriageworks, Clothing store, Paintshop and ATP precincts
- A number of existing buried utilities will need to be identified, rerouted, and co-ordinated.
- Coordination with neighbouring Stakeholders and Landowners is required for construction access.
- Approval from existing Stakeholders on the north side would be required for permanent access entry and exit points.
- Approval from existing Stakeholders and Land owners on the southern side would be required for permanent access entry and exit points, noting this.
- Significant constraints due to heritage listed structures requiring detailed assessment and approvals.
- Significant constraints due to the operational requirements associated with use of building (LES and Locomotive) on the southern side in a manner which allows for the current planned usage.
- Significant constraints due to the operational requirements associated with Carriageworks who service the building from the Traverser area.
- Significant long tern disruption to the maintenance facility on the southern side is not likely to be acceptable due to the critical part this place to the rail network.
- Temporary diversions or access alternative will be required to achieve dive structures. Due to the heritage and stakeholder operational constraints (ie. Maintenances building and LES building), temporary diversions are unlikely to be acceptable, reducing the feasibility of a tunnelling option.
- There are no unrestricted areas available at ground level to stage and launch tunnelling construction works, increasing the complexity and reducing the feasibility of the tunnel option.
- Consideration and co-ordination would be required with planned redevelopment of the Paintshop sub-precinct which is likely to further increase the complexity of the tunnel option.

Redfern North Eveleigh Paint Shop Precinct

Bridge catchment analysis

Prepared by: s74 Out of scope

Reviewed by:

11 October 2021 | Rev 1.0

Questions to be answered

Is there a need and/or benefit of an active transport bridge between North and South Eveleigh?

1. Who would benefit from the bridge?
   - Spatial catchment analysis

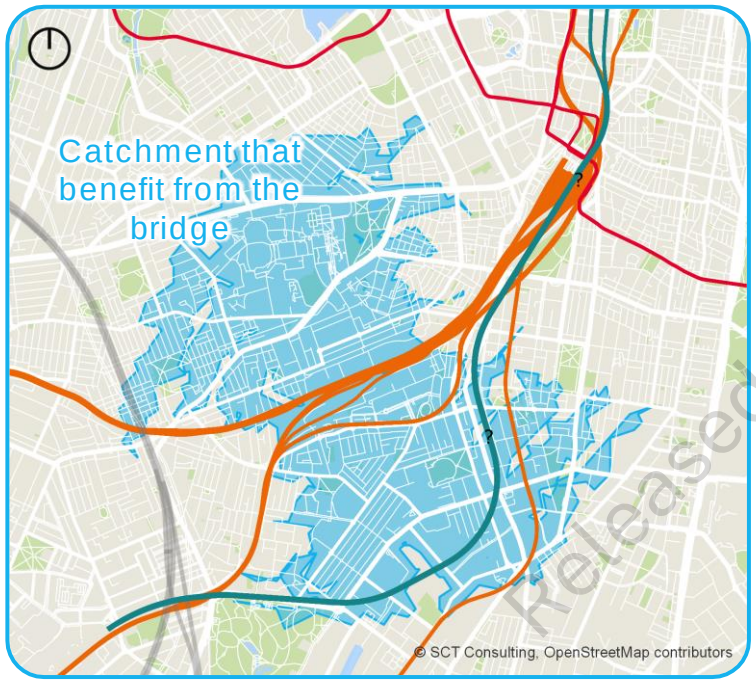
2. What quantum of people are likely to use the bridge?
   - Review of existing travel patterns (analysis of mobile phone data)
   - Confidence in data
   - Expected users of the bridge

3. How integral is the Redfern-North Eveleigh development to improving use of the bridge?
   - Potential increase in users of the bridge based on changes in land-use

Executive summary

Catchment analysis

Determine who benefits from the bridge compared to the existing scenario and future scenario (with Redfern Station southern concourse).



Travel time saving

An estimate of the average travel time benefits for a customer using the bridge (compared to other alternative corridor crossings).

Average travel time saving

5-8 minutes

per cross corridor journey.

Executive summary

Current demand

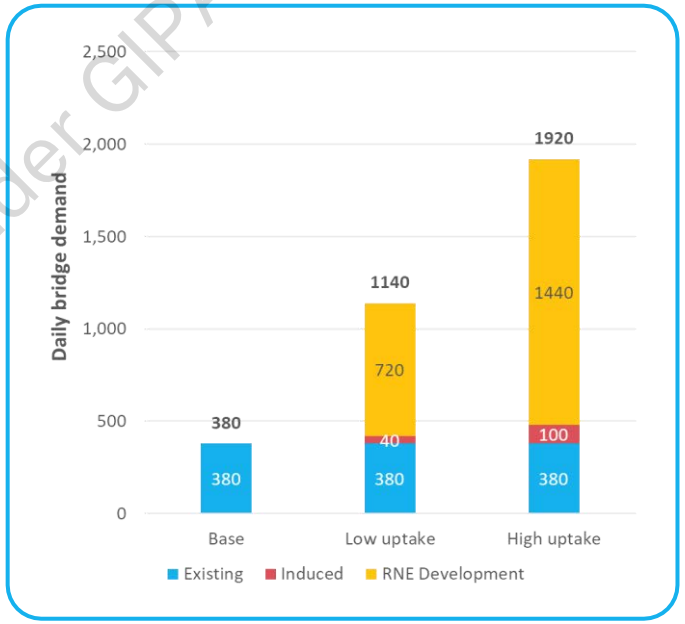
Who may use the bridge based on existing travel patterns?

340-420 journeys per weekday

Future demand

Increase in customers due to:

- Provision of the bridge (induced trips)
- Development of Redfern North Eveleigh Precinct



Productivity

Cumulative benefit of the bridge.

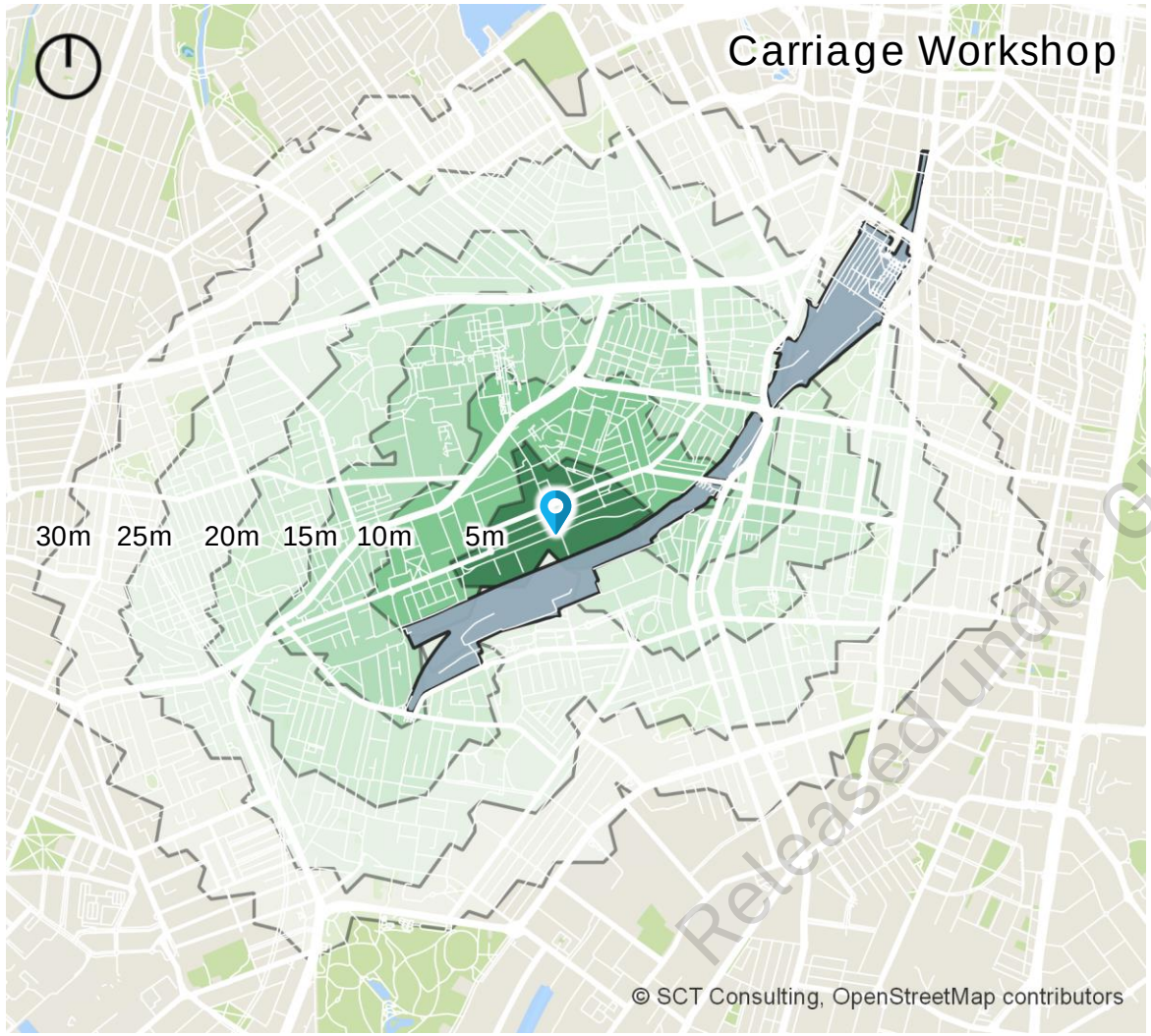
41-208 people-hours saved

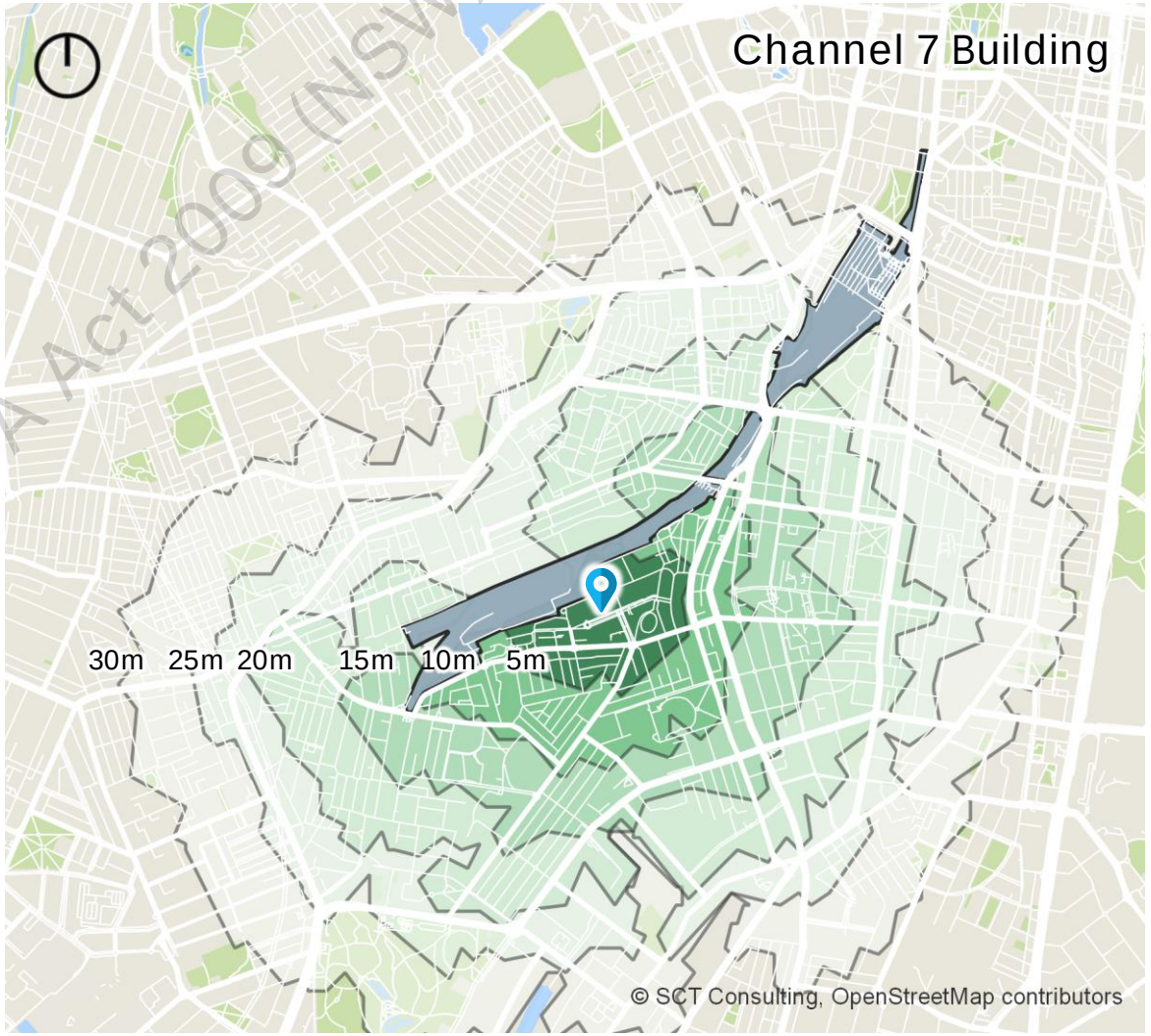
per typical weekday.

[01]

Who would benefit from the bridge?

Existing 30-minute walking catchments

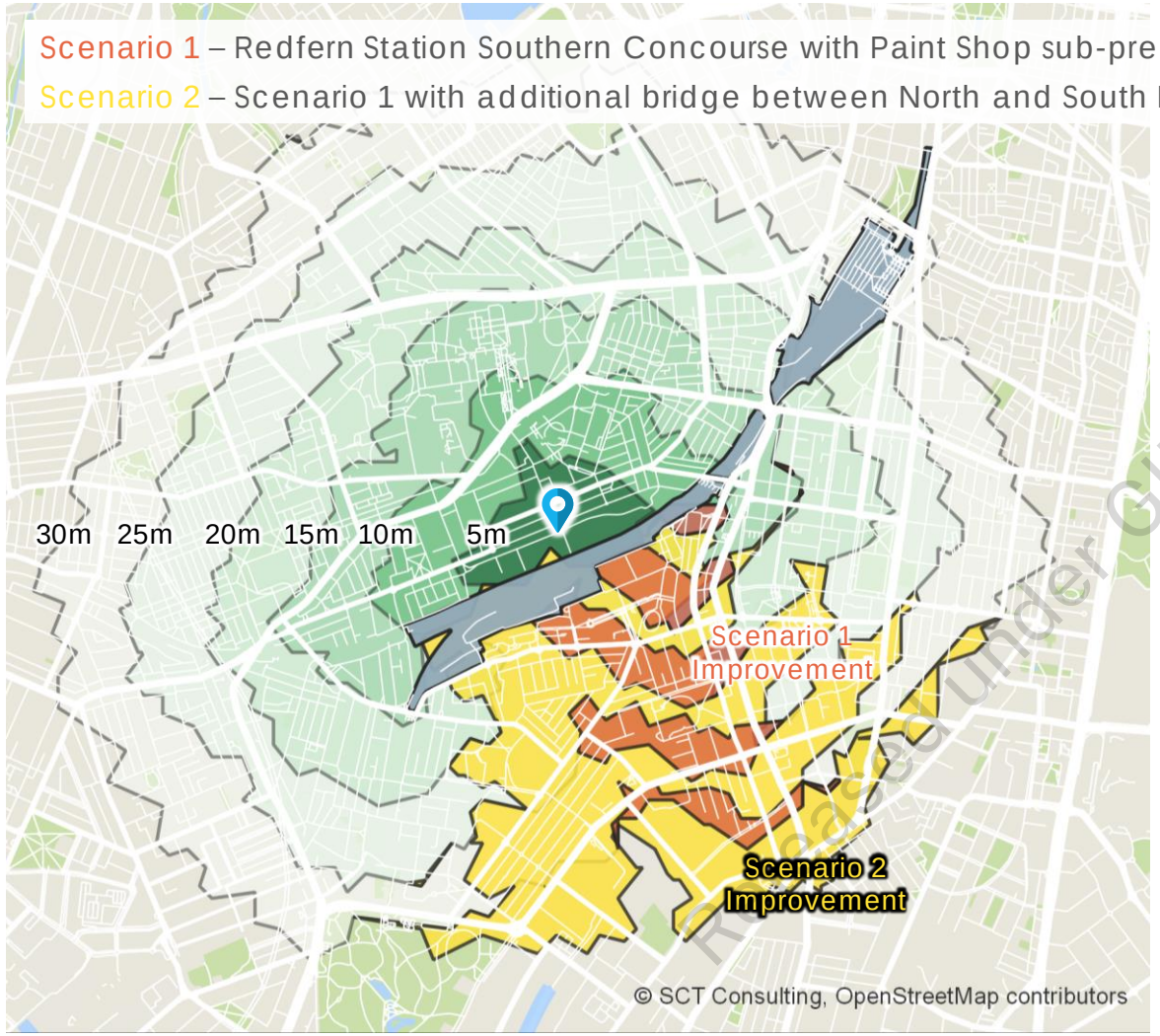


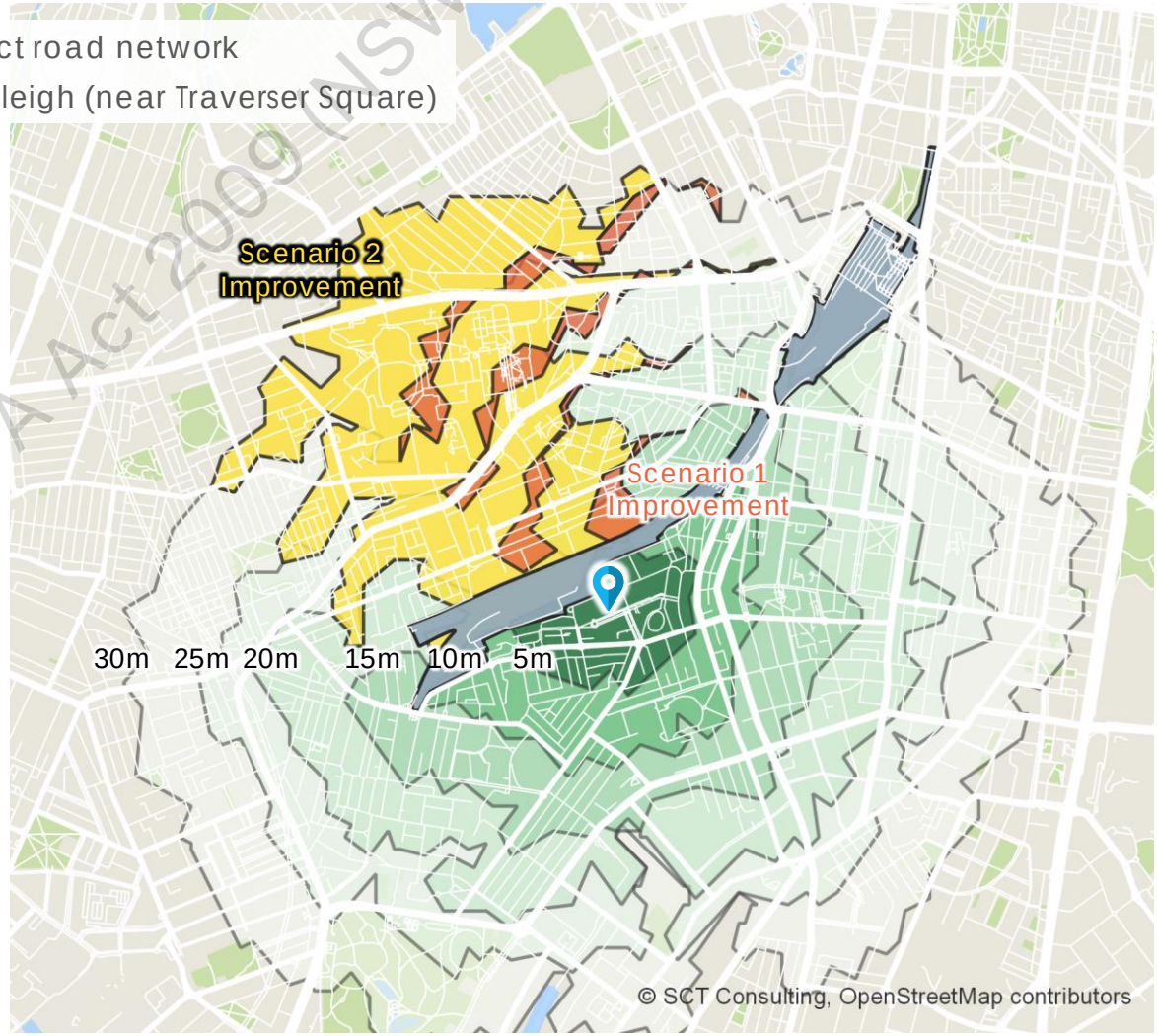


Improvements to 30-minute walking catchments

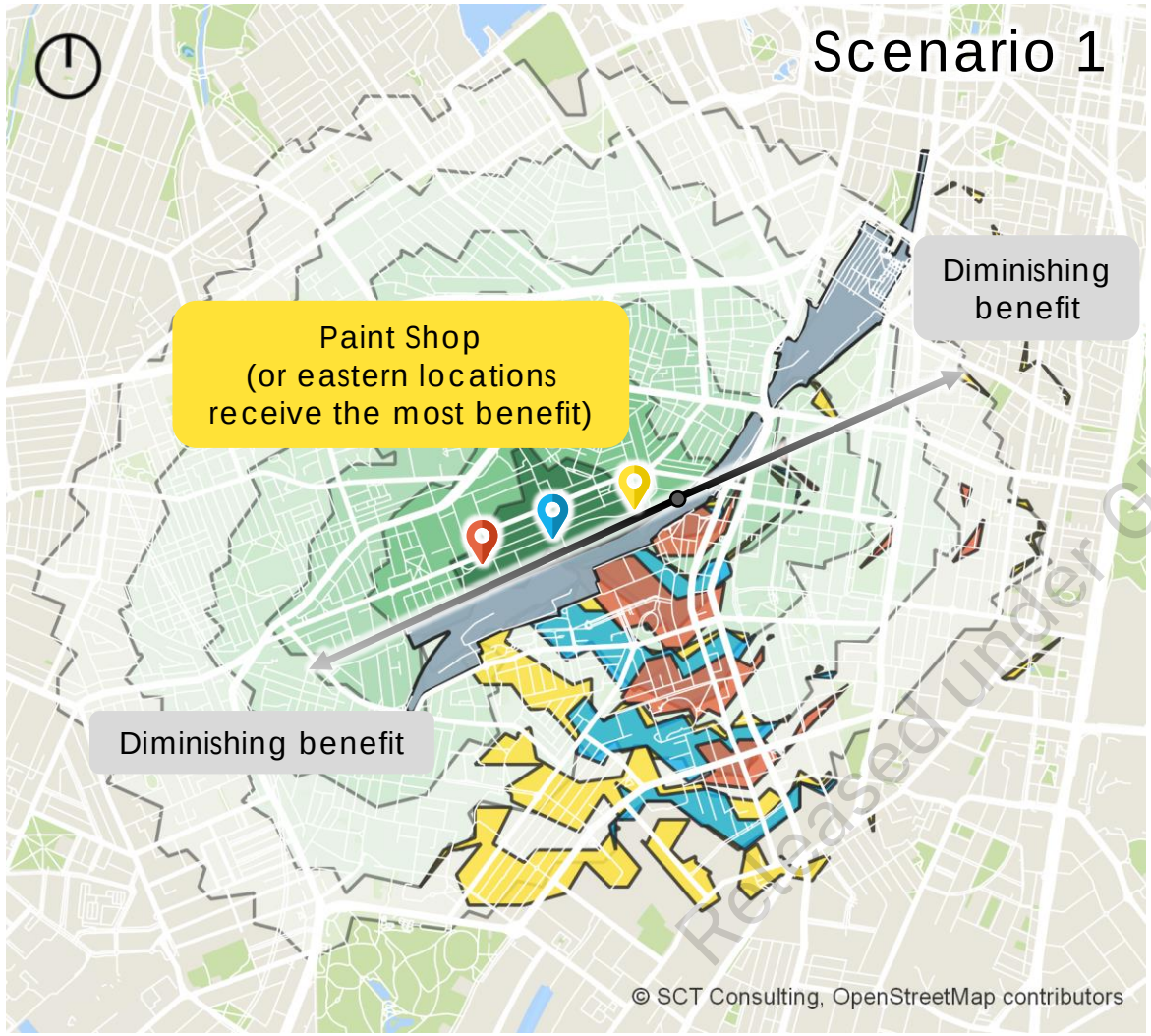
Scenario 1 – Redfern Station Southern Concourse with Paint Shop sub-precinct road network

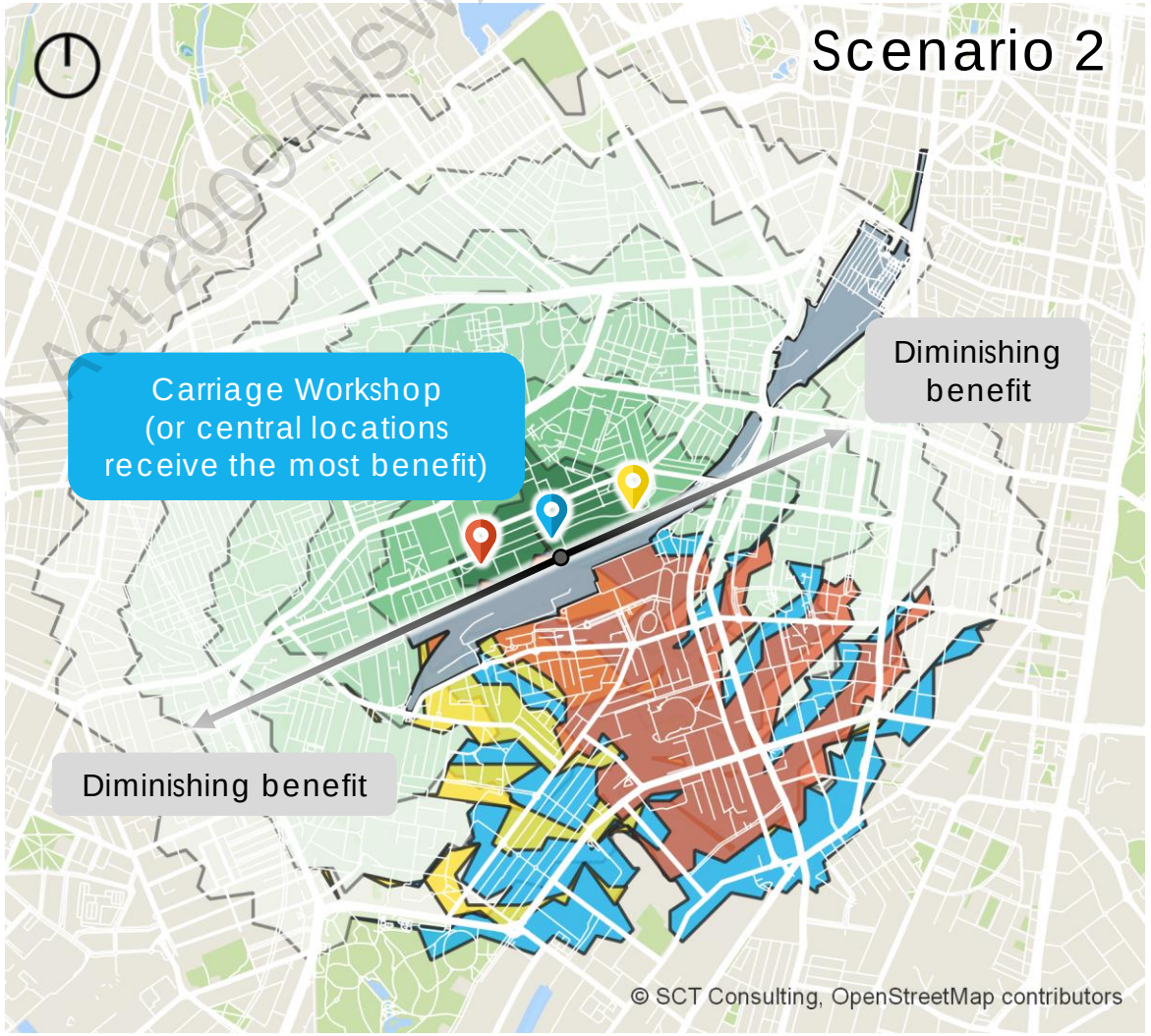
Scenario 2 – Scenario 1 with additional bridge between North and South Eveleigh (near Traverser Square)



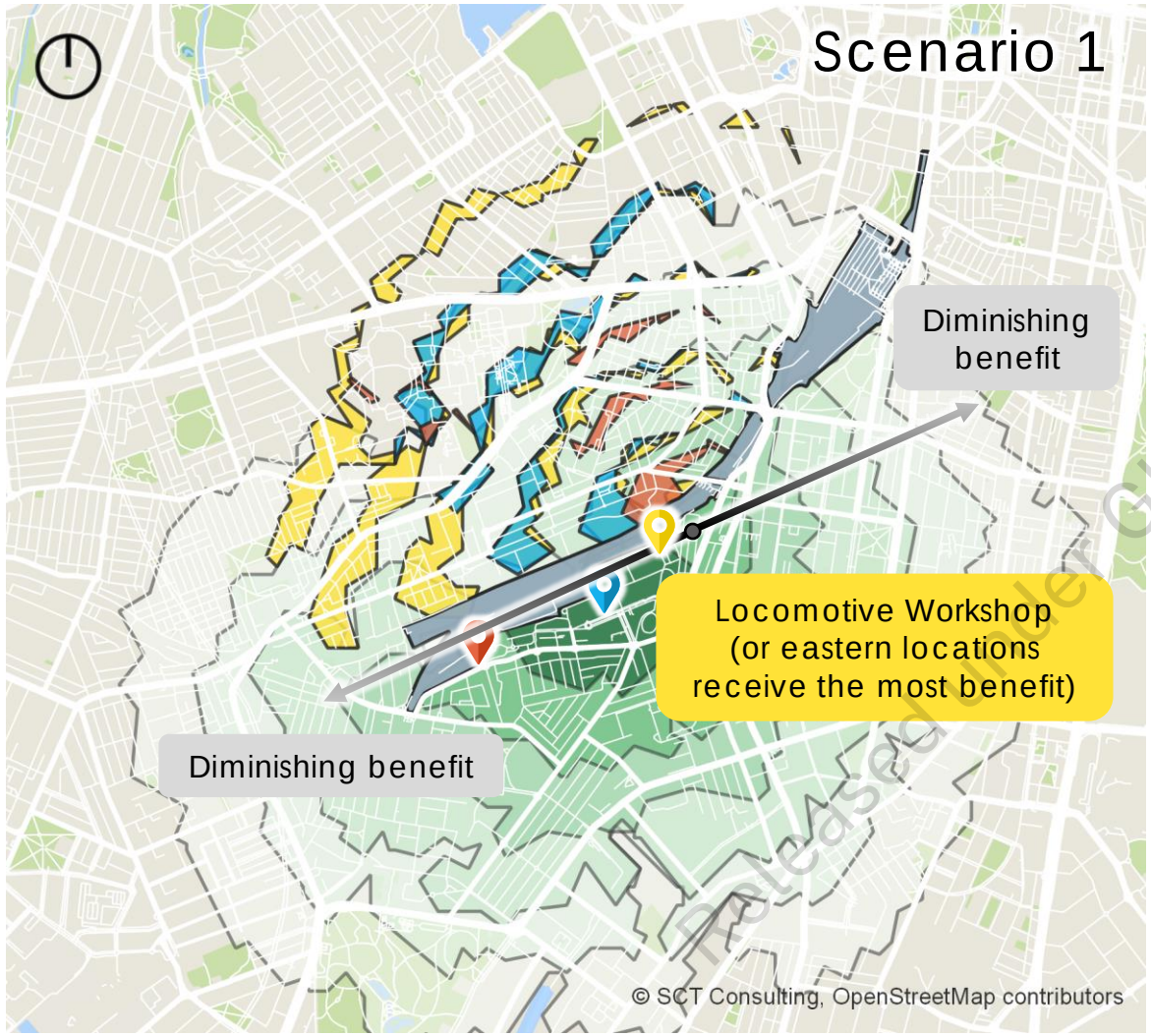


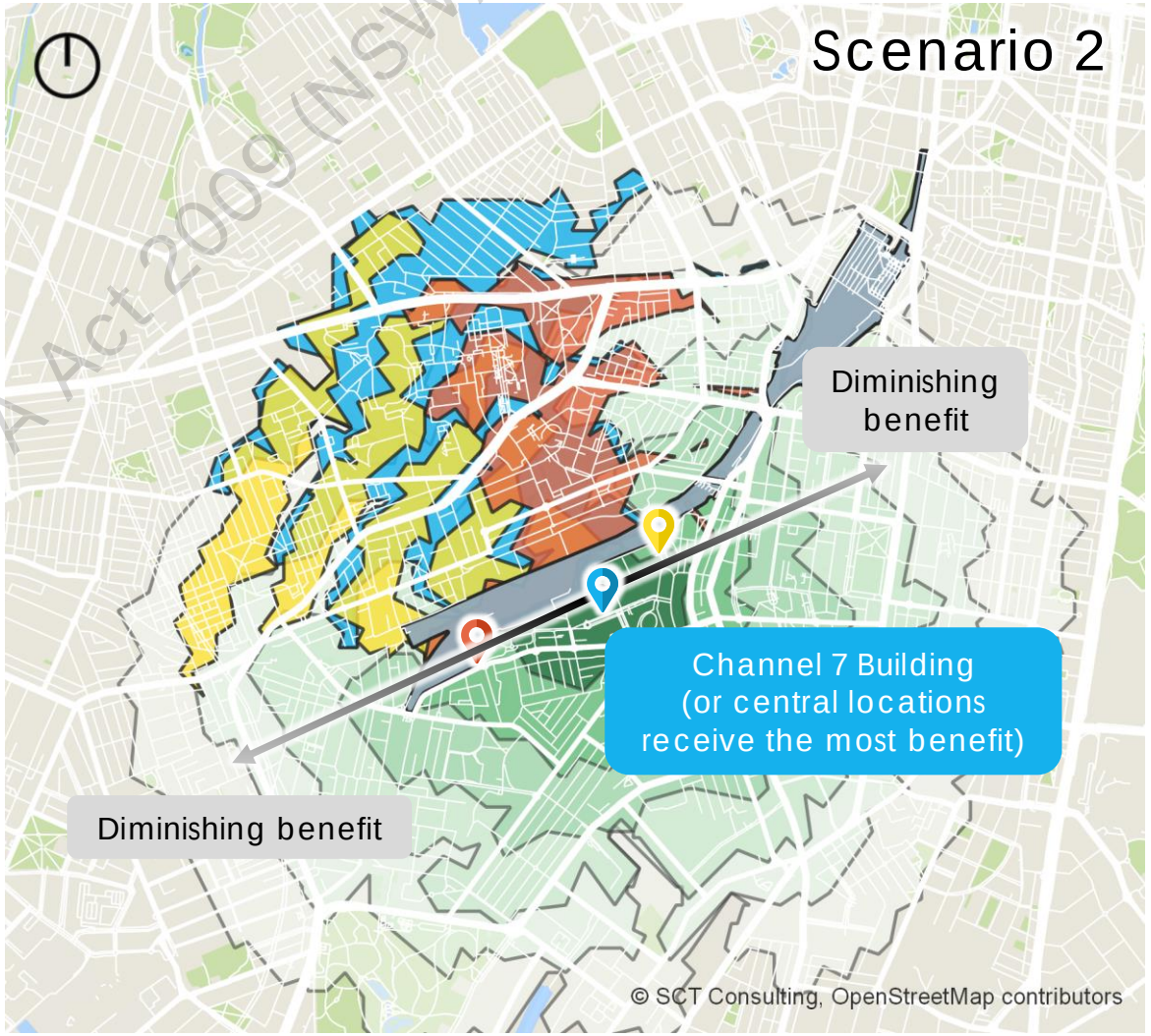
Northern Sites – Improvements by location





Southern Sites – Improvements by location





Scenario 2 benefit – land use

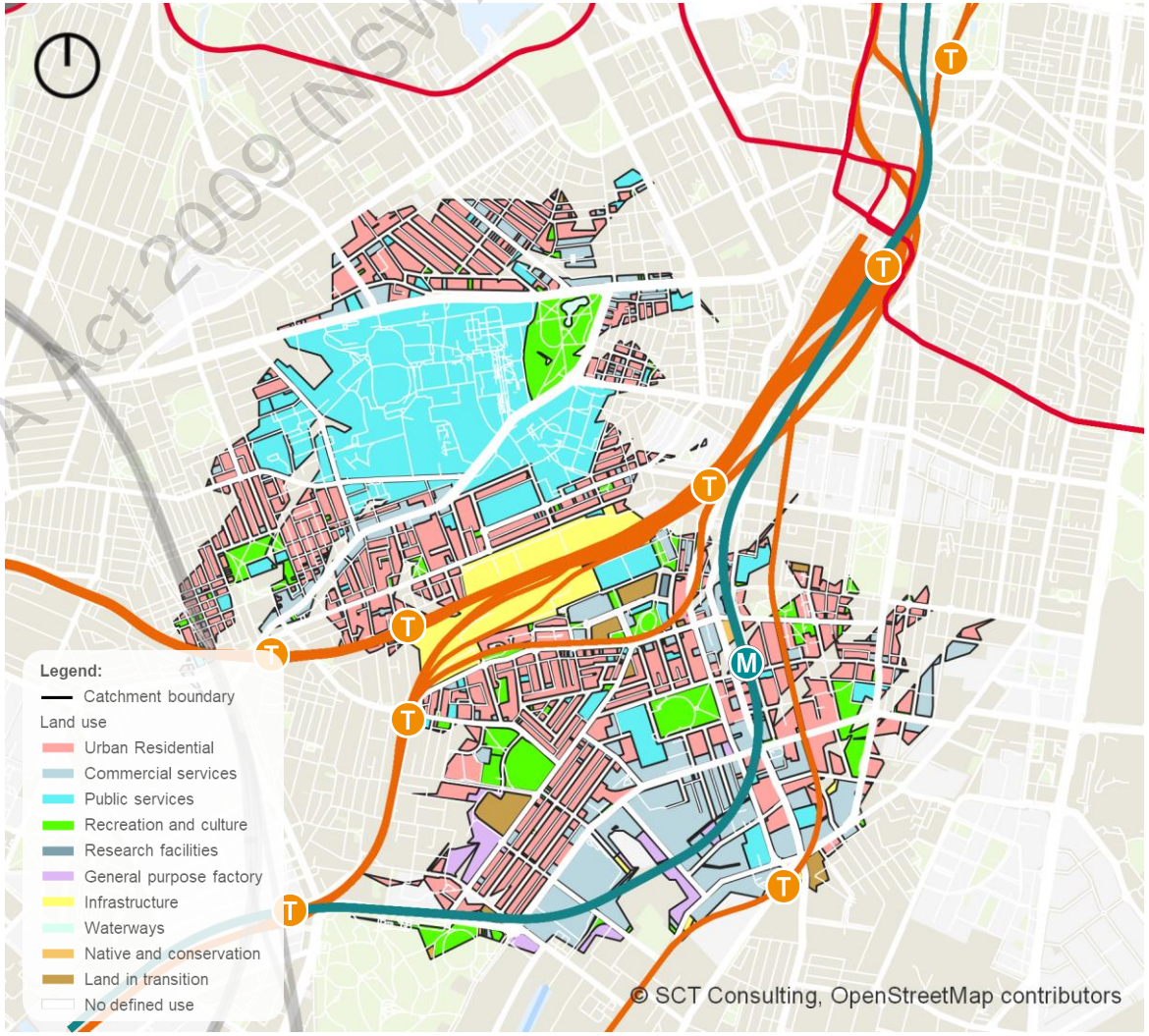
Main beneficiaries of the additional bridge are cross-rail corridor journeys to/from:

- Urban residential
- Public services (University of Sydney)
- Commercial (North and South Eveleigh precincts). Noting RNE precinct is currently listed as infrastructure (railways).
- Light industrial and commercial (Waterloo and Green Square)

Average travel time saving

5-8 minutes

For cross corridor journeys in the highlighted regions. For some customers benefit may be more, and likewise for other customers the benefit may be less.



Study area - benefiting regions (and O-D connections)

Catchment analysis indicates greatest benefit to Regions B and E (and travel to and from these locations).

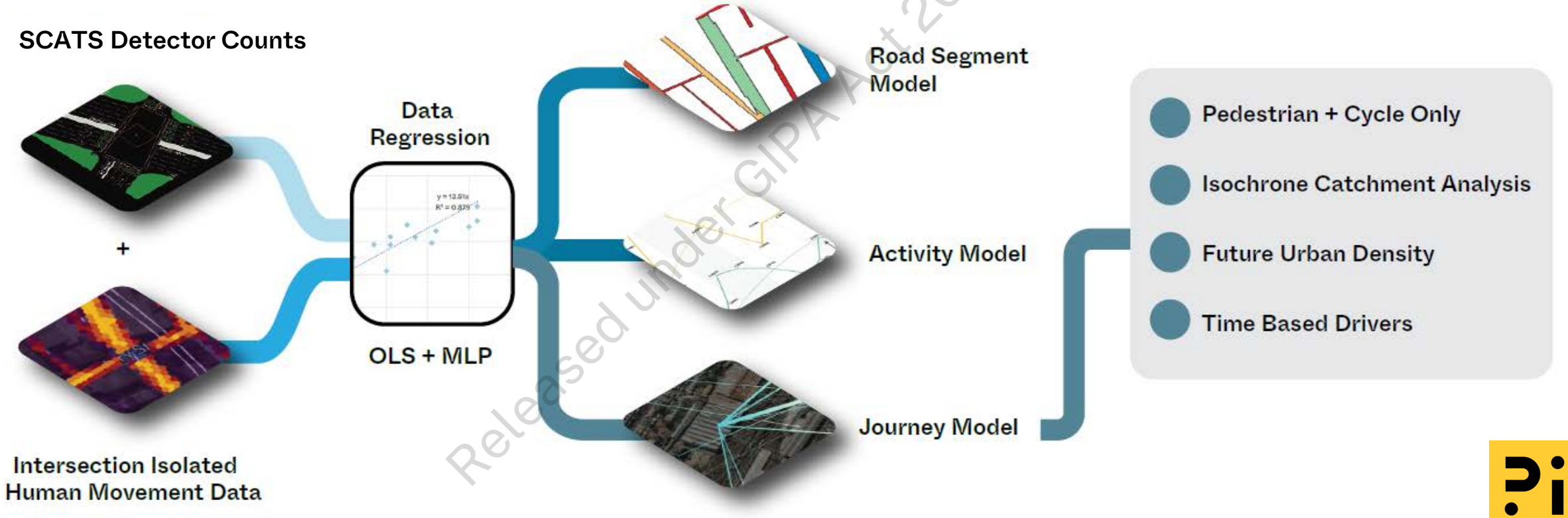
Regions A – F and C –D already have high levels of permeability, which is corroborated by high observed trips.

[02]

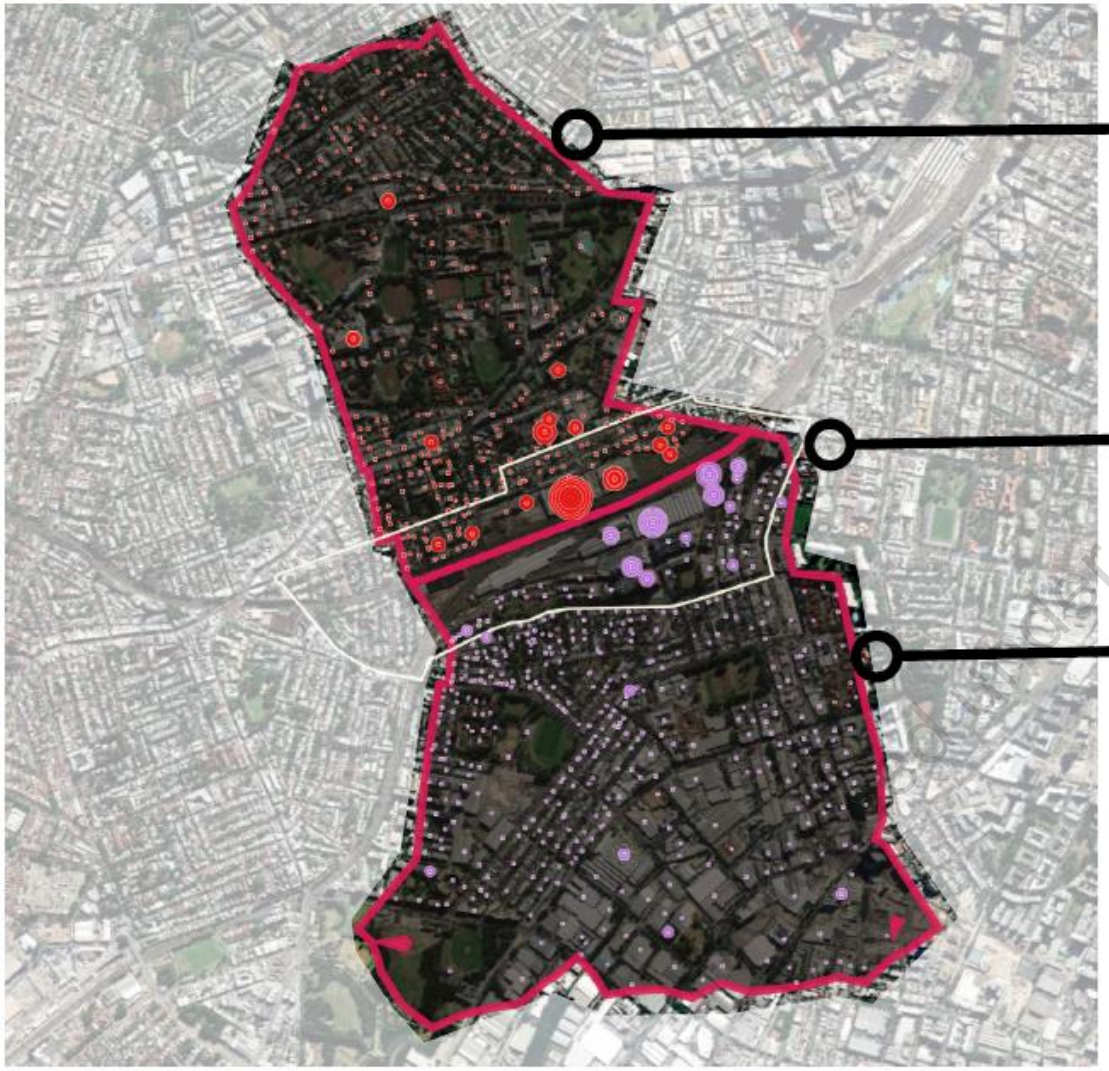
What quantum of people are likely to use the bridge?

Bridge demand analysis - process

We used a number of data processing methods to predict the number of journeys per hour that would use the proposed bridge.



Current observed cross-corridor origins and destinations



North

Primary Generator: University of Sydney

Precinct Boundary

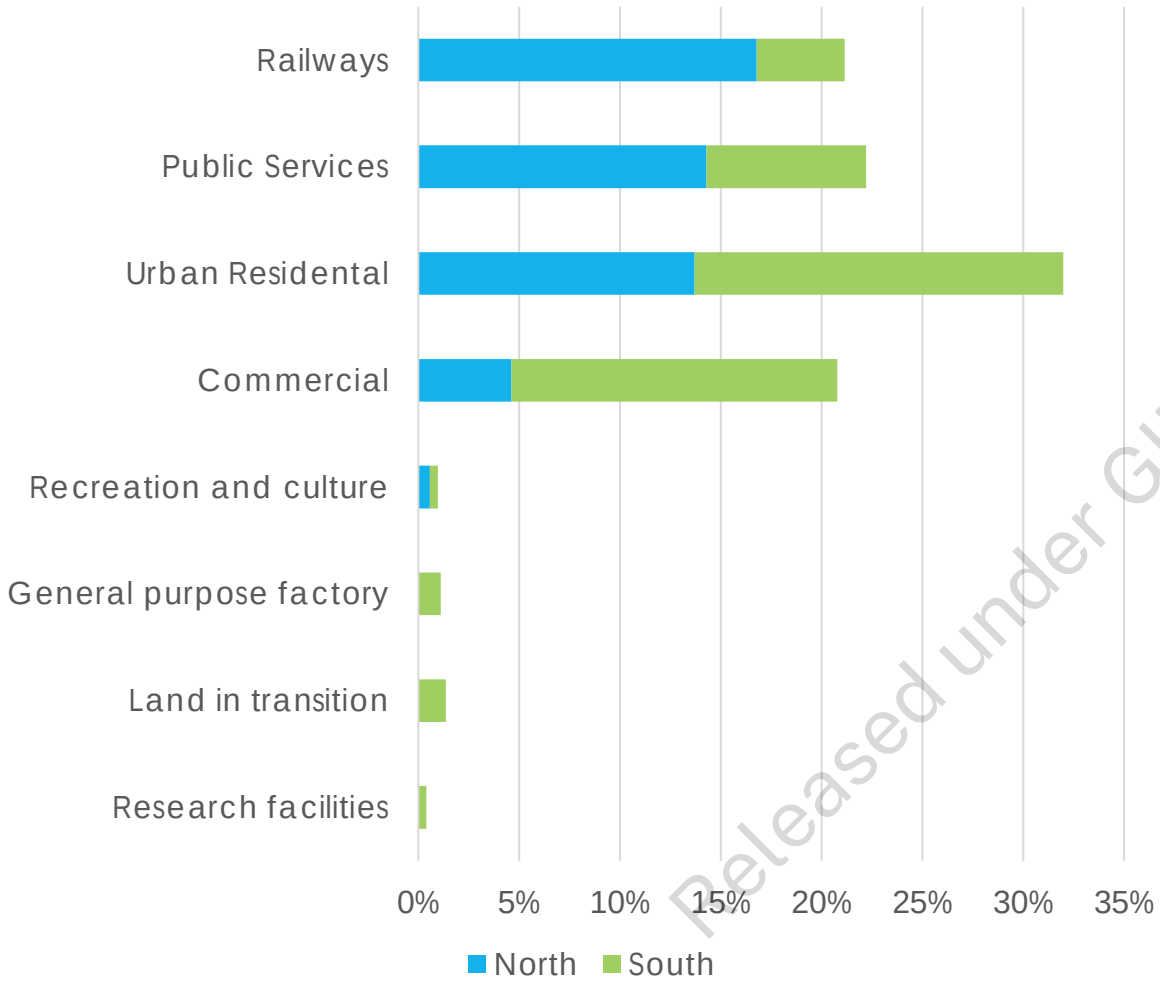
Percent of Total Journeys: 26%

(Excludes Redfern Station activity)

South

Primary Generator: Urban Residential

Cross-corridor trips by land-use



(Excludes Redfern Station activity – some areas around corridor including RNE precinct are classified as Railways)

Journey origins

(the reciprocal can be assumed for a return journey)

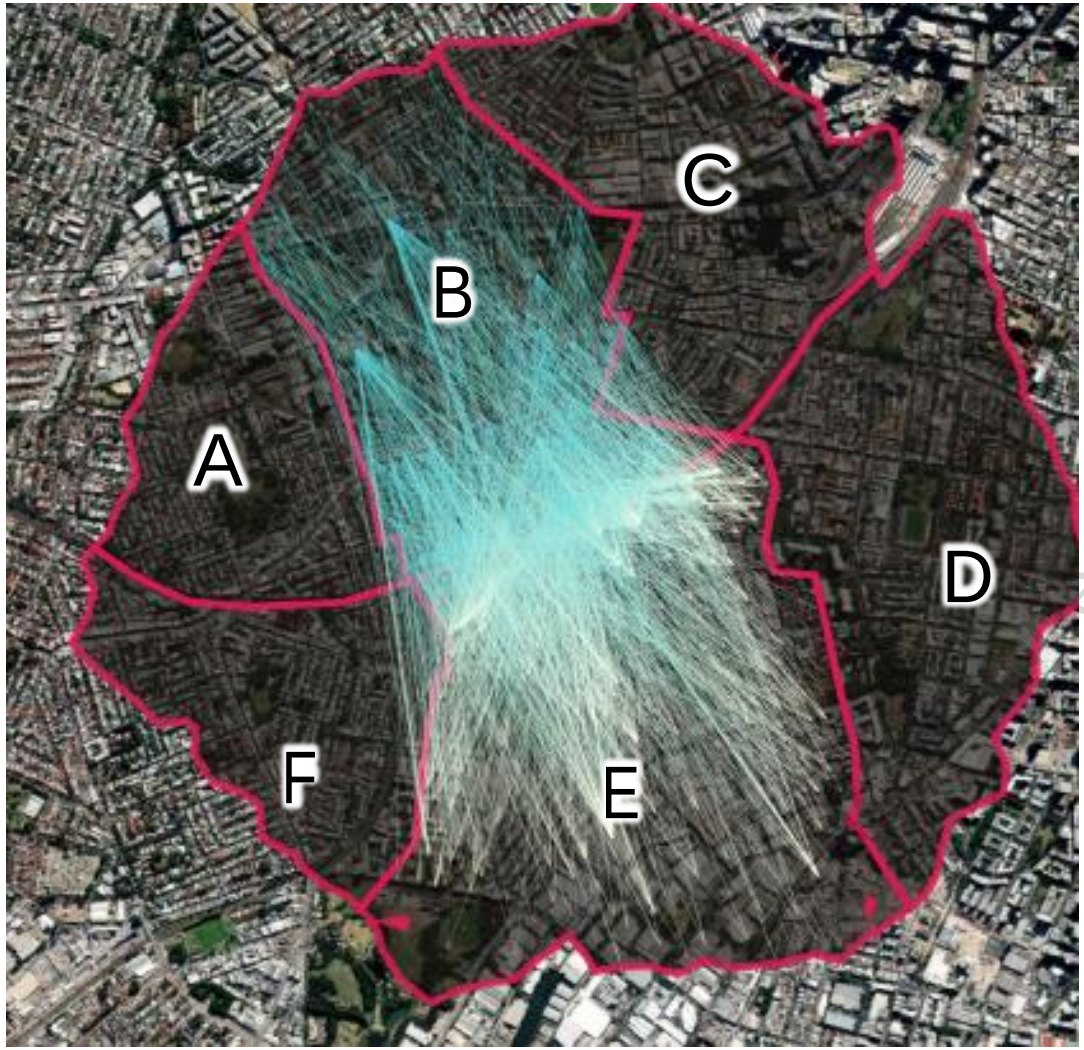
32%

Journeys originate from residential land-uses

<2%

Journeys originate from land-uses classified as recreation and culture.

Current demand for bridge



Validated trips

340-420 journeys per day

R^2 Average

0.8875

Typical walking characteristics

53% less than 1000m in length

Peaks:

8:15-9:15 AM

4:45-5:45 PM

About the model:

Model Size: 152,470 Journeys

Number of Buildings: 1,391

Time Interval: 15 minutes

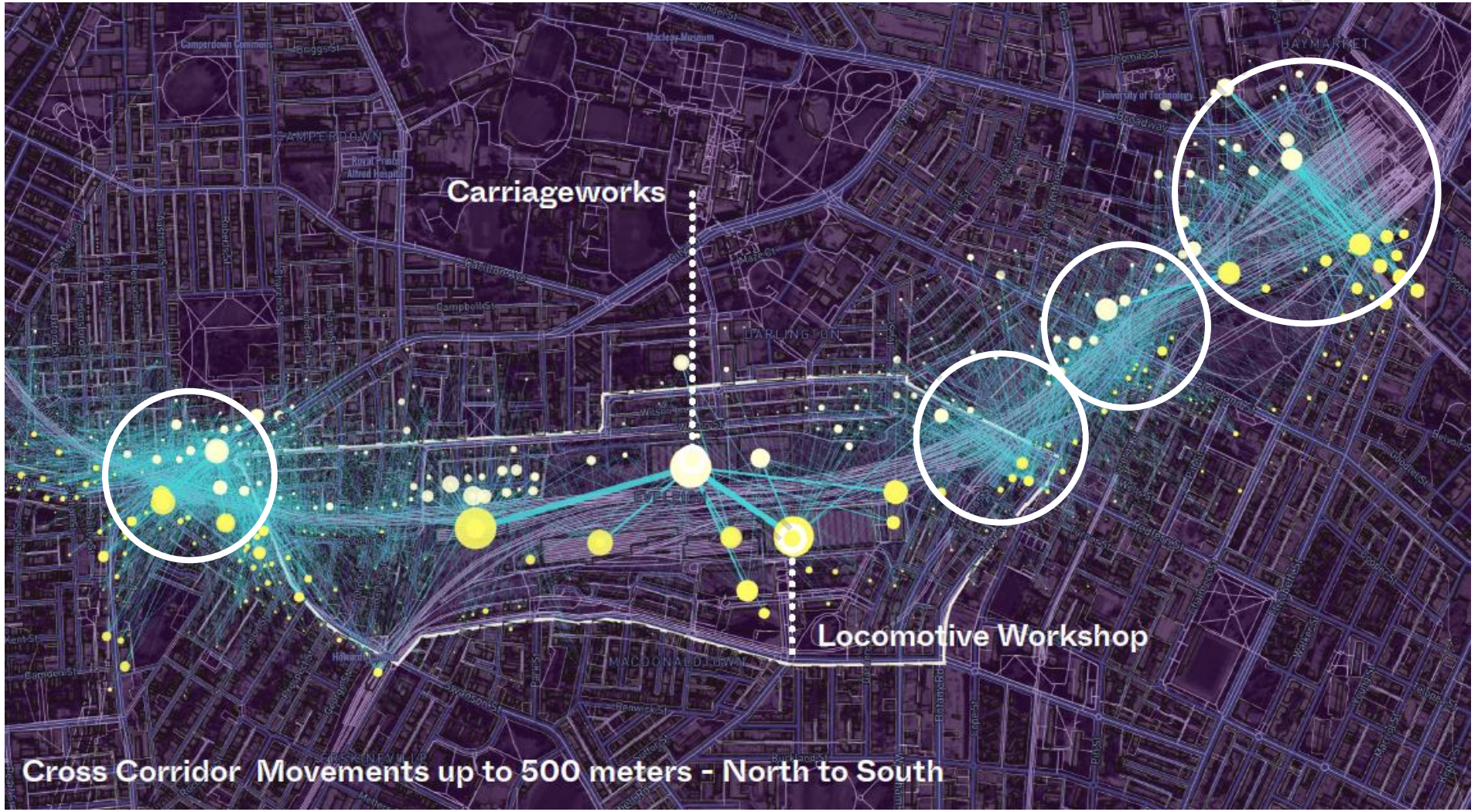
Time Series: Weekdays Only

Mode: Non-Vehicle

[02]

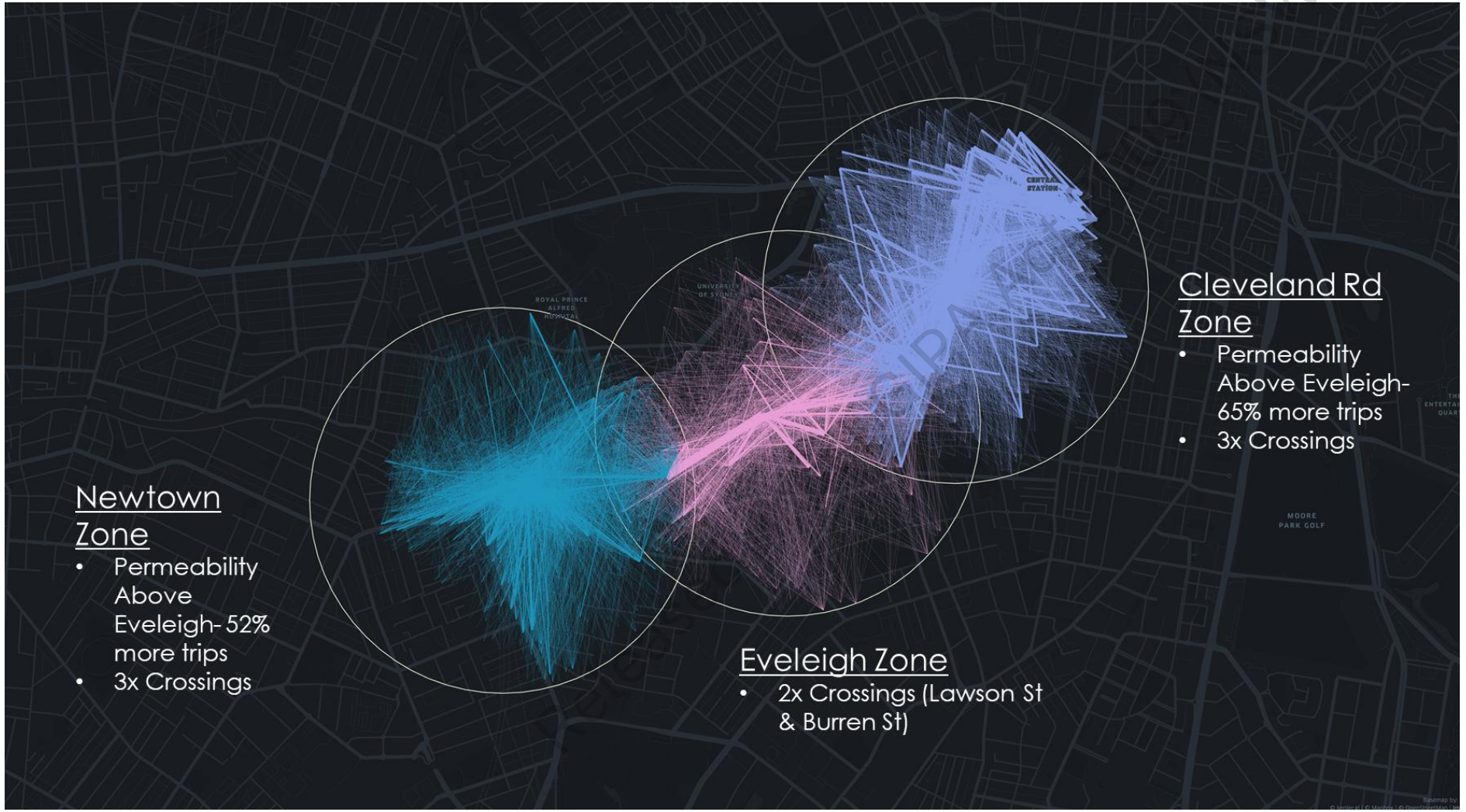
Role of Redfern-North Eveleigh development?

Increased activity due to attractions



Observed activity due to generators and attractions either side of the rail corridor (with a nearby crossing)

Increased activity due to attractions



Conservative assumption for uptake in activity

+10% to +25%

Based on observed activity in adjacent regions

Increased activity due to land-use uplift

Proportion of Redfern-North Eveleigh precinct will utilise the bridge. Bridge may be used for access to and from the precinct and recreational purposes including lunch breaks to move between attractions at either the north or south precinct.

+10-20% of RNE precinct daily population

(includes customers who would use the bridge multiple times per day – with current 10-20% walk mode share for the precinct)

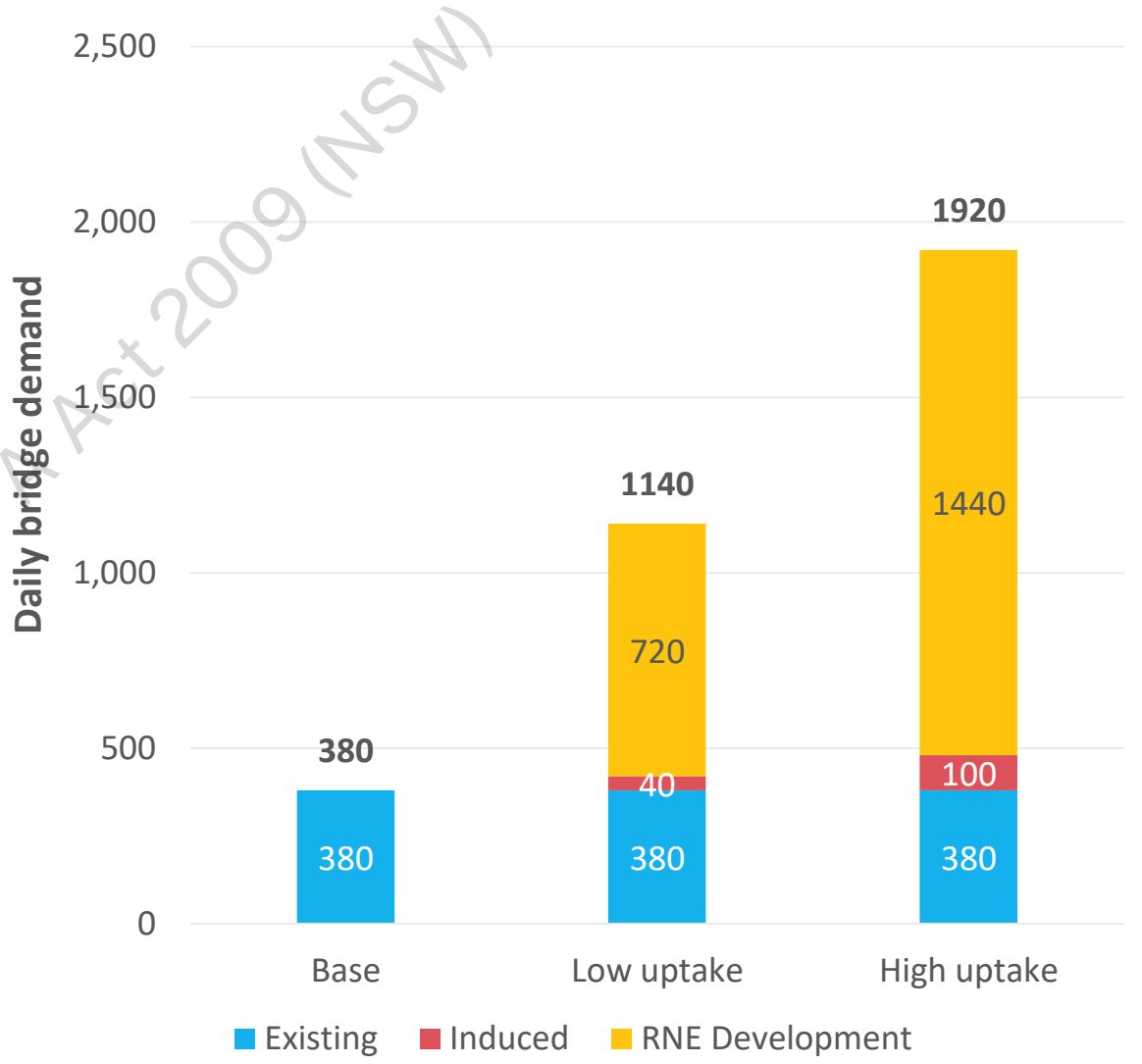
Potential bridge users

Induced demand:

- Increased permeability between generators and attracts
- Lower level of activity either side of rail corridor compared to regions like Newtown

RNE development related demand:

- Single largest contributor to use. Daily count includes an estimate for trips to and from the precinct.
- Assumes precincts are being established as self-serving for residents and employees.
  - If land-uses are linked between RNE and South Eveleigh we would expect more daily trips.



Potential benefit – daily productivity

Average travel time saving

5-8 minutes

per cross corridor journey.

Base scenario

41 hours

Reduced travel time for customers daily (typical weekday).

Low uptake scenario

124 hours

Reduced travel time for customers daily (typical weekday).

High uptake scenario

208 hours

Reduced travel time for customers daily (typical weekday).

sctconsulting.com.au

SCT Consulting

North to South Eveleigh Active Transport Link

Public Transport Projects- Optioneering Review v3

Redfern North Eveleigh Precinct

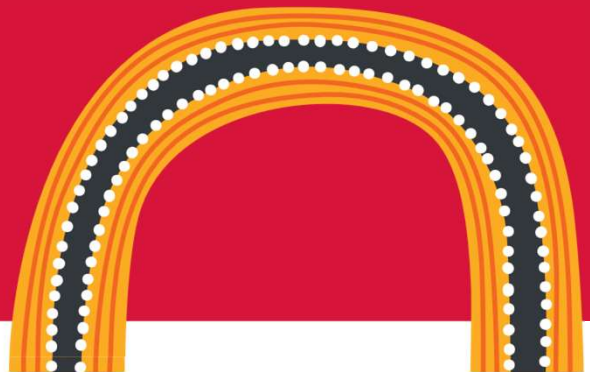
June 2025

Transport.nsw.gov.au

NSW GOVERNMENT

01

Location Photos



Location Photos – bridge/ramp landing zones

Locomotive Street

Carriageworks Way / Wilson Street

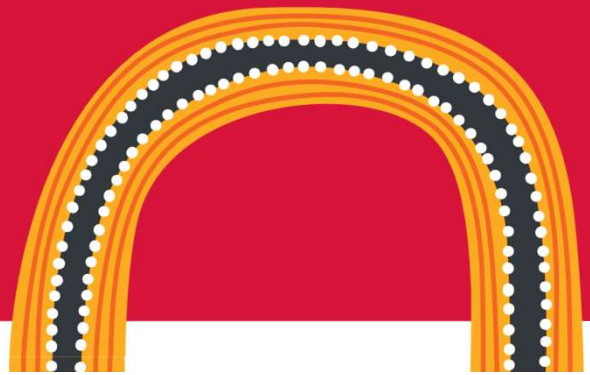
Location Photos – existing tunnel



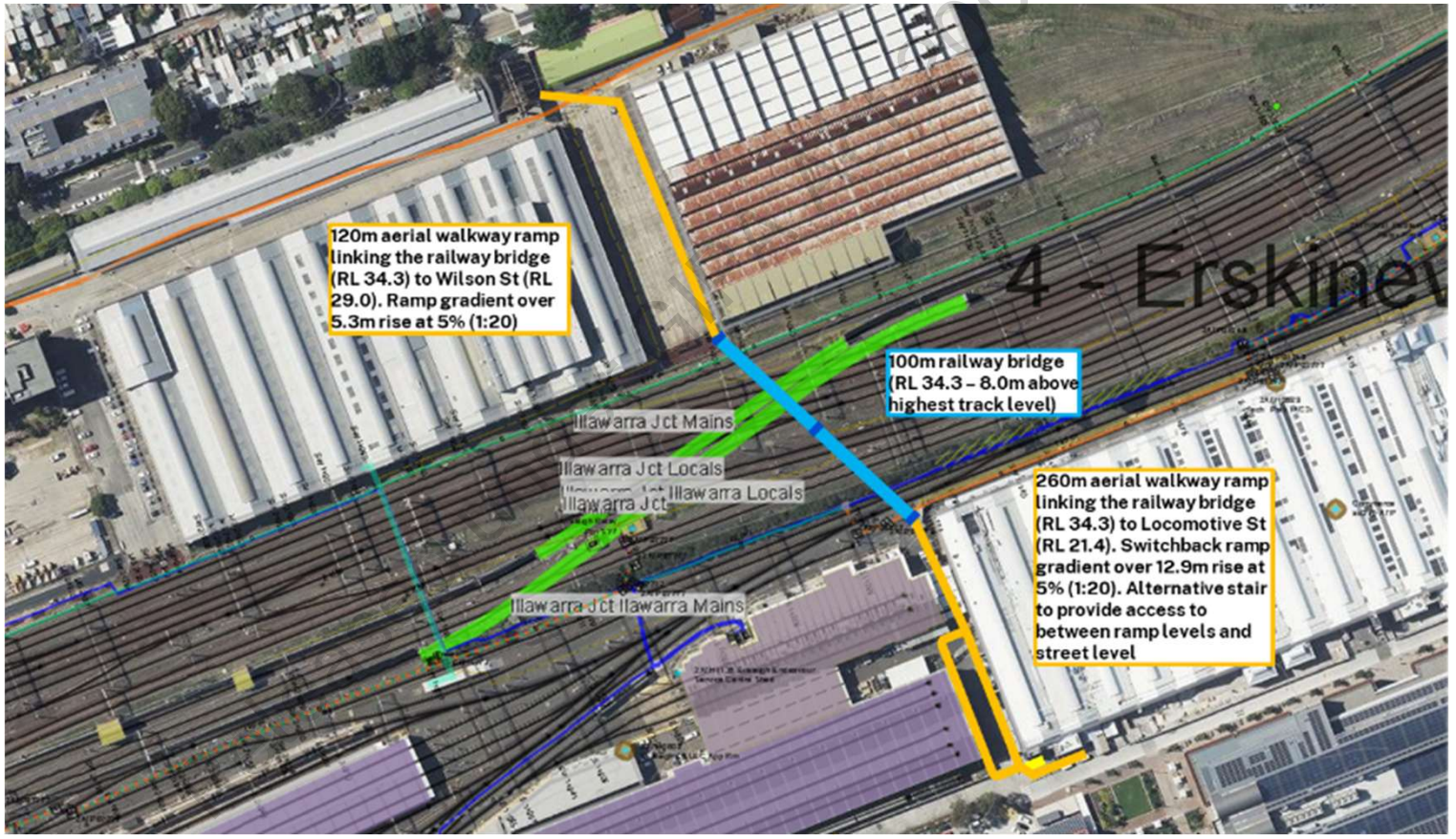



02

Options



Option 1 – Overbridge with Ramps



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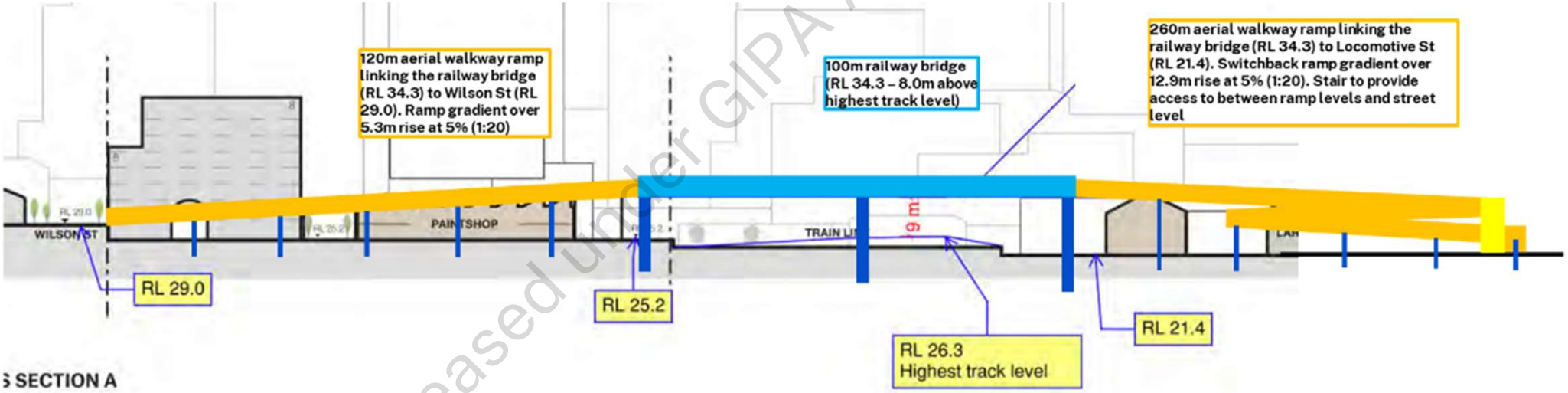
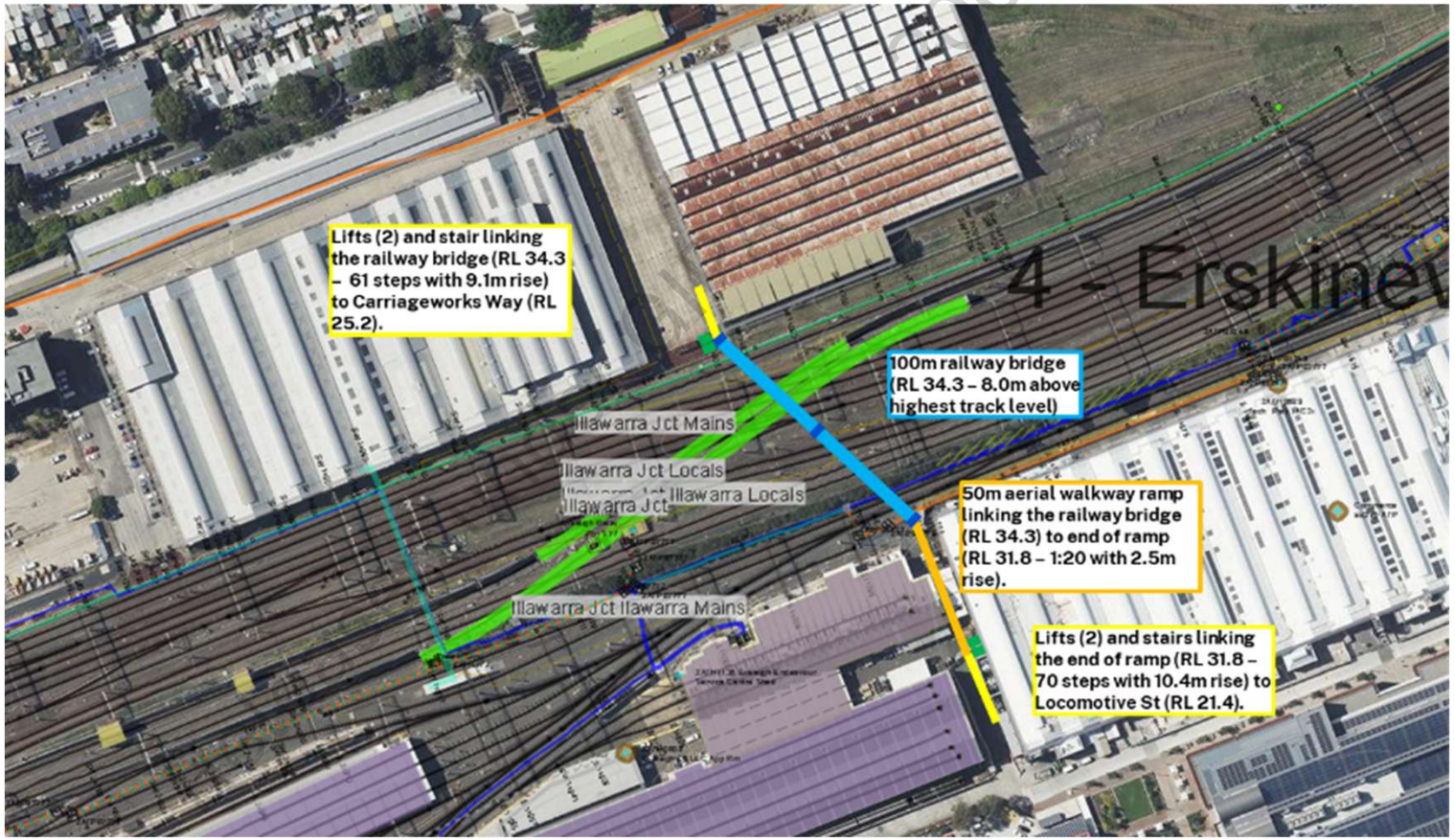


Option 2 – Overbridge with Lifts / Stairs



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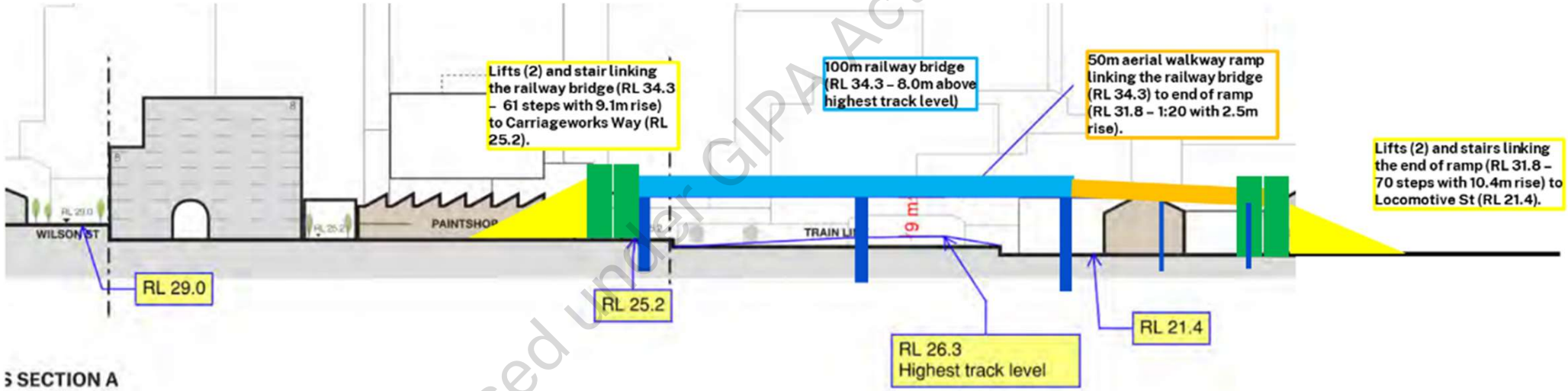
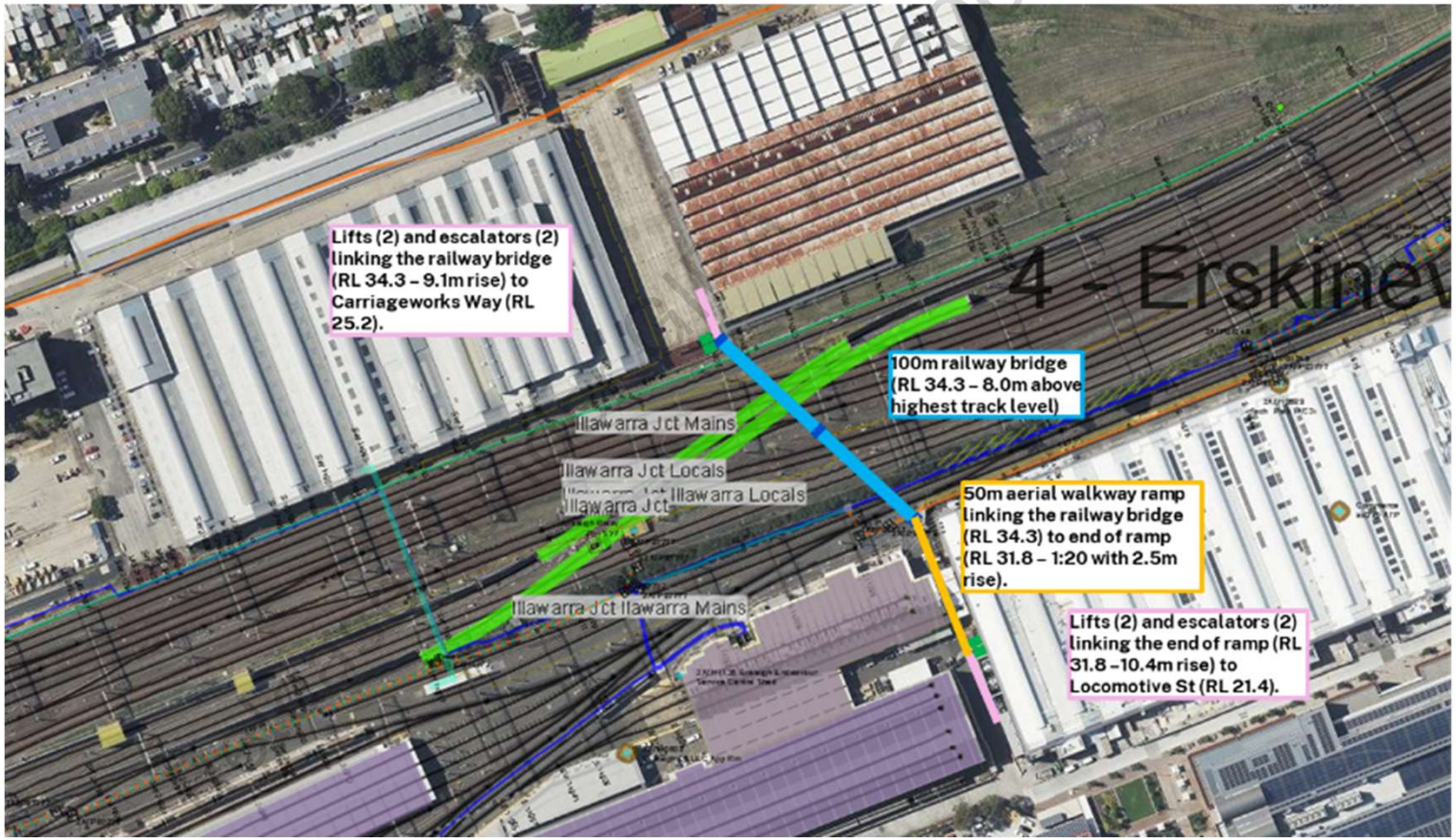
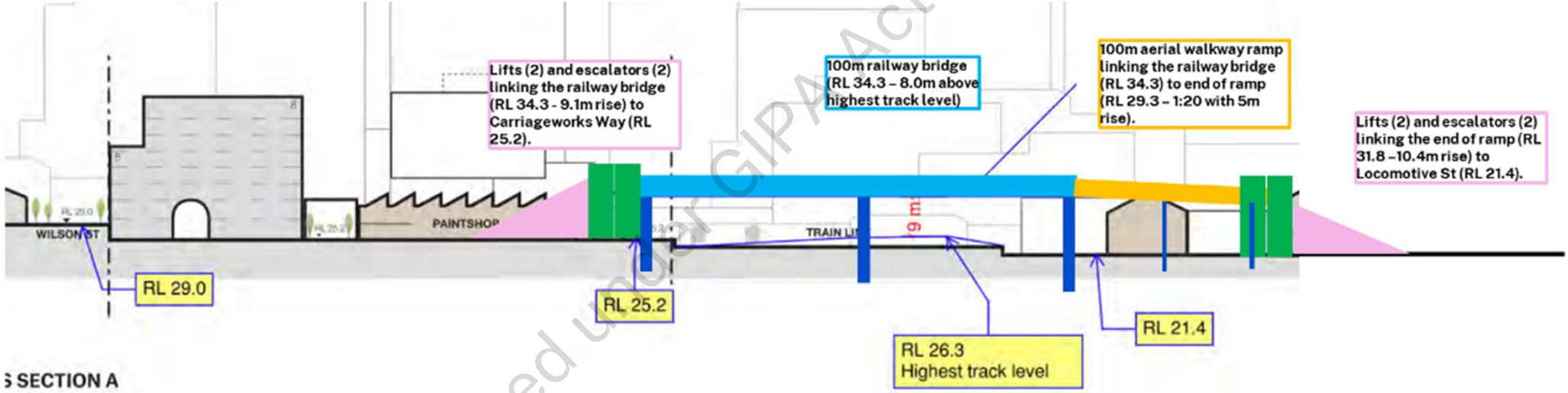


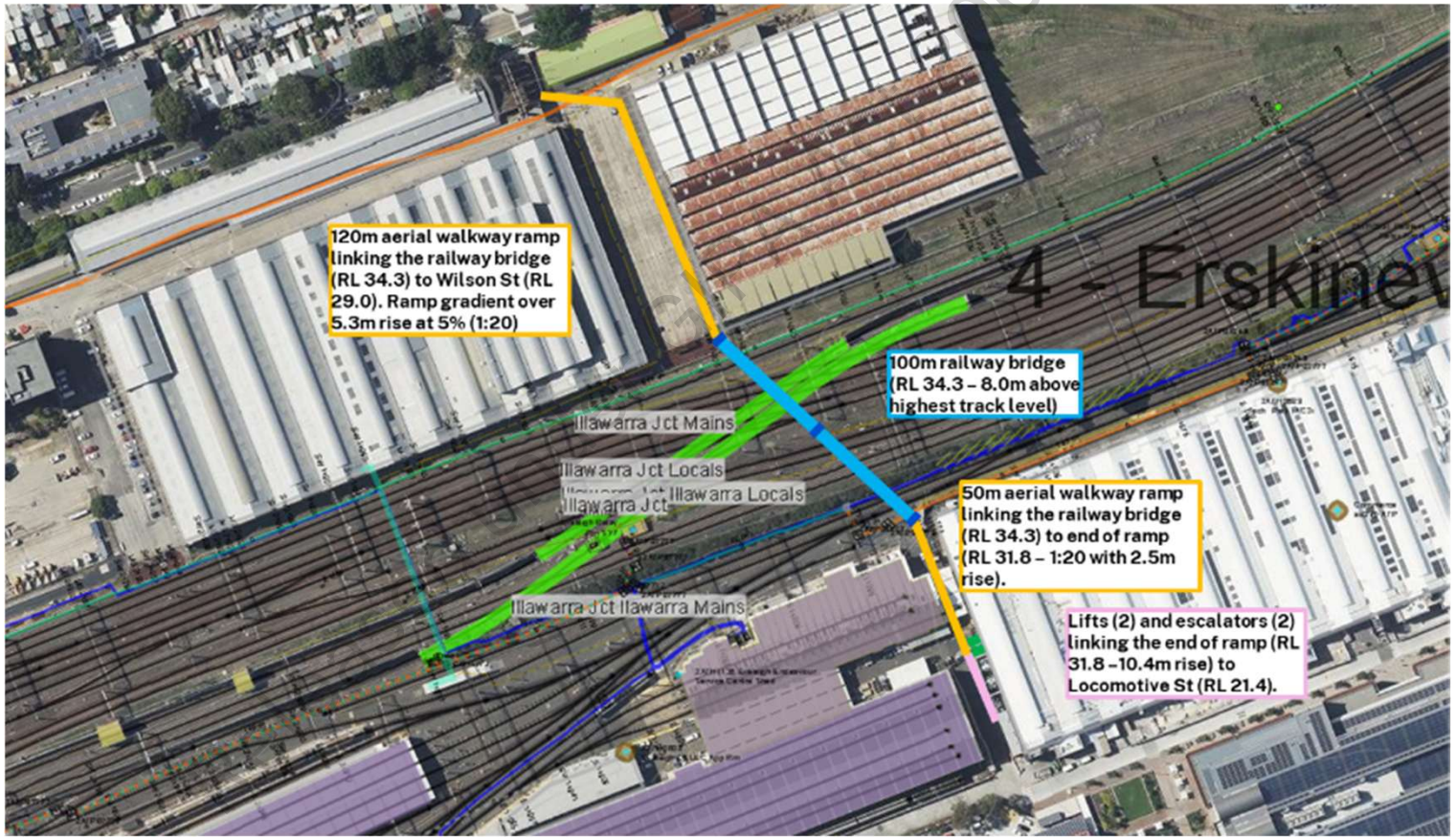
Option 3 – Overbridge with Lifts / Escalators



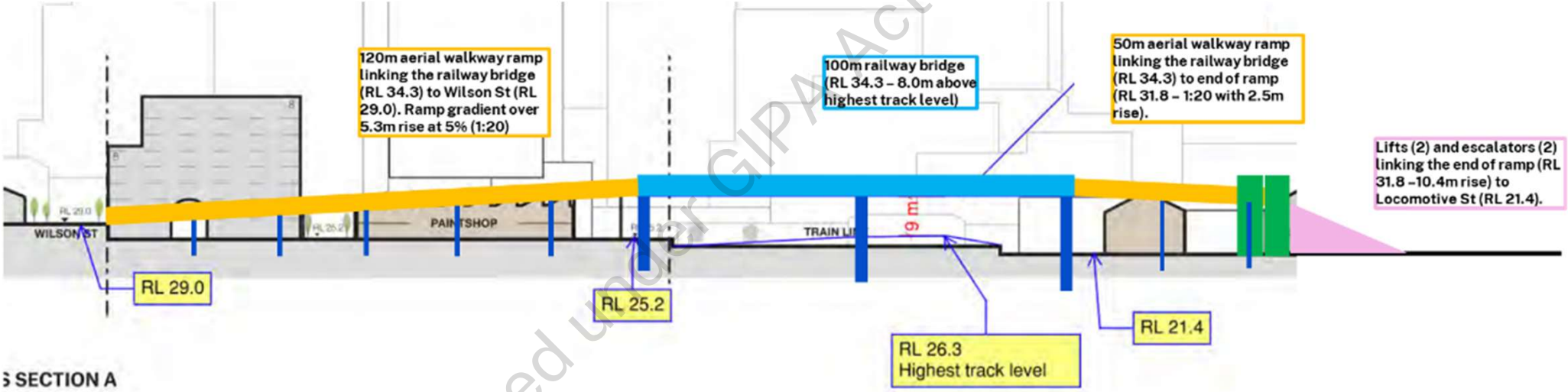
Option 3 – Overbridge with Lifts / Escalators



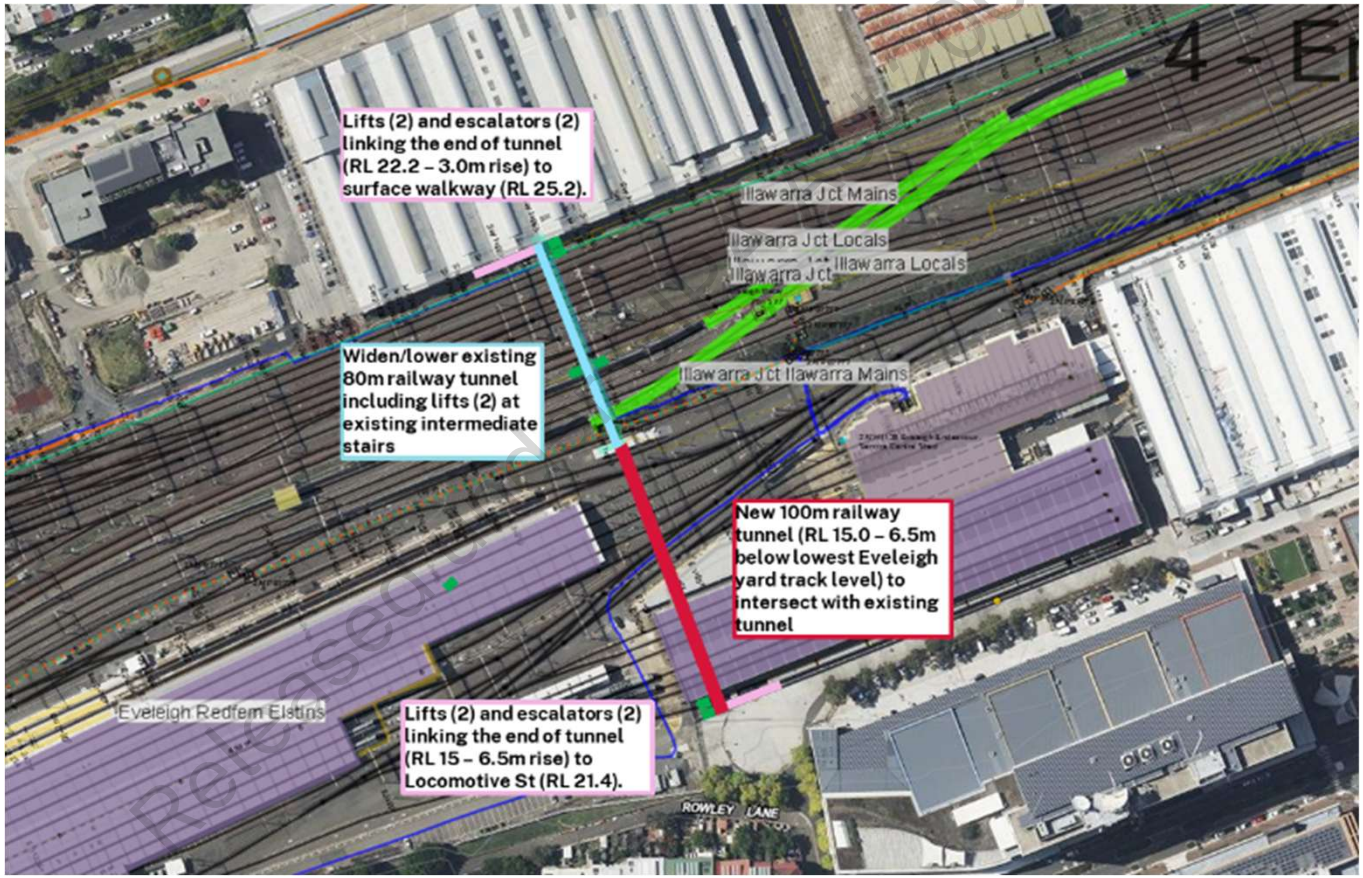
Option 4 – Overbridge with Ramps / Lifts / Escalators



Option 4 – Overbridge with Ramps / Lifts / Escalators



Option 5 – Existing Tunnel with Lifts / Escalators



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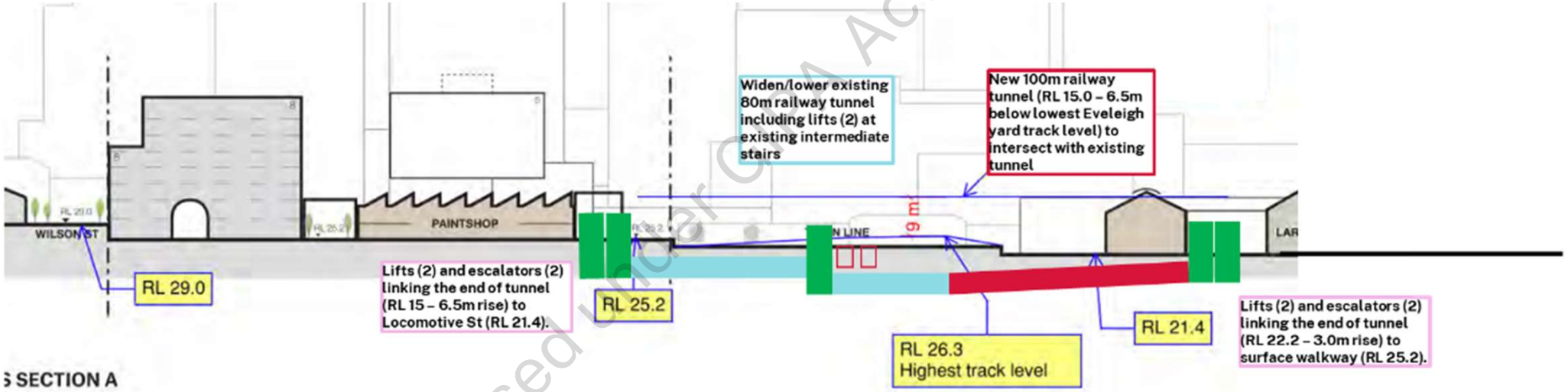
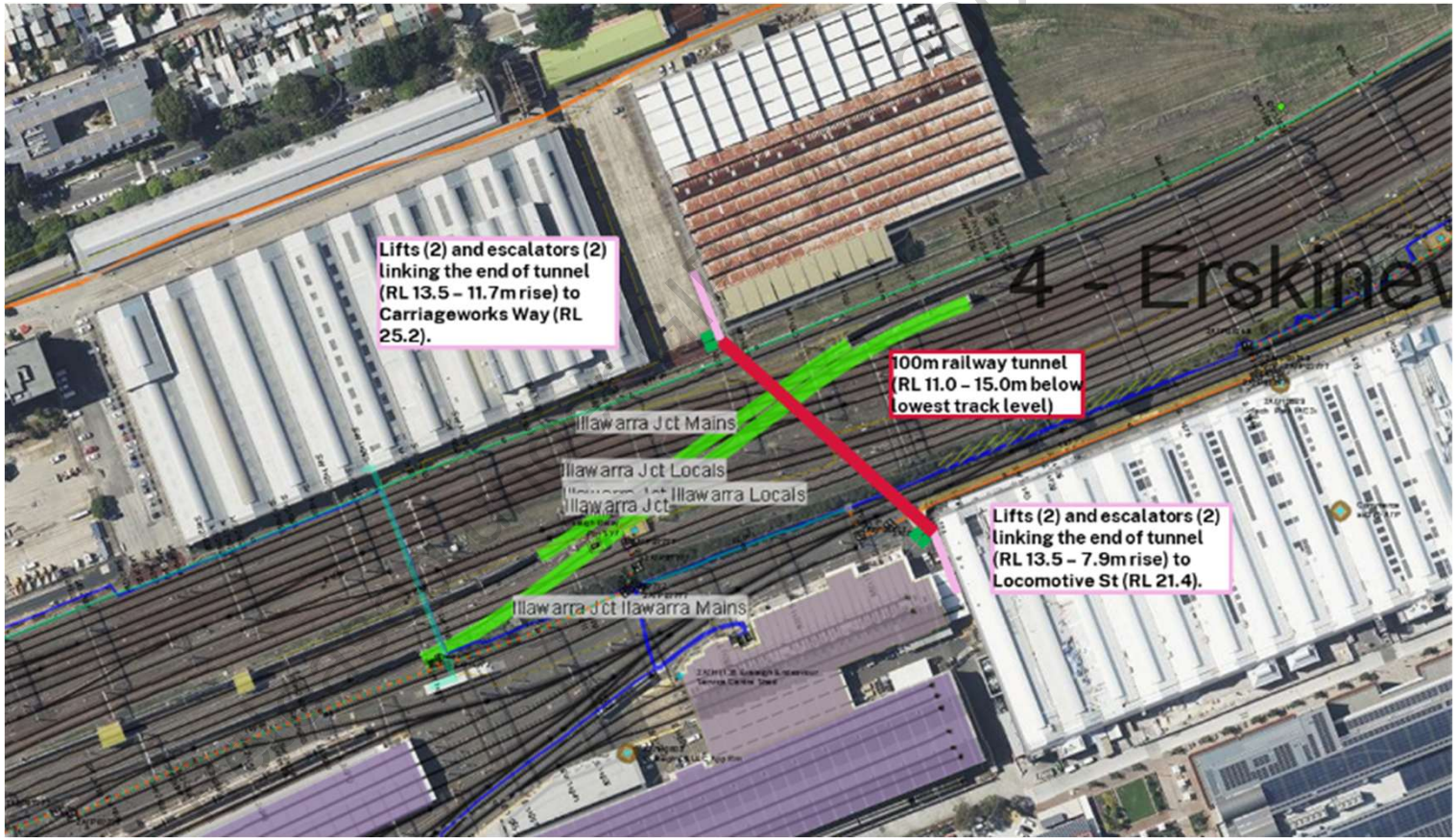


Option 6 – New Tunnel with Lifts / Escalators



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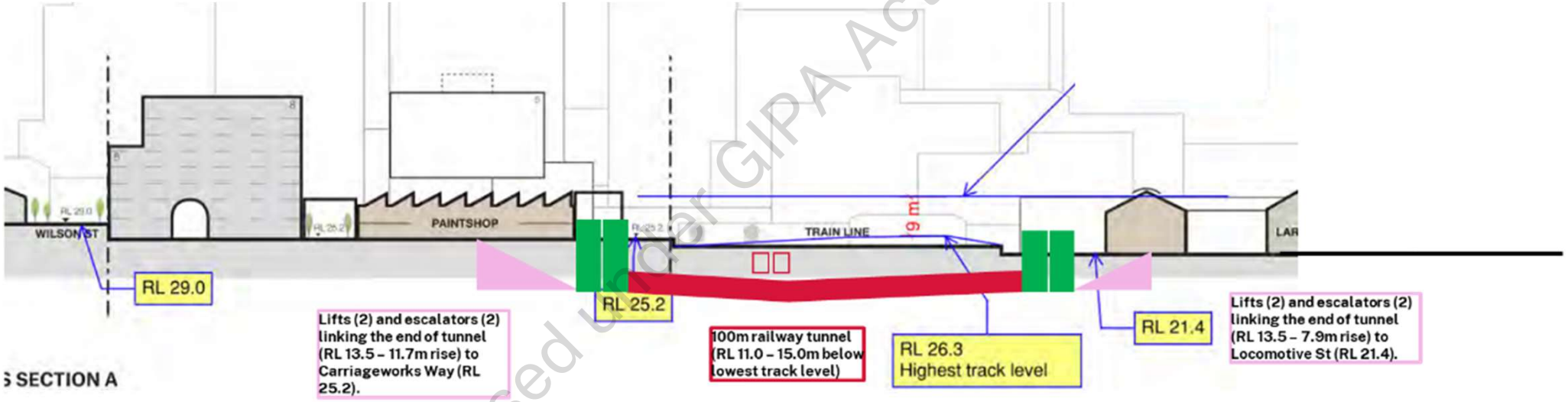
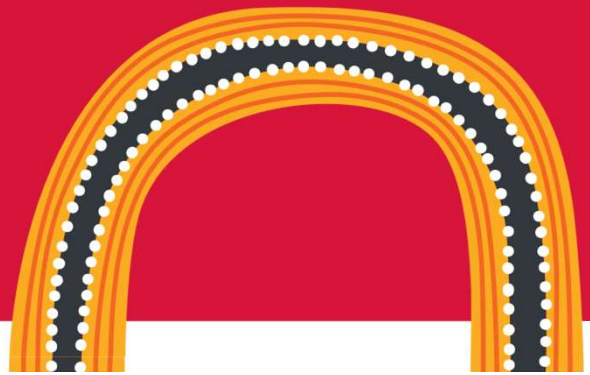
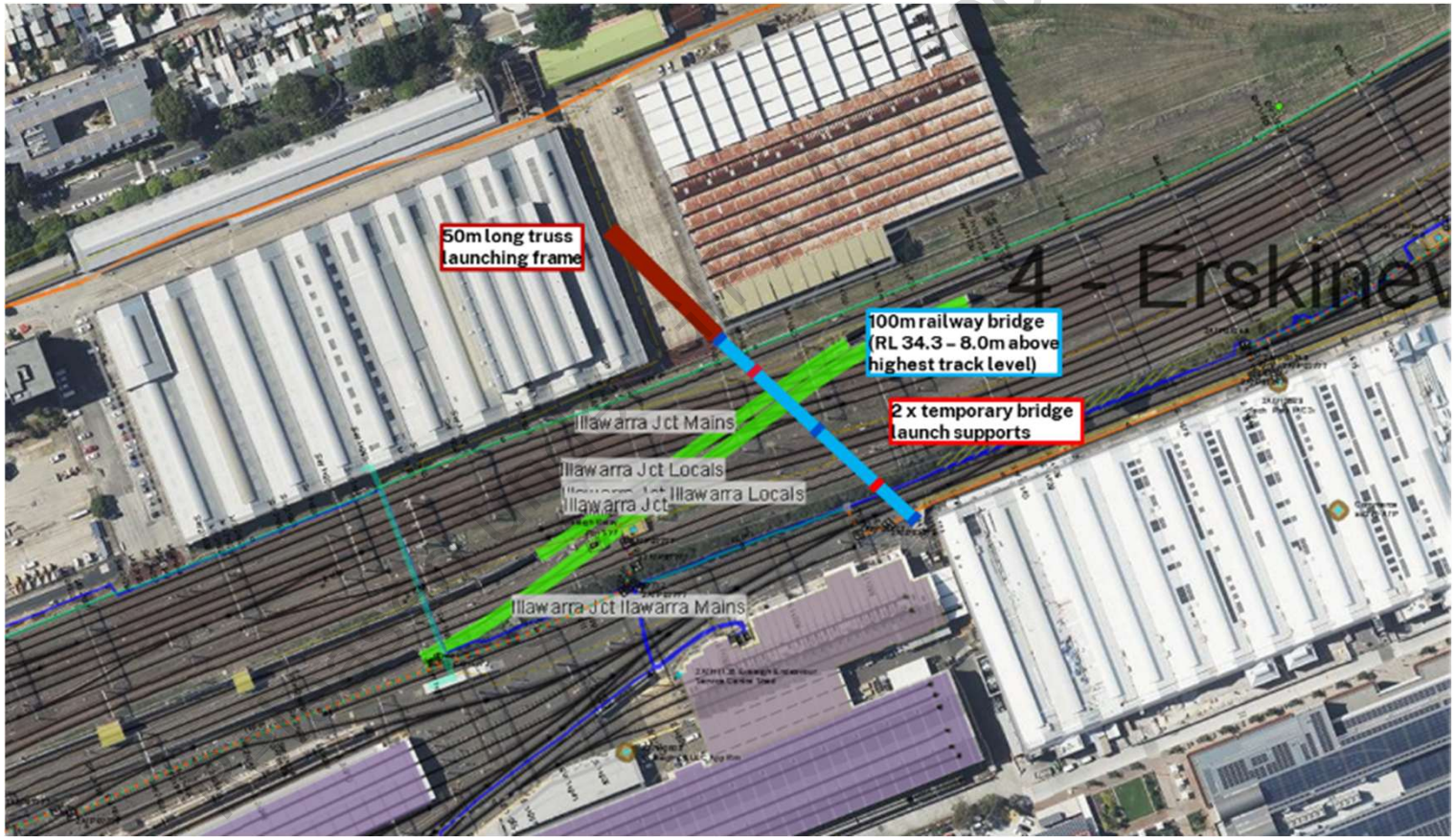


03

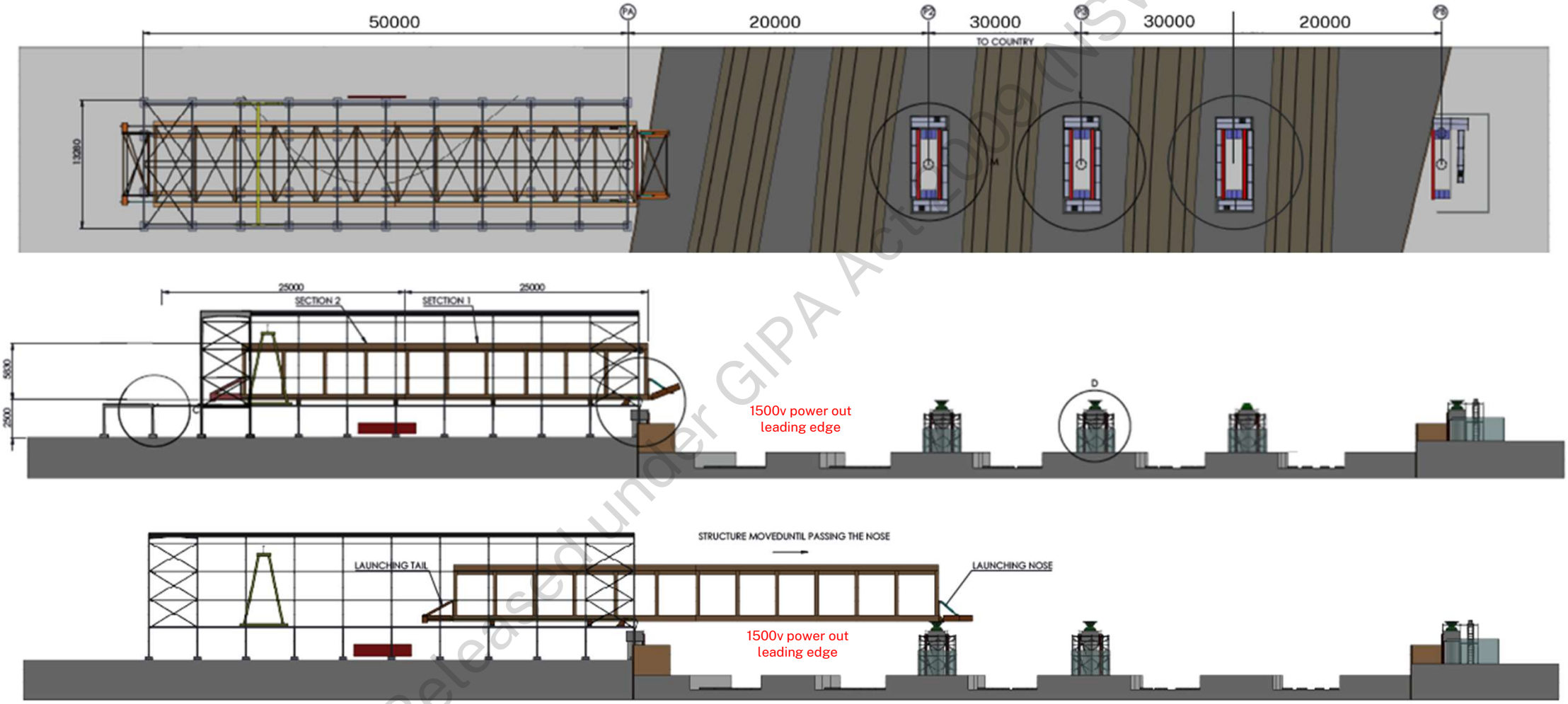
Steel Truss Overbridge Launch



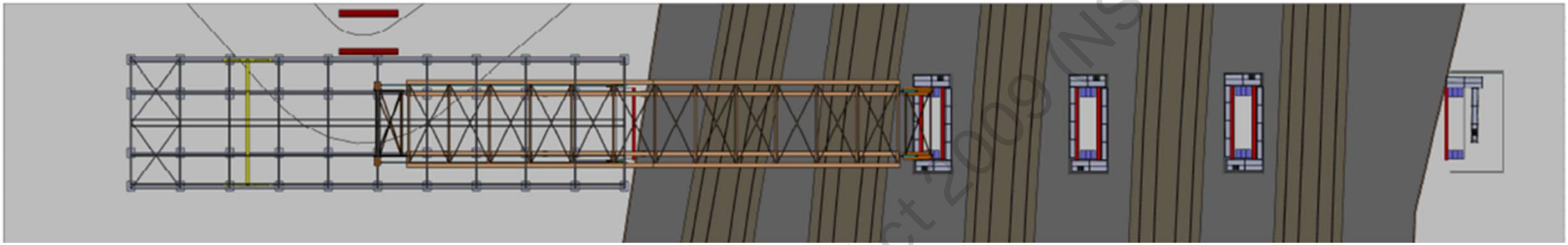
Steel Truss Overbridge Launch

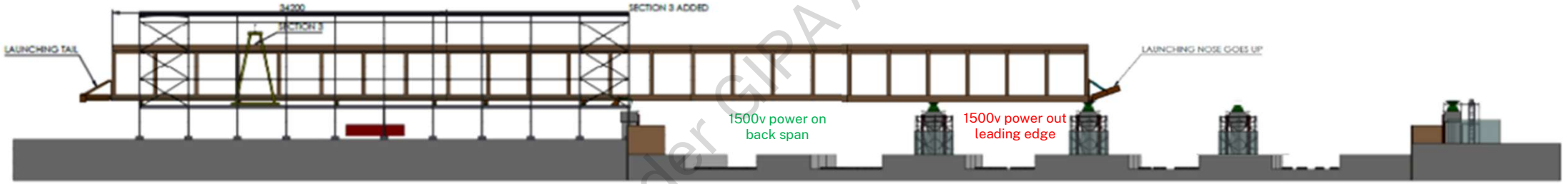


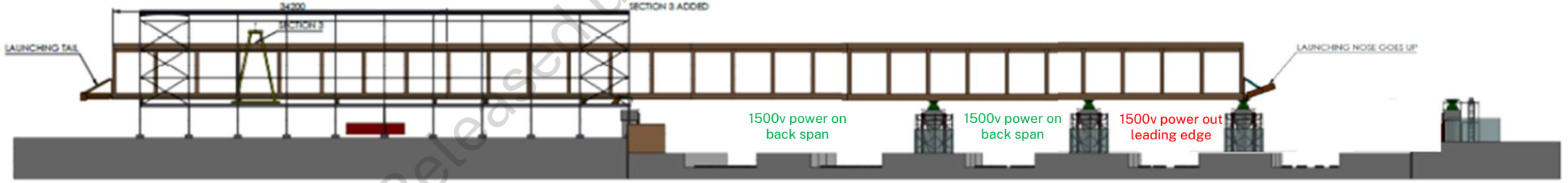
Steel Truss Launch Sequence



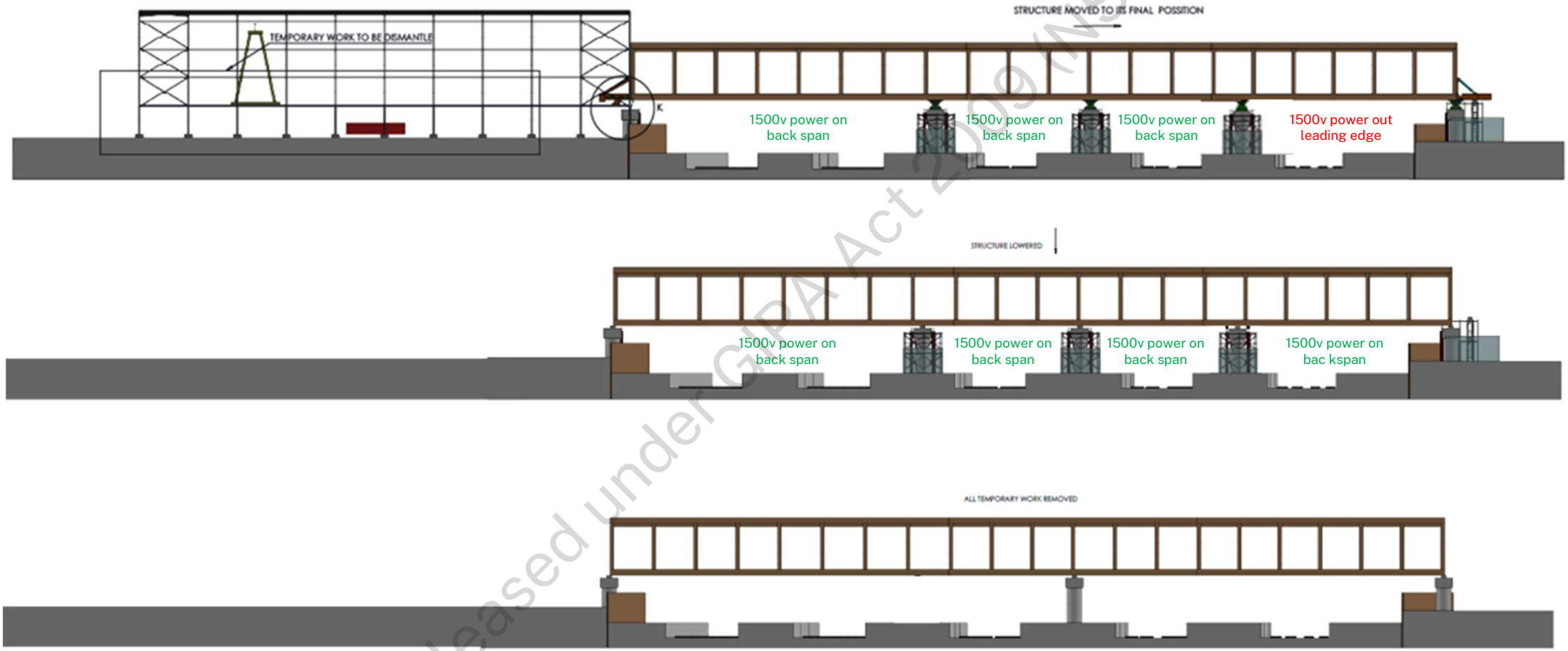
Steel Truss Launch Sequence





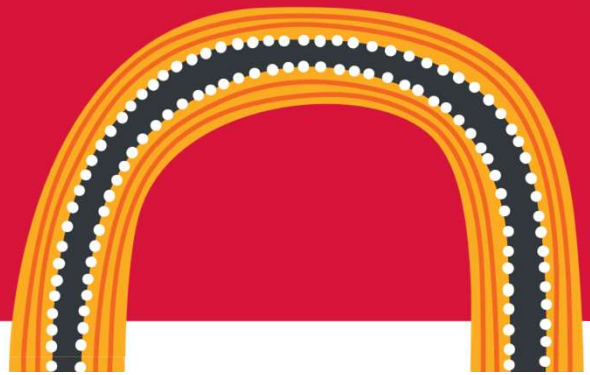


Steel Truss Launch Sequence



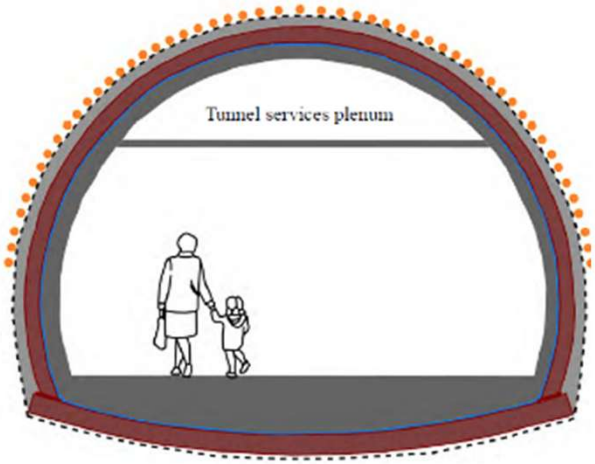
04

Tunnelling



Tunnelling

New Tunnel

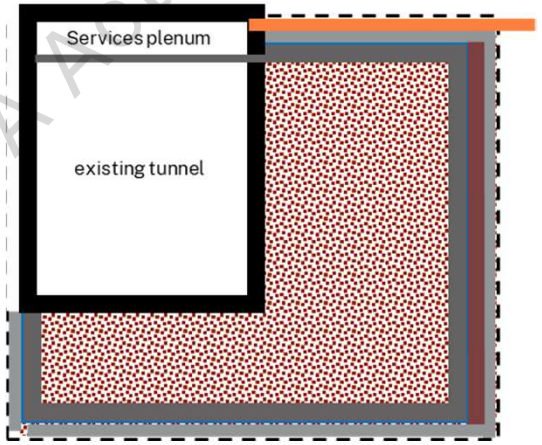


Tunnel Support

- Excavation profile – achieved using small road header or excavator
- Spiles/canopy tube pre-support
- Primary shotcrete lining
- Temporary steel sets
- Waterproofing
- Permanent cast in situ lining

Image from the Arncliffe Pedestrian underpass, completed 2.5m below running rail

Existing tunnel – widening/underpinning



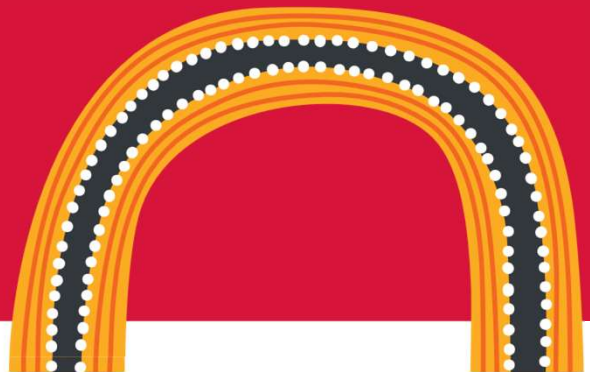
Tunnel Support

- Excavation profile – achieved using small road header or excavator
- Spiles/canopy tube pre-support
- Primary shotcrete lining
- Temporary steel sets
- Waterproofing
- Permanent cast in situ lining

Image of existing tunnel

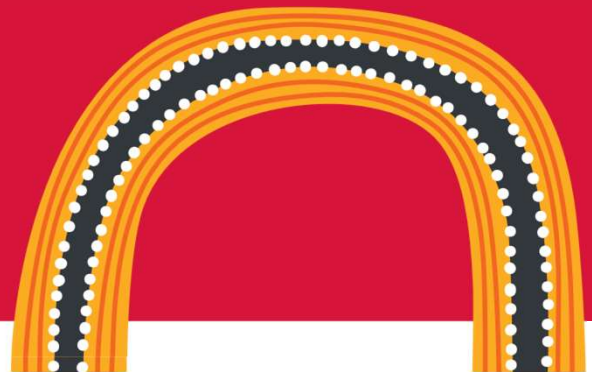
05

Estimate Summary



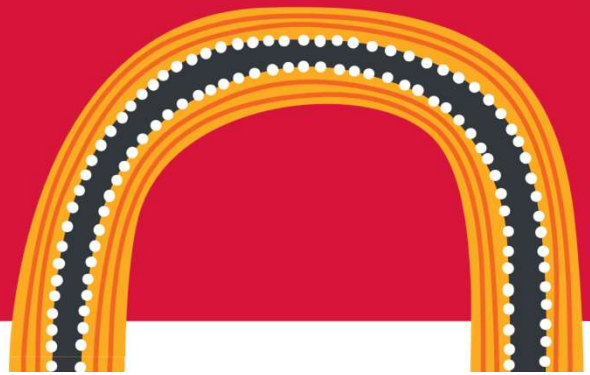
06

Project Schedule – Overbridge



07

Option Assessment

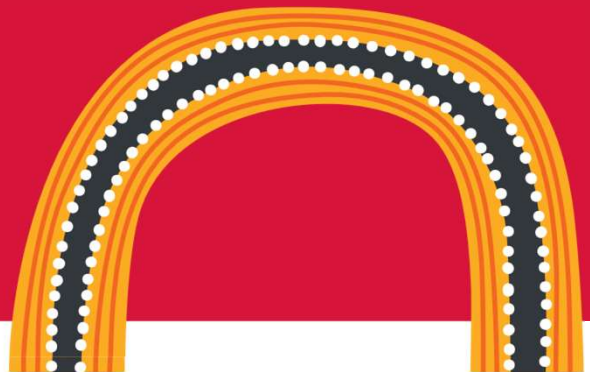


Option Assessment

Assessment Criteria	Option 1 (Overbridge - Ramps)	Option 2 (Overbridge - Stairs / Lifts)	Option 3 (Overbridge – Lifts / Escalators)	Option 4 (Overbridge - Ramps / Lifts / Escalators)	Option 5 (Existing Tunnel –Lifts / Escalators)	Option 6 (New Tunnel – Lifts / Escalators)
Project OTP						
Pedestrian outcomes						
Cyclist outcomes						
Safety / Security (CPTED)						
Fire Engineering						
Precinct connection						
Planning/ Heritage impacts						
Sydney Trains / operational impacts						
Possession requirements						
Project Budget						
Ranking	**2**	**4**	**3**	**1**	**6**	**5**

08

Recommendation



Recommendation

Option 4 – Overbridge (Ramps / Lifts / Escalators) is recommended to proceed as the preferred option:

- Provides the best pedestrian access
- Provides good cyclist access
- Provides the best precinct connection outcome
- Provides the best CPTED / security outcomes
- Provide good fire engineering outcomes

Option 4 – Overbridge (Ramps / Lifts / Escalators) risks include:

- Similar risk for Options 1, 2, 3 and 4 - State Significant Heritage approvals (i.e. either via EIS DPHI or S60 Heritage NSW)
- Identical risk for Options 1, 2 ,3 and 4 - Steel truss launch methodology has not previously been delivered in Australia over 1500v OHW. However, during the development of the Redfern Station New Southern Concourse in 2020, a steel truss launch methodology was developed in consultation/support of Sydney Trains. Was not adopted as it did not result in schedule/savings for that specific site.