Concept Design Report

Government of South Australia

Department of Planning, Transport and Infrastructure

O-Bahn City Access Project

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1 PROJECT OVERVIEW

The existing Adelaide O-Bahn Infrastructure consists of a dedicated bus corridor extending 12km from Modbury to just north of the Torrens River terminating on park Terrace at Gilberton. The current track supports bus speeds of up to 100km/h, with the capability of transporting 18,000 passengers an hour. However, once city bound buses reach Gilberton, significant delays and congestion severely restrict bus service. In peak hour, traffic congestion is responsible for delays of up to 20 minutes from Gilberton to the CBD, while adding further congestion along Hackney Road.

Stage 1 considers the upgrading of the 1.6km corridor from the current O-Bahn termination point at Gilberton to the North Terrace/Botanic Road intersection that will incorporate a priority O-Bahn corridor, significant reductions in congestion and bus service delays. Through optimisation of the O-Bahn traffic flow, positive effects such as increased economic stimulation localised to the Adelaide CBD and reduced congestion on Hackney Road will be realised.

1.1 PROPOSED TUNNEL

The E8 team identified in consultation with DPTI that a tunnel that extends from the current O-Bahn infrastructure to the southern side of the Richmond Street intersection on Hackney Road where it will return to grade. Re-aligning the city bound O-Bahn track under Park Road will locate both O-Bahn tracks together in one tunnel. The tunnel then continues under the north bound Park Road to the west and continues under Bundeys Road to the northern bank of the River Torrens. The tunnel remains at level and then daylights through the river bank across the southern side of the River Torrens. A bridge super structure is required to maintain continuity between both sides of the river. The tunnel then passes under the newly realigned Hackney Road outbound lanes, then re-surfacing between the north and south bound lanes of Hackney Road.

This option provides minimal bus/traffic interaction therefore reducing the chance of vehicle contact. Furthermore, this solution will reduce travel times of both public traffic and O-Bahn patrons due to limited interaction between these parties and not limiting future road network expansion.

2 TRANSPORTATION DEPARTMENT

2.1 INTRODUCTION

During the detailed design, the Transport Department will investigate, design and detail for the extent of the transport related works between Botanic Road and the existing O-Bahn infrastructure. The flowing sections outline the scope of works this will include for the detailed design. Each task that is detailed, will be communicated and coordinated in conjunction with the other departments, to ensure that all departments are working with appropriate and accurate information.

2.2 TUNNEL ALIGNMENT

The tunnel alignment will be detailed and designed between the existing O-Bahn infrastructures to just south of Richmond Street. This will involve investigating horizontal alignments to ensure acceptable curvatures are adopted and to ensure that the tunnel aligns with the dedicated bus lanes and existing O-Bahn infrastructure. Vertical geometry will be investigated, to ensure that there are suitable clearances between finish surface levels, road networks and above to the Torrens River. In determining the horizontal and vertical alignment, the design speed for the tunnel will need to be investigate and decided upon. Due to the lack of survey data, to detail the tunnel design, the team will decide the reference point (Coordinates) using Google earth. These reference points will be detailed as chainages on the Hackney Road map. In addition, the tunnel will be designed in accordance to Austroads Tunnel Design Part 1 to 3. Once all the concept drawings are finished, they will be distributed to the other departments for review.

2.3 HACKNEY ROAD ALIGNMENT

The Hackney Road realignment will be detailed and designed between Park Road at the existing O-Bahn alignment and Botanic Road. This will involve investigating the horizontal and vertical alignment for the extent of works. This will involve identifying and detailing suitable lane widths for both buses and vehicles, road cross falls and if applicable, acceptable curvatures. In addition, the following other aspects of Hackney Road will be investigated, designed and detailed, including U-turn facilities, right turn facilities, pedestrian's refuges

along Hackney Road and shared pedestrian/cyclist paths. These items will be designed in accordance with relevant Australian Standards and Austroads guidelines.

2.4 INTERSECTIONS REALIGNMENTS

Hackney Road/North Terrace and Bundeys Road/Park Terrace will be designed and detailed. The extent of detailing will include showing lane widths at intersections, signal rephasing and aspects of traffic signals for pedestrians. In addition, all intersections within the extent of the site will be reviewed, redesigned and detailed where applicable to reflect changes to traffic movements.

2.5 CARPARK RE-DESIGN

Due to the realignment of Hackney Road to allow enough space for two dedicated bus lanes, the existing parking infrastructure requires redesign at a number of locations. This will require designing and detailing two new car parks on the western side of Hackney Road. The first car parks is located between Botanic Road and Plane Tree Drive (Entrance). The second car park is located between Plane Tree Drive entrance and exit.

2.6 NEW SIGNAGE AND DELINEATION

The realignment along Hackney Road and Park Road will require new signage to be installed. The new signage will be designed and detailed in accordance with AS1743, this will include new signage for local access streets along Hackney Road. In addition, any required line marking and lane marking will be designed and detailed.

2.7 TRAFFIC MANAGEMENT

Traffic management plans will be designed and detailed for the duration of the project for all construction, to minimise as much as practical the impact works will have on the public. This will include assessing the effect construction will have on Hackney Road and surrounding road networks, providing suggested signal rephasing and other mitigation strategies where applicable. In addition, traffic management drawings will be detailed to ensure all traffic management is to the appropriate standard.

2.8 AUTOCAD DRAWINGS

Following the investigation and design of the items listed above, detailed drawings will be provided for the signalised intersections at Bundeys/Hackney and Botanic/Hackney, Hackney Road alignment, detailing lane widths, cross falls, U-turns, shared pathway and parking facilities, the horizontal and vertical alignment of the tunnel, all signage and pavement markings relating to the new alignments and traffic management plans for construction works.

3 SERVICES DEPARTMENT

3.1 INTRODUCTION

The services department will be responsible for detailing the items listed below. This will include the power lines, water services and tunnel services. All items listed below will be drawn to scale using AutoCAD to outline exactly where they will be running.

3.2 POWER LINES ABOVE GROUND

The above power lines will need to have all power being relocated due to the sheet piling that will be occurring during construction. This will include looking at the cost of diverting power or upgrading other power lines if they do not have the capacity to carry the diverted power. Other options to consider may be to use a temporary power generator, however, the costs associated will need to be detailed and will ultimately determine which method will be used. If power cannot be diverted and the temporary generators are not viable, the power lines will be relocated.

3.3 UNDERGROUND POWER SERVICES

The power that is supplied by the underground services needs to be permanently diverted to a different grid. This will involve research to determine if the other lines have the capacity to take on the extra demand or if they need to be upgraded. Some services will need relocating, all of which will be detailed in the drawings.

3.4 WATER SERVICES

Due to a clash at the entry and exit of the tunnel, sections of the mains water supply will need to be relocated. Consideration must be taken to determine if the relocation will interfere with any other pre-existing services that may be in the area. Further research will also need to be conducted to determine if the sewerage systems will need relocation due to interference with the tunnel. Preliminary research suggests that this will not be an issue.

Furthermore, the additional stormwater runoff due to the additional impermeable area will need to be calculated to determine if the pre-existing stormwater drainage system will be able to cope with the new volume of stormwater runoff.

3.5 TUNNEL SERVICES

The lighting of the tunnel will need to be designed and comply with the AZ/NZS 1158.5.2007 Lighting for roads and public spaces – Part 5: Tunnels and Underpasses. Emergency services will also need to comply with their corresponding standards, including fire systems, emergency lighting, exit signs.

Ventilation of the tunnel will be designed in accordance with Austroads 2015 'Guide to Road Tunnels Part 2: Planning, Design & Commissioning' which will include 8 fans in each direction as specified in the feasibility study. The services corridor will also be detailed and drawn on a scaled diagram to specify exactly where the other services such as CCTV, telecommunications, pipe works, electrical cables and cable trays will be.

3.6 ROAD SERVICES & LIGHTING

The road lighting along Hackney Road will be detailed, complying with the standard AS/NZS 1158 Road Lighting as well as DPTI Road Design – Standards and Guidelines "A guide to the design of road lighting LD001". Lighting of the shared pedestrian and cyclist bridge will also be designed to the appropriate standards.

3.7 NBN & TELECOMMUNICATIONS

Relocation of the services will be required due to a clash with the tunnel. All relocation will be conducted via a common service trench and conduit which will be designed.

3.8 GAS SERVICES

Relocation of the pipes at the intersection of Bundeys Road and Hackney Road will be required. This will be done by an extension of the gas pipe along the western side of Hackney Road and under War Memorial Drive. This will be detailed in a scaled drawing.

4 GEOTECHNICAL DEPARTMENT

4.1 INTRODUCTION

The scope of the works, associated with the Geotechnical Aspects of the detailed design for the O-Bahn City Access Project, will be outlined in this short report. The civil capital works will include designing the pavement for the road and shared user pathways, along the Hackney Road stretch, within the site area. As well as this, the Geotechnical Department, will investigate design and carry out the works associated with the installation of the foundation for any services relocations. As a team, the Geotechnical Department will design the exit for the tunnel onto Richmond Road, which will require not only a specific pavement design but also the implementation of a retaining wall type structure. By liaising with both Structural and Transport Departments, the Geotechnical Department will determine the appropriate tunnel foundations with support columns where required. Lastly, the tie backs, as part of the sheet pile retaining wall, will need to be designed to correct specifications as part of this stage of the project.

4.2 CAD DRAWINGS: ALL

Following the investigation and design of the items listed above, detailed drawings will be provided for the pavement design for both the Richmond Road Off-On ramp and the Hackney Road Widening, the Retaining Wall Structures, the Footings for the tunnel structure and the Foundation Columns. If required, Geotechnical will provide a detailed drawing, of the tie back system, within the sheet pile retaining wall sections of the project.

4.3 HACKNEY WIDENING: PAVEMENT DESIGN

The preliminary design for the pavement, was completed in the feasibility stage of the project. However, the Geotechnical Department, will undertake CIRCLY analysis and complete further investigation on the changes in soil profile along Hackney Road, if required the team will design an additional pavement cross section for different sections of the project site.

4.4 FOUNDATIONS AND COLUMNS DESIGN

According to previous geotechnical reports, the bearing capacity of soil is expected to be relatively low at locations closer to the River Torrens. Therefore, it was recommended that raft footing is adopted as the solution for base support of the tunnel; as this type of footing design is proven to be affective for low bearing capacity soil locations. Individual footing foundations were also taken into consideration; however, it is more economical to adopt raft footing as the dimensions required for an individual footing are about 75% of the size of the raft footing for the same loading capacity. Figure below illustrates the layout of a raft footing:

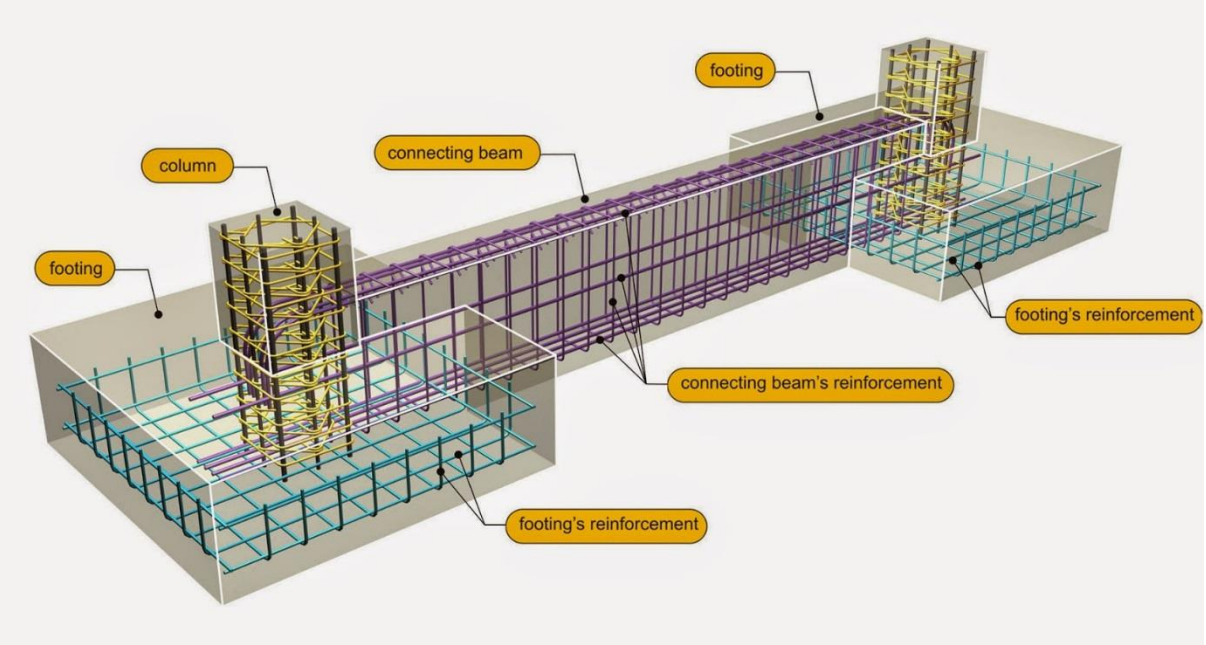

Figure 1: Layout of Raft Footing

All design methods and considerations will follow Austroads Guide to Road Tunnel, AS 5100 and AS 1170 standards.

4.5 TUNNEL EXITS: PAVEMENT AND RETAINING WALL

Before the commencement of works can be carried forward, Geotechnical Department has to excavate the earth and construct in-situ ground-slabs in order to have carriageways for pavement sublayers and then, retaining walls in order to support the embankment backfills.

However, in the concept of works, we will separate these into two components. In showing conceptual ideas to the design process, will be pavement and also retaining walls. These will be later drawn in detailed drawings with the use of AutoCAD software. Permanent sheet pile retaining walls are required (see Figure 2 below), indicating it as a conceptual design to how we are implementing the designs for the tunnel exit. Subsequently, we will be designing in detail, the actual configurations with the fixtures using U-type steel sheet piles to connect with one another. Additionally, aesthetics for covering the sidewalls consist of a formwork to allow for concreting, this gives a better outlook to cover up the steel retaining structure. This design, will be co-ordinated with the use of Plaxis and GeoStudio 12 software. Pavement conceptual design will be as the cross section of roads. Although, in terms of details these will be drafted in form of an AutoCAD drawing to stipulate it in a finer detail of showing each layer.

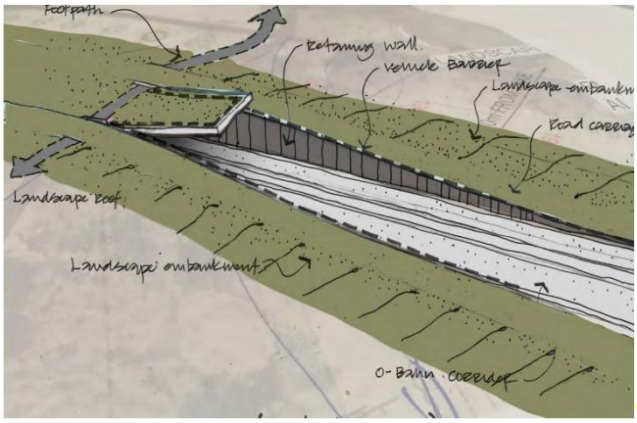

Figure 2: O-Bahn Retaining Wall Exit Concept

4.6 SERVICES RELOCATION: FOUNDATIONS

Identifying powerlines, we need electricity demand, (or the power pole type) to determine loading on the pole, which we will receive from either services or the Structural Department, in order to

determine footing size alongside AS/NZS 7000 (Overhead line design). With low bearing strength soil an increase in the sinking depth will increase the footing strength. This is the main method to increase footing strength as a 25% increase in sinking depth almost doubles the footing strength. Another method if not possible to use the sinking method is baulking but it needs lots of free space. Which is not likely to have clear space from services and kerbs. So these methods will need to be used along Hackney Road were applicable with the differing soil. Similarly, we will need to work alongside the Services Department to determine what services are required around Hackney Road and more importantly the area required for the underground services and any foundations required.

4.7 TIEBACK RETAINING WALL

With designing a tie back retaining walls, we need to determine what type of loads are being applied, such as bearing capacities, force from the anchor and the lateral load from the tunnel roof. It is also important to identity what soil conditions surround these anchor points, as we will need to ensure that these anchors don't move under load. Useful standard that will help determine this type of retaining structure follow as: AS 4678—2002 and the Australian Standard on Earth Retaining Structures (DR-96405, 1996).

The type of tieback retaining wall we will be using is a sheet piled wall, as these sheets can be driving into the ground allowing for easy excavation. Our problem will arise with these designing the correct thickness of these sheets to hold back the soil as well as holding the load of the tunnel roof, as predominantly these sheet piles have quite a limited capacity in the vertical loading direction. We will also need to design a wall beam in the horizontal direction along the length of the retaining wall, this will accommodate for the fixed end of the anchor to the retaining wall. We will also need to determine where each anchor will need to go and what the spacing is required between each anchor, once we have determined a design for a single section. When we have achieved a design, we will need to check the failure surface used in the limit equilibrium analyses of anchored walls. Which can be determined with Schnabel Foundation Company (1996). Draft Final Report--Ground Anchor Walls: Research.

5 STRUCTURAL DEPARTMENT

5.1 INTRODUCTION

The following section outlines the conceptual tunnel solution put forward by the Structural Department, which will be detailed during this next phase of the project. The tunnel solution incorporates two different structures that will have to be addressed. The first being the tunnel structure itself, while the second is the bridge structure for when the tunnel spans the River Torrens. The detailed design stage will encompass the design of all individual structural elements, associated with the structure type. The tunnel solution will require additional widening to the existing O-Bahn infrastructure, to accommodate the continuation of the inbound lane. The widening of the existing O-Bahn tunnel will be addressed with the same tunnel structure that will be detailed, when the tunnel passes under an existing roadway.

5.2 TUNNEL STRUCTURE

The tunnel structure itself will be designed not only to support the applied bus loadings, but it will also have to address the application of traffic loads (tunnel under roadways) and soil pressures. In order to support the applied overhead loads and provide lateral restraint to the retaining wall, precast prestressed concrete segments will be attached on either side to an in-situ corbel, which will be supported by the retaining wall. Where the tunnel passes under an existing road, sheet pile retaining walls are to be applied. The soil to the north of the river will require excessive excavation in order to construct an in-situ concrete retaining wall. Due to the existing site conditions there is insufficient space to revert to this construction type, hence sheet pile retaining walls will be implemented. As majority of the retaining wall is to be constructed using sheet piles, the costs associated with acquiring and setting up the machine are already outlaid. Therefore rather than revert to an in-situ concrete wall through the minor section where possible, sheet pile retaining walls will be used throughout the entire tunnel busway.

An emergency egress and services corridor will be afforded throughout one side of the tunnel structure. The emergency egress corridor will be at the level of the O-Bahn kerbing, with the services corridor above. The two corridors will be separated by a concrete slab, as depicted in Figure 3. The base slab of the tunnel structure will provide the driving surface for the O-Bahn buses, and hence will be afforded the appropriate kerbing to provide the supporting system for the guide wheels. The kerb will be 180mm in height with a clear distance of 2600mm adhering to the O-Bahn design specifications, with an additional 500mm wide kerb between the inbound and outbound lanes, as demonstrated in Figure 3. In order for the buses

to have a smooth transition when entering/exiting the guideway at low speed, a steel guide system will be implemented for a further 40m to the entrance and exit at the southern end of the tunnel, tapering from 3.2m to 2.6m at the entrance to the tunnel ramp.

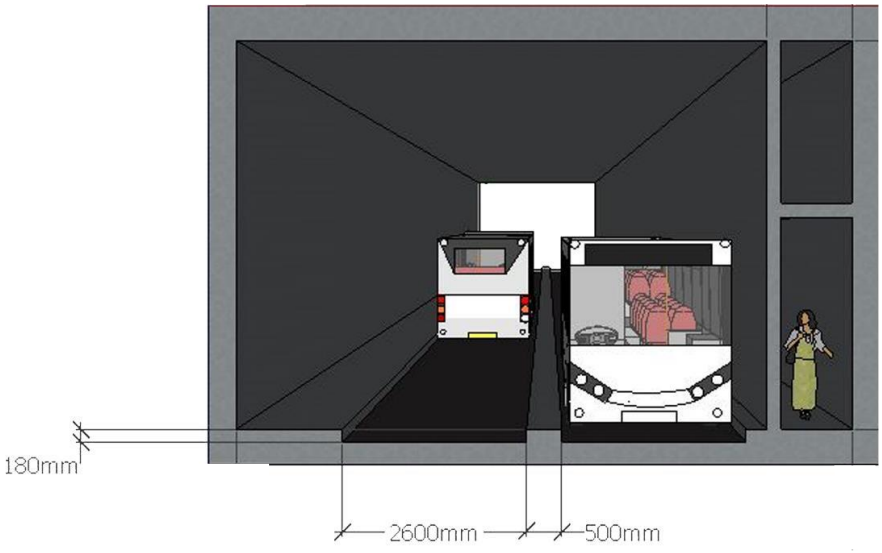

Figure 3: Proposed Tunnel Structure

5.3 BRIDGE STRUCTURE

The bridge structure will be supported by two circular columns on either river bank. Information regarding the footings will be detailed by the Geotechnical Department. The bridge structure will incorporate an inverted T headstock, supporting three precast prestressed super-T girder beams. This reduces the overall height of the bridge whilst maintaining the minimal clearance above footpaths. Bearing pads are going to be implemented at the connection location between the Super-T girders and the headstock, these pads will located on the flange of the headstock and be in the form of engineered rubber The tunnel structure incorporated on the bridge structure will be identical to the one stated above, except the tunnel walls will be cast in-situ reinforced concrete. The tunnel walls will also be designed to withstand the applied loading, due to the green wall proposed by the Environmental Department.

As the tunnel structure passes over the River Torrens, the tunnel ceiling with act as the supporting deck for the shared pedestrian and cyclist footbridge. Therefore the top of the tunnel ceiling will incorporate a non-slip finish, whilst also including the appropriate fixtures, to ensure the shared footbridge will satisfy all required standards. The tunnel ceiling for this

particular section will be designed to withstand the applied loading for a shared pedestrian and cyclist footbridge as specified in AS5100.

5.4 TRAFFIC BARRIER

Traffic barriers are going to be implemented on the grade separation on the southern ramp of the O-Bahn tunnel. This is to prevent the possible occurrence of vehicular traffic entering the designated busway, reducing the possibility of interaction between O-Bahn buses and passenger vehicles. The traffic barriers will be reinforced concrete members, designed to withstand the required loads as specified in AS5100.

6 ENVIRONMENTAL DEPARTMENT

6.1 INTRODUCTION

The Environmental Department will be considering design aspects associated within the vicinity of the O-Bahn bus tunnel which is to be constructed over the River Torrens. The following section outlines in brief detail the core concepts that will be undertaken by the Environmental Department which will be conducted accordingly through close collaboration with all other department. It should be noted that all final design options will be undertaken in accordance with Australian Standards outlined in the E8 Environmental Impact Statement (EIS). AutoCAD drawings will be produced for important items to give a visual representation of what the item will look like.

6.2 GREEN WALL

The main task to be undertaken by the Environmental Department is the design of a modular green wall which will occupy the exterior walls of the bus tunnel crossing the River Torrens. Dimensions of this wall will match specifications of the tunnel supplied by the Structural Department and will extend from start to finish, and top to bottom on both exterior walls of the tunnel. This will ensure an aesthetically appealing alternative to more traditional facades, whilst at the same time giving back to the environment by incorporating native flora to a living piece of art.

6.3 IRRIGATION AND MAINTENANCE

A gravity fed drip irrigation system using recycled water will be incorporated into the green wall design to ensure the wall will receive proper watering and nutrients. The use of an electronic pump from a nearby stormwater catchment reservoir will supply the irrigation system year round. A maintenance platform will be designed to protrude from the bottom edge of each wall, ensuring access for personnel whenever deemed necessary.

6.4 STORMWATER COLLECTION AND RECYCLING

The primary water source for the green wall will be stormwater runoff that will be diverted from both ends of the tunnel through a filtration system and into a treated detention tank. Specifications of the tank will be designed by the Environmental Department, as well as

filtration systems leading into the tank. The location of the tank will be decided upon through collaboration with the Services and Urban Planning Department.

6.5 WATER SENSITIVE URBAN DESIGN

Gross pollutant traps and infiltration trenches will be designed to aid in the treatment of the storm water runoff along Hackney Road. It is proposed that three of each of the WSUD technologies will be incorporated into this project, the locations of which are outlined in the E8 Environmental Impact Statement, section 9.2.2. The presence of these traps and trenches will ensure that storm water runoff is being treated properly before being deposited into the River Torrens, which will in turn reduce pollutants and possible future algal blooms.

6.6 RIPARIAN BUFFER

The location for the riparian buffer will be along the riverbanks of the River Torrens, downstream from the location of the tunnel. The works for this buffer includes researching the types of vegetation that will be the most beneficial for the projects aim. Another is to identify the magnitude of the buffer and to determine the extent of the buffer along the riverbank. This will ensure the buffer to be as economical as possible.

The maintenance schedule may need to be further analysed as it may need to be reduced or increased during different seasons. Furthermore, plans of action may need to be organised for specific weather events such as droughts and floods. Maintenance methodology will need to be designed for. This is to discover which materials and equipment will be needed for this process.

7 URBAN PLANNING DEPARTMENT

7.1 INTRODUCTION

The Urban Planning Department will be working in conjunction with every other department along with the local community to achieve the best aesthetic and practical use of the whole project area. This will be completed by designing different sections of the project area as outlined in the following tasks. The Urban Planning Department will work closely with each of the other departments to produce the most aesthetically pleasing design whilst maintaining its practical use.

7.2 TREE AND VEGETATION MANAGEMENT

Urban Planning's involvement in the management of flora goes beyond the environmental constraints to look at what is the most beneficial outcome for the greater community. The study and associated proposals are particularly required around the Adelaide Parklands due to the heritage and social factors, as well as policies that are summed up in the Adelaide Park Lands Act 2005.

As a result of this, Urban Planning will investigate the flora – trees, shrubs and ground cover – that is required to be replaced due to the works with the O-Bahn development. This will be based around;

- Plant species
- Tree and shrub maturity
- The location of plantings – from the perspective of aesthetics, safety, infrastructure stability, screening, maintenance, etc
- Any associated features that can be incorporated into planting areas
- The provision of alternate water sources for irrigation until plants mature

This will require assessing the current situation and looking into Local Government policies to ensure a positive planning direction. It will also involve communication with other Department such as Environmental, Traffic and Structural.

7.3 EXTERIOR FEATURES OF THE TUNNEL BRIDGE

The exterior of the tunnel will include a green-wall of plants along each side which will be designed by the Environmental Department. The pavement above the tunnel bridge will encompass one bicycle lane in each direction along with a separate walkway. The dimensions of each of these sections of the pavement will be investigated in order to find the design that best suites both cyclists and pedestrians. Using the appropriate guidelines, a speed limit will be determined for cyclists along the bridge.

The wearing course that will be used on the footpath will be designed in conjunction with the hand-railing along the bridge to achieve the optimal aesthetic appeal of the bridge. This can be further enhanced by the lighting along the bridge to ensure the visual appeal of the bridge can be viewed at all times. The bridge requires a name before the opening, this will be decided with help from the state electorates, local councils and also the local community. A plaque will be used to show the name of the bridge along with a small description of the connotation behind the name. The Urban Planning department will make sure all standards have been met when designing these aspects as well as collaborating with other department to achieve the best possible outcome.

7.4 INTERIOR FEATURES OF THE TUNNEL

The storm water management on the inside of the tunnel will be managed by the services department. The aim for the Urban Planning Department will be to enhance the visual appeal of the storm water management. The lighting on the inside of the tunnel will be designed by the services department although the Urban Planning department will have a key role in the design of the lighting due to the visuals on the interior walls of the tunnel. The design of the interior walls will be completed by the Urban Planning Department using input from the local community.

The materials used on the interior of the tunnel are a key part of the aesthetic appeal on the tunnel. These include the materials used for the pavement design, the roof of the tunnel and also services such as ventilation and lighting.

7.5 LAND ACQUISITION

As part of the Urban Planning section of the feasibility study, the land use and management of the surrounding area has been established using several maps. In order for the proposed tunnel to be constructed there may need to be land acquisition of the surrounding area. The Urban Planning department will be investigating if land acquisition is required and if so how difficult and costly it may be.

8 CONCEPT DELIVERY

The sections detailed in this report form the entirety of the detailed design in which E8 Consulting will provide service to our clients in this next project phase. The contents of this paper wll be discussed in a client meeting to be held on the 18th of May, 2017 at the University of South Australia, Mawson Lakes where final details will be decided.