Figure 19.12 Non-Aboriginal heritage items and heritage conservation areas – Map 5

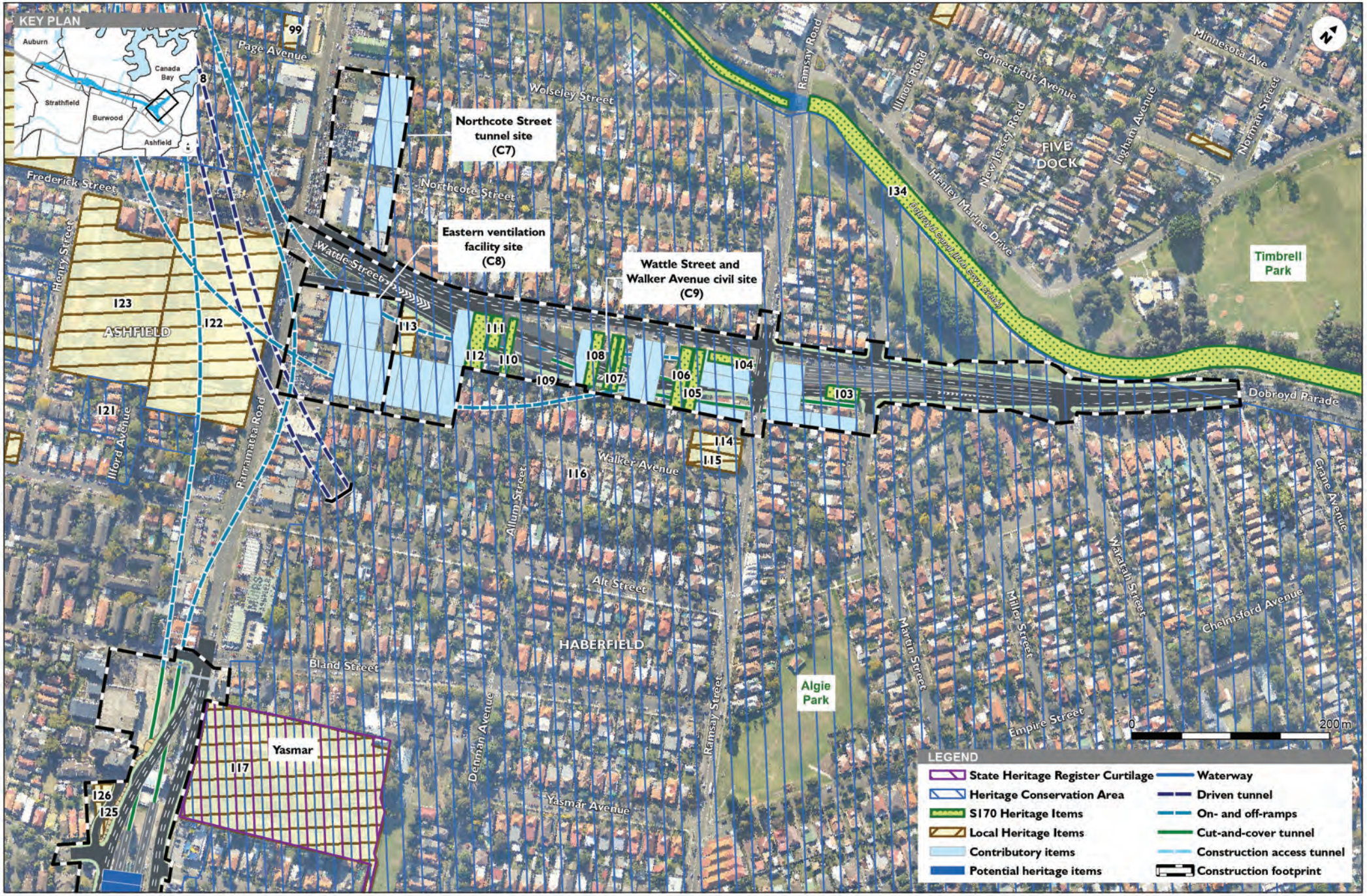

Figure 19.13 Non-Aboriginal heritage items and heritage conservation areas – Map 6

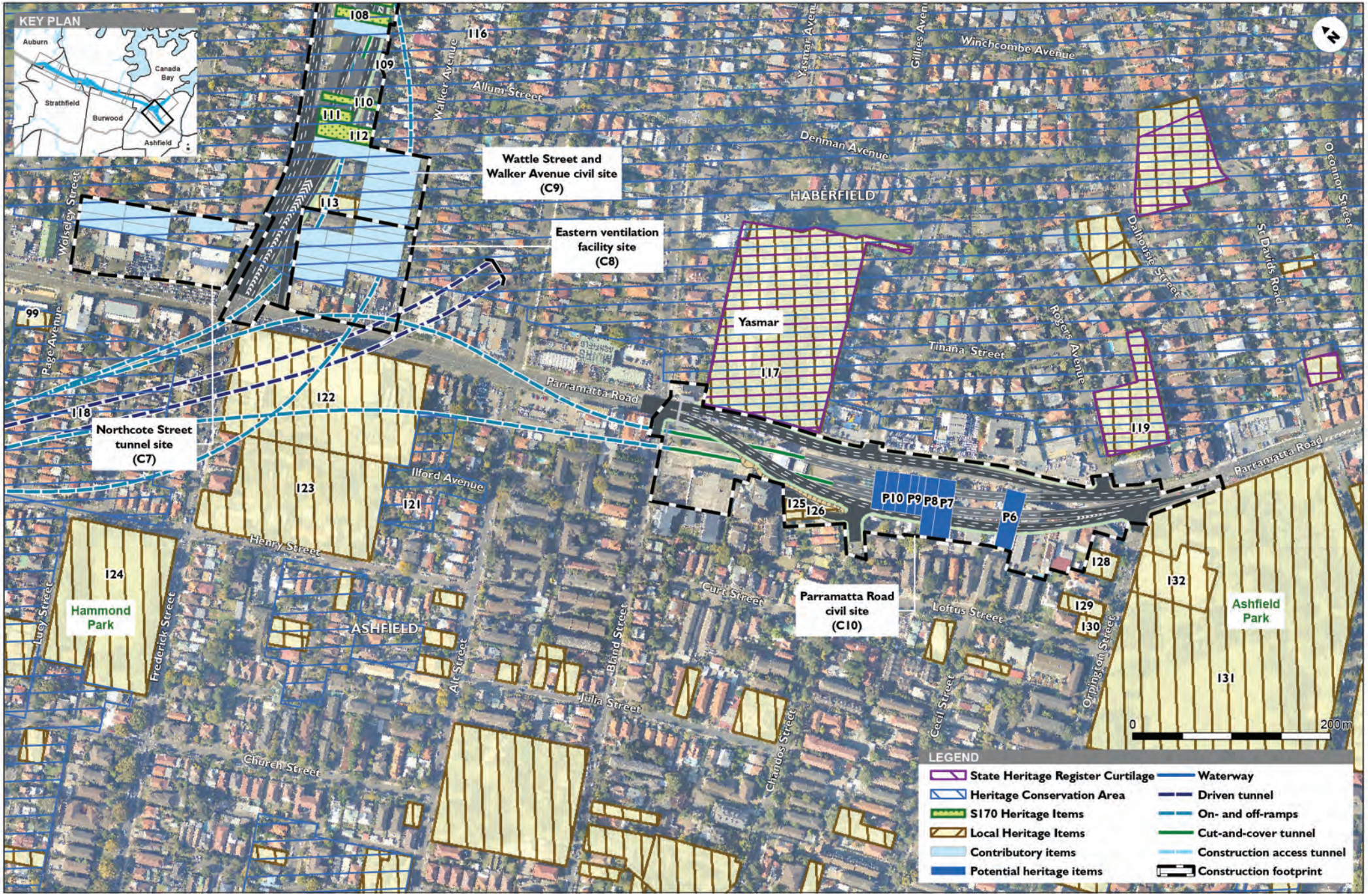

Figure 19.14 Non-Aboriginal heritage items and heritage conservation areas – Map 7

Table 19.9 Heritage items within Area 1 − Homebush

Figure ref.	Item name	Address	Locality	Significance	Listing
3	Wentworth Hotel	195 Parramatta Road	Homebush West	Local	Strathfield LEP 2012 (Item no. I62)
6	Weatherboard cottage & garden	1 Short Street East	Homebush	Local	Strathfield LEP 2012 (Item no. I38)
4	1950s garden, carport and fence	74 Underwood Road	Homebush	Local	Strathfield LEP 2012 (Item no. I51)
16	Shops	16–18 George Street	North Strathfield	Local	Canada Bay LEP 2013 (Item no. I212)
P1	Bungalow	2 Short Street East	Homebush	Potential heritage item	Identified during heritage assessment

Table 19.10 Heritage conservation areas within Area 1 − Homebush

Figure ref.	Item name	Address	Locality	Significance	Listing
1	Welfare Street Heritage Conservation Area, Inter-war bungalow style group	Welfare Street and Flemington Road	Homebush West	Local	Strathfield LEP 2012 (Item no. C6)

Bounded by Welfare Street and Park, Flemington and Parramatta roads, the Welfare Street heritage conservation area is of local significance as it features a homogenous group of bungalow housing dating from circa 1920.

Area 2 − North Strathfield and Concord

Area 2, comprising North Strathfield and Concord, is characterised by a fine-grained pattern of Victorian, Federation and interwar cottages and bungalows, with a number of substantial houses among them. Many of the streets are lined with mature trees, which are identified on the Canada Bay LEP 2013. The Powells Estate heritage conservation area is a rare Victorian era subdivision and development that defines the residential character of the area. The Wesleyan Uniting Church on Concord Road is a large brick interwar building with a substantial bell tower. It is a landmark on the eastern edge of Concord Road. Concord Road and Sydney Street are major arterial roads with direct connections to the existing M4 and Parramatta Road.

There are 14 listed heritage items and one heritage conservation area located within the area that would potentially be directly affected by the project (see **Table 19.11** and **Table 19.12**). The heritage assessment identified a further four houses as potential heritage items (see **Table 19.11**) and six potential contributory items to the heritage conservation area (refer **Appendix S**). The locations of these items are shown in **Figure 19.10**.

Table 19.11 Heritage items within Area 2 − North Strathfield and Concord

Figure Ref.	Item Name	Address	Locality	Significance	Listing
61	House	2 Carrington Street	North Strathfield	Local	Canada Bay LEP 2013 (Item no. I64)
59	House	4 Carrington Street	North Strathfield	Local	Canada Bay LEP 2013 (Item no. I66)
56	House	14 Carrington Street	North Strathfield	Local	Canada Bay LEP 2013 (Item no. I69)
24	House	11 Sydney Street	North Strathfield	Local	Canada Bay LEP 2013 (Item no. I433)
23	House	23 Sydney Street	North Strathfield	Local	Canada Bay LEP 2013 (Item no. I434)

Figure Ref.	Item Name	Address	Locality	Significance	Listing
22	House	33 Sydney Street	North Strathfield	Local	Canada Bay LEP 2013 (Item no. I435)
19	House	35 Sydney Street	North Strathfield	Local	Canada Bay LEP 2013 (Item no. I539)
51	House	64 Concord Road	North Strathfield	Local	Canada Bay LEP 2013 (Item no. I108)
52	House	99 Concord Road	Concord	Local	Canada Bay LEP 2013 (Item no. I100)
21	House & Garden	10 Thornleigh Road	Concord	Local	Canada Bay LEP 2013 (Item no. I461)
53	Wesley Uniting Church and hall	81 Concord Road	North Strathfield	Local	Canada Bay LEP 2013 (Item no. I99)
31	House	123 Patterson Street	Concord	Local	Canada Bay LEP 2013 (Item no. I381)
25	Street trees	Sydney Street	Concord	Local	Canada Bay LEP 2013 (Item no. I431)
47	Street trees	Edward Street	Concord	Local	Canada Bay LEP 2013 (Item no. I182)
P2	House	15 Young Street	North Strathfield	Potential heritage item	Identified during heritage assessment
P3	House	54C Sydney Street	North Strathfield	Potential heritage item	Identified during heritage assessment
P4	House	56 Sydney Street	North Strathfield	Potential heritage item	Identified during heritage assessment
P5	House	71 Concord Road	North Strathfield	Potential heritage item	Identified during heritage assessment

Table 19.12 Heritage conservation areas within Area 2 − North Strathfield and Concord

Figure Ref.	Item Name	Address	Locality	Significance	Listing
18	Powells Estate Heritage Conservation Area	Queen, Carrington & Sydney Street	North Strathfield	Local	Canada Bay LEP 2013 (Item no. CT)

The Powells Estate Heritage Conservation Area is a rare local example of a Victorian period development. A number of the original Victorian homes survive, including some fine villas. The area retains considerable historical significance.

Area 3 − Cintra Park

Cintra Park and St Lukes Park are flanked by interwar residential development to the east and west, with Parramatta Road to the south. Cintra Park is not listed as a heritage item. There are two listed heritage items within Area 3 that would potentially be directly affected by the project (see **Table 19.13**). The locations of these items are shown in **Figure 19.11**.

Table 19.13 Heritage items within Area 3 − Cintra Park

Figure Ref.	Item Name	Address	Locality	Significance	Listing
72	St Luke's Park entrance, gates and trees only	Loftus Street	Concord	Local	Canada Bay LEP 2013 (Item no. I308)
133	Sewage Pumping Station No 22 (SP0022)	84 Gipps Street	Concord	Local	Sydney Water section 170 Register

Area 4 − Haberfield and Ashfield

The entirety of the suburb of Haberfield is listed as a heritage conservation area on the Ashfield LEP 2013. It is Australia's first fully planned and developed garden suburb. The conservation area is highly intact, with the form, materials, scale and setbacks of the predominantly brick federation and interwar period houses and their landscaped gardens, and the suburb's tree-lined streets, providing consistent and aesthetically significant streetscapes. While the high traffic volumes of Wattle Street detract from the pleasant suburban qualities in the western area of the conservation area, the buildings along it remain intact and many are listed as heritage items. The commercial buildings along Parramatta Road provide a buffer between the garden suburb and the high-traffic road.

The area of Ashfield between Chandos and Orpington Streets is characterised by a mix of development, ranging from 1890s terrace houses to contemporary commercial developments, particularly car yards. There is a consistent interwar bungalow streetscape on the western side of Chandos Street, while Orpington Street is defined by Ashfield Park to the east. The Parramatta Road streetscape in this area does not have any heritage items, but features a mix of 1890s terraces and houses, interwar Art Deco flats and car yards.

There are 20 listed heritage items within the area and one heritage conservation area that would potentially be directly affected by the project (see **Table 19.14** and **Table 19.15**). During the heritage assessment, a further nine houses were identified as part of six potential heritage items (see **Table 19.14**) and 24 houses were identified as potential contributory items to the heritage conservation area (refer **Appendix S**). The locations of these items are shown in **Figure 19.13** to **Figure 19.14**.

Table 19.14 Heritage items within Area 4 − Haberfield and Ashfield

Figure Ref.	Item Name	Address	Locality	Significance	Listing
117	Yasmar	185 Parramatta Road	Haberfield	State	State Heritage Register (no. 01379) Ashfield LEP 2013 (Item no. 444)
134	Dobroyd Stormwater Channel No. 53	Iron Cove Creek	Haberfield	Local	Sydney Water S170 Register
113	House	9 Wattle Street	Haberfield	Local	Ashfield LEP 2013 (Item no. 642)
112	House	19 Wattle Street	Haberfield	Local	Roads and Maritime section 170 Register
111	House	21 Wattle Street	Haberfield	Local	Roads and Maritime section 170 Register
110	House	23-25 Wattle Street	Haberfield	Local	Roads and Maritime section 170 Register
109	House	35 Wattle Street	Haberfield	Local	Roads and Maritime section 170 Register
108	House	37-39 Wattle Street	Haberfield	Local	Roads and Maritime section 170 Register
107	House	41-43 Wattle Street	Haberfield	Local	Roads and Maritime section 170 Register

Figure Ref.	Item Name	Address	Locality	Significance	Listing
106	House	51 Wattle Street	Haberfield	Local	Roads and Maritime section 170 Register
105	House 'Bunnia'	53 Wattle Street	Haberfield	Local	Roads and Maritime section 170 Register
104	House	164 Ramsay Street	Haberfield	Local	Roads and Maritime section 170 Register
115	Houses	146-148 Ramsay Street	Haberfield	Local	Ashfield LEP 2013
114	Houses	150-152 Ramsay Street	Haberfield	Local	Ashfield LEP 2013
103	House	46 Martin Street	Haberfield	Local	Roads and Maritime section 170 Register
122	Commercial building (formerly Vita-Weat building/Peek Freans Biscuit Factory)	476 Parramatta Road	Ashfield	Local	Ashfield LEP 2013 (Item no. 273)
125	House	96 Chandos Street	Ashfield	Local	Ashfield LEP 2013 (Item no. 72)
126	House	94 Chandos Street	Ashfield	Local	Ashfield LEP 2013 (Item no. 71)
128	House	86 Orpington Street	Ashfield	Local	Ashfield LEP 2013 (Item no. 248)
129	House	82 Orpington Street	Ashfield	Local	Ashfield LEP 2013 (Item no. 247)
131	Ashfield Park (public reserve)	Parramatta Road, Orpington, Pembroke and Ormond Streets	Ashfield	Local	Ashfield LEP 2013 (Item no. 272)
132	Ashfield Bowling Club	Orpington Street	Ashfield	Local	Ashfield LEP 2013 (Item no. 243)
P6	Semi-detached house	162 Parramatta Road	Ashfield	Potential heritage item	Identified during heritage assessment
P7	House	170 Parramatta Road	Ashfield	Potential heritage item	Identified during heritage assessment
P8	House	172 Parramatta Road	Ashfield	Potential heritage item	Identified during heritage assessment
P9	Pair of Victorian filigree terrace houses	174-176 Parramatta Road	Ashfield	Potential heritage item	Identified during heritage assessment

Figure Ref.	Item Name	Address	Locality	Significance	Listing
P10	Group of interwar flat buildings	178-182 Parramatta Road	Ashfield	Potential heritage item	Identified during heritage assessment

Table 19.15 Heritage conservation areas within Area 4 − Haberfield and Ashfield

Figure Ref.	Item Name	Address	Locality	Significance	Listing
116	Haberfield Heritage Conservation Area	N/A	Haberfield	Local (potential State significance)	Ashfield LEP 2013

The Haberfield Heritage Conservation Area has significance as it is the first successful comprehensively planned and marketed garden suburb in Australia. Designed and developed by real estate entrepreneur and town planning advocate, Richard Stanton, its subdivision layout and tree lined streets, its pattern of separate houses on individual lots (the antithesis of the unhealthy crowded inner suburbs of the period) and its buildings and materials, clearly illustrate his design and estate management principles. Haberfield pre-dates the first garden suburbs in Britain by some five years.

It is significant in the history of town planning in NSW. The separation of land uses, exclusion of industry and hotels, designation of land for community facilities and its comprehensive provision of utility services and pre-development estate landscaping profoundly affected housing trends, state subdivision practice and planning legislation in twentieth century Australia.

It is significant in the history of Australian domestic architecture for its fine ensemble of Federation houses and their fences, and shops, most with their decorative elements intact.

It is outstanding for its collection of modest Federation houses displaying skilful use of materials and a high standard of workmanship of innovative design and detail particularly reflective of the burgeoning naturalistic spirit of the Federation year in which they were built.

The form, materials, scale and setback of buildings and their landscaped gardens fronting tree lined streets together provide mature streetscapes of aesthetic appeal. Haberfield is a major research repository of the Federation era, garden design and plant material, architectural detail, modest house planning, public landscaping and utility provision.

19.3 Assessment of impacts

19.3.1 Historical archaeology

This section provides an assessment of the potential impact on the archaeological resources identified in **section 19.2.1** resulting from surface works associated with construction of the project.

The tables below identify which facility sites or work areas would affect each HAMU.

Area 1 − Homebush

The potential impacts on the archaeological potential of the three HAMUs in Area 1 are summarised in **Table 19.16**.

Table 19.16 Potential impacts on the archaeological potential of Area 1 − Homebush

HAMU	Potential impacts	Impact rating
1 – Homebush Bay Drive to Wentworth Reserve	Excavation associated with the project could be to at least the basal clay across the whole HAMU, and would affect soil horizons that may contain archaeological relics. Service installation, bridge foundations and landscaping would have more localised impacts. The project would be likely to have a minor to moderate adverse impact on the potential historical archaeological resource.	Minor to moderate adverse
2 – Coleman Avenue to Pomeroy Street		

HAMU	Potential impacts	Impact rating
3 – Pomeroy Street to Powells Creek	The Pomeroy Street civil site (C2) would have minor, isolated impacts on archaeology. The Underwood Road civil and tunnel site (C3) and Powells Creek civil site (C4) would be likely to cause greater impacts to the ground surface. Overall, the project would impact on soil horizons which may contain archaeological relics. Service installation, bridge foundations and landscaping would have more localised impacts. Works are likely to have a minor to moderate adverse impact on the potential historical resource.	Minor to moderate adverse

Area 2 − North Strathfield and Concord

The potential impacts on the archaeological potential of the four HAMUs in Area 2 are summarised in **Table 19.17**.

Table 19.17 Potential impacts on the archaeological potential of Area 2 − North Strathfield and Concord

HAMU	Potential impacts	Impact rating
4 – Sydney Street (south) to Parramatta Road	Extensive excavation work is proposed in this HAMU associated with the Concord Road interchange. The project may have a moderate to major adverse impact on the potential historical resource. Work on the M4, including the installation of bridge pylons, would not affect any items of historical archaeology, as these will have been removed during the construction of the existing M4.	Moderate to major adverse
5 – Concord Road south (from Sydney Street to Alexandra Street)	Trenching and surface disturbance works in this HAMU would have an impact on soil horizons that may contain archaeological relics. The works are likely to have a moderate to major adverse impact on the potential historical resource.	Moderate to major adverse
6 – Thornleigh House (former)	The project involves removal of the sandstone gate posts, gates and sandstone flagging on the Thornleigh driveway, and associated excavation and road construction. This would have a major adverse impact on the Thornleigh driveway and sandstone gateposts and gates.	Major adverse
7 – Concord Road north (from Sydney Street to Napier Street)	Widening of Concord Road would impact on soil horizons that may contain archaeological relics. This would be likely to have a moderate adverse impact on the potential historical resource.	Moderate adverse

Area 3 − Cintra Park

The potential impacts on the archaeological potential of the HAMU in Area 3 are summarised in **Table 19.18**.

Table 19.18 Potential impacts on the archaeological potential of Area 3 − Concord Oval

HAMU	Potential impacts	Impact rating
8 – Cintra Park (east of Concord Oval)	This HAMU has historical associations with Longbottom Stockade convicts and convict labour including farming, the most famed of all being the French speaking Canadians exiled for participating in an uprising in Lower Canada. The project has the potential to disturb or destroy the known and potential archaeological resource. This would be likely to have a moderate to major adverse impact, particularly if intact relics associated with the Longbottom Stockade are identified.	Moderate to major adverse

Area 4 − Haberfield and Ashfield

The potential impacts on the archaeological potential of the three HAMUs in Area 4 are summarised in **Table 19.19**:

Table 19.19 Potential impacts on the archaeological potential of Area 4 − Haberfield and Ashfield

HAMU	Potential impacts	Impact rating
9 – Northcote Street tunnel site	The project would impact on soil horizons that may contain archaeological relics. The project would be likely to have a moderate adverse impact on the potential historical resource.	Moderate adverse
10 – Wattle Street interchange	The project would impact on soil horizons that may contain archaeological relics. Service relocation works and landscaping would have localised impacts on the historical archaeological resource, while tunnel excavation impacts would be more extensive. The project would be likely to have a minor to moderate adverse impact on the potential historical archaeological resource.	Minor to moderate adverse
11 – Parramatta Road interchange	Excavation works in this HAMU would affect soil horizons that may contain archaeological relics. The project would be likely to have a moderate adverse impact on the potential historical resource.	Moderate adverse

19.3.2 Heritage items and conservation areas

This section provides an assessment of the potential impact of the project on the heritage significance of the listed heritage items and conservation areas and potential heritage items described in **section 19.2.2**. The assessment assigns an impact type to each item and heritage conservation area – setting, vibration, partial demolition and demolition. Impacts on 'setting' include visual impacts, which are discussed further in **Chapter 13** (Urban design and visual amenity).

Vibration impacts to heritage items would be considered on a case by case basis. Where a historic building is deemed, following inspection, to be sensitive to damage from vibration, a more conservative management approach would be undertaken. Ten heritage listed buildings would be within the area susceptible to vibration impacts for structurally unsound buildings and would be investigated further during detailed design to confirm the likelihood of any impacts. Vibration impacts could potentially result in cosmetic damage. The following sections list the heritage items potentially susceptible to vibration impacts. Impacts from vibration are discussed in full in **Chapter 11** (Noise and vibration) **section 11.32 and 11.4.4**.

Ground movement caused by groundwater drawdown and tunnel-induced movement could also have impacts on heritage items. The groundwater impact assessment for the project (refer **Chapter 18** (Groundwater)) identifies that potential ground movement may result in 'slight' to 'very slight' impacts (cosmetic damage) to buildings above the tunnels.

Area 1 − Homebush

The potential for adverse heritage impacts resulting from the project in Area 1 relates to visual impacts on the setting of listed heritage items and conservation areas from ancillary construction facilities and permanent operational infrastructure. There would be no direct physical impacts on heritage items in Area 1. The continued use of the existing at-grade carpark under the M4 as a carpark would not have an impact on the Bakehouse Quarter (former Arnott's complex), as no works are proposed. The proposed Powells Creek civil site (C4) would be divided from the Bakehouse Quarter by the existing M4 and would also not have any impact on this heritage item.

Table 19.20 describes the impacts on listed heritage items and potential heritage items in Area 1.

Table 19.20 Assessment of impacts on heritage items and potential heritage items in Area 1 − Homebush

Figure ref.	Item name and location	Impact assessment description	Impact type and rating
Listed heritage items			
3	Wentworth Hotel	Construction of the widened Homebush Bay Drive off-ramp would not have a direct impact on the Wentworth Hotel. The existing area of car park and trees between the hotel and the off-ramp would remain, though narrowed. Its historical significance and landmark qualities would not be compromised by the project.	Setting − neutral
6	Weatherboard cottage and garden, 1 Short Street East	The Underwood Road civil and tunnel site (C3) would be located opposite this heritage item, and the western ventilation facility would be located in proximity to this item. The project would have a minor adverse visual impact on this item. The significance of the property as a good example of an early, modest timber cottage would not be affected by the works. The project would also result in the loss of an interwar Californian bungalow at 2 Short Street East opposite, which provides some historical context to the timber cottage.	Setting – minor adverse
4	1950s garden, carport and fence, 74 Underwood Road	The project would not have an impact on the garden, carport and fence at 74 Underwood Road. The significance of the property as a rare Neptune fantasia garden would not be affected by the works.	Setting – neutral
16	Shops 16–18 George Street	The project would have no impact on the shops at 16–18 George Street, as they would be separated visually and physically from the works by the existing M4.	Setting – neutral
Potential heritage items			
P1	Bungalow, 2 Short Street East	This potential heritage item would be demolished to accommodate the Underwood Road civil and tunnel site (C3). The aesthetic and representative significance of the house as a fine example of an interwar bungalow with Arts and Craft style details would be lost as a result of its demolition.	Demolition – major adverse

Table 19.21 describes the impacts on heritage conservation areas in Area 1.

Table 19.21 Assessment of impacts on heritage conservation areas in Area 1 − Homebush

Figure ref.	Item name	Impact assessment description	Impact type and rating
1	Welfare Street heritage conservation area, interwar bungalow style group	The existing separation between the heritage conservation area and the widened Homebush Bay Drive off-ramp would remain, though narrowed. Some existing trees would be removed and new trees would be planted along the widened off-ramp. The Welfare Street heritage conservation areas' representative and aesthetic significance would not be compromised by the project.	Setting – neutral

Area 2 − North Strathfield and Concord

The potential for adverse heritage impacts resulting from the project in Area 2 derives from the demolition of existing heritage items and encroachment on the setting of other heritage items, to accommodate the Concord Road interchange.

Physical impacts would result from the demolition of buildings and removal of significant trees, in addition to possible damage from the effects of vibration, as discussed in **Chapter 11** (Noise and vibration). Visual impacts would arise from the construction ancillary facilities, demolition of heritage items affecting the setting of other items, and the operation of permanent infrastructure such as new tunnel ramps, ancillary facilities and noise barriers.

The proposed cycleway ramp along Queen Street, North Strathfield, from Parramatta Road to the M4 would not have an impact on the railway bridge, an item of local heritage significance and would not obstruct significant views to the bridge.

Table 19.22 describes the impacts on listed heritage items and potential heritage items in Area 2.

Table 19.22 Assessment of impacts on heritage items and potential heritage items in Area 2 − North Strathfield and Concord

Figure Ref.	Item name and location	Impact assessment description	Impact type
Listed heritage items			
61	House, 2 Carrington Street	The Concord Road civil and tunnel site (C5) would be located to the rear of these items. Construction of the project would have a moderate adverse impact on the setting of each house. The demolition of the residential properties along the north side of Sydney Street would have a moderate adverse impact on the setting, affecting views from Carrington Street and the rear lane.	Setting – moderate adverse Potential vibration
56	House, 14 Carrington Street		
59	House, 4 Carrington Street		
24	House, 11 Sydney Street	The significance of these houses as rare examples of Victorian homes in the Canada Bay LGA would be lost through demolition, along with their aesthetic contribution to the Sydney Street streetscape. This would be a major adverse impact on the Powells Estate heritage conservation area, to which these houses are contributory items.	Demolition – major adverse
23	House, 23 Sydney Street		
22	House, 33 Sydney Street	The project would have a moderate adverse impact on the setting of the houses. The Concord Road civil and tunnel site (C5) to the east of the dwellings would be a temporary moderate adverse impact. The demolition of the residential properties on the north and south side of Sydney Street would be a moderate adverse impact on the setting. The demolition of the residential properties in the immediate vicinity would affect the streetscape setting.	Setting – moderate adverse Potential vibration
19	House, 35 Sydney Street		
51	House, 64 Concord Road	The construction of the project would have a major adverse impact as it would result in demolition of the house. The significance of the house as an example of a transitional Victorian/Federation house would be lost, along with its aesthetic contribution to the Concord Road streetscape.	Demolition – major adverse

Figure Ref.	Item name and location	Impact assessment description	Impact type
52	House, 99 Concord Road	The construction of the project would have a minor adverse impact on the setting of the house through the partial loss of the garden. Temporary minor adverse visual impacts would arise from construction along Concord Road. The realignment of Concord Road would result in the encroachment of the roadway on front curtilage of the dwelling. The landscape setting is important in maintaining visual and physical separation of the house from the roadway and the partial loss of this would be minor adverse impact on the heritage values of the property.	Partial demolition (garden) and setting – minor adverse
21	House and garden, 10 Thornleigh Avenue	The construction of the project would have a minor impact on the setting of the house. Temporary minor adverse visual impacts would arise from construction along Concord Road. The widening of Concord Road would encroach onto the property. The landscape setting is important in maintaining visual and physical separation of the house from the roadway. The partial loss of the open landscape setting of the adjacent property would have a minor adverse impact on the heritage values of the property.	Setting – minor adverse
53	Wesley Uniting Church and hall, 81 Concord Road	Construction work in the immediate vicinity of the church and along the primary elevation would have a temporary moderate visual impact. The widening of Concord Road would impact the historical access arrangement through reducing the western and part of the southern curtilage of the heritage item, and the gateposts and sandstone driveway would be removed. These are of historical and aesthetic significance and their removal would have a major adverse impact on the significance of the heritage item. The current landscape setting between the church and Concord Road, including its brick boundary wall, is important in maintaining visual and physical separation between it and the roadway. The permanent loss of the landscape setting would have a moderate adverse impact on the aesthetic value of the item. The demolition of dwellings to the south and west would have a moderate adverse impact on the setting of the church. This residential context, particularly the scale of buildings in the surrounding streetscape, contributes to the significance of the item. The new road infrastructure including noise barriers would have a moderate adverse impact on views of the heritage item from the street, and would reduce its landmark values and contribution to the streetscape.	Partial demolition (gates and grounds)– major adverse Potential vibration
31	House, 123 Patterson Street	Temporary minor adverse visual impacts would arise from construction along Concord Road. The construction of the project would have a minor adverse impact on the setting of the house.	Setting – minor adverse

Figure Ref.	Item name and location	Impact assessment description	Impact type
25	Street trees, Sydney Street	The project would result in the removal of approximately six to eight mature brush box trees that line both sides of the street, east of Concord Road. The removal of trees would have a minor adverse impact on the streetscape. The majority of the street trees along the length of Sydney Street would be retained and therefore there would only be a minor adverse impact on the group.	Partial demolition – minor adverse
47	Street trees, Edward Street	Construction works would result in the removal of approximately 10 mature brush box trees that line both sides of the street. The removal of trees would have a minor adverse impact on the streetscape. The majority of the street trees would be retained and therefore the works would only have a minor adverse impact on the group.	Partial demolition – minor adverse
Potential heritage items			
P2	House, 15 Young Street	This potential heritage item would be demolished to accommodate the Concord Road civil and tunnel site (C4). The aesthetic and representative significance of the house, as an example of a Federation Arts and Craft style house with an unusual decorative pressed metal oriel window apron, would be lost.	Demolition − major adverse
P3	House, 54C Sydney Street	This potential heritage item would be demolished to accommodate the Concord Road civil and tunnel site (C4). The significance of the house, as an unusual example of an interwar bungalow with Arts and Crafts influences, would be lost, along with its aesthetic contribution to the Sydney Street streetscape.	Demolition − major adverse
P4	House, 56 Sydney Street	This potential heritage item would be demolished to accommodate the Concord Road civil and tunnel site (C4). The significance of the house, as an example of a Federation bungalow, would be lost, along with its aesthetic contribution to the Sydney Street streetscape.	Demolition − major adverse
P5	House, 71 Concord Road	This potential heritage item would be demolished to accommodate the Concord Road civil and tunnel site (C4). The significance of the house, as a good intact example of a transitional Federation/interwar bungalow, would be lost.	Demolition − major adverse

Table 19.23 describes the impacts on heritage conservation areas in Area 2.

Table 19.23 Assessment of impacts on heritage conservation areas in Area 2 − North Strathfield and Concord

Figure Ref.	Item name	Impact assessment description	Impact type
18	Powells Estate heritage conservation area	The project is located in the southern section of the Powells Estate heritage conservation area. The project would require demolition of 11 dwellings in the conservation area Of these, 10 dwellings have been identified as being contributory items to the significance of conservation area, and 11 and 23 Sydney Street are also individually listed heritage items of local significance. The project would have a major adverse impact on the heritage significance of the Powells Estate heritage conservation area. It would result in the demolition of a number of aesthetically distinctive and rare Victorian-era houses in the Canada Bay LGA, as well as intact representative examples of Federation and early post-war development in this area. The demolition of these dwellings would impact on the legibility of the original subdivision layout and reduce its integrity. It would diminish the visual coherence of the conservation area and remove buildings and landscapes that contribute to the significant historical and visual context of the remaining conservation area buildings. The works would affect the Sydney Street and Concord Road streetscapes, as these dwellings contribute to the streetscape. The demolition of residential properties on the north side of Station Street would also result in the truncation of Concord Lane, which would have a minor impact on the historical arrangement of this street. The proposed substation at the corner of Sydney Street and Concord Road would further affect the character and setting of the heritage conservation area.	Partial demolition – major adverse

Area 3 − Cintra Park

Heritage impacts resulting from the project in Area 3 arise from use of the car park associated with the Cintra Park tunnel site (C6) at the northern end of Concord Oval. This has the potential to affect significant Moreton Bay fig trees along the Loftus Street boundary of the oval.

Table 19.24 describes the impacts on listed heritage items in Area 3.

Table 19.24 Assessment of impacts on heritage items in Area 3 – Cintra Park

Figure ref.	Item name and location	Impact assessment description	Impact type
72	St Lukes Park entrance, gates and trees, Loftus Street	The project would have a potential moderate adverse impact on the heritage significance of St Lukes Park (Concord Oval) if it results in the removal of any of the historic Moreton Bay fig trees along the oval's Loftus Street boundary. Two of the fig trees within the overflow carpark would potentially be impacted due to work within the car park. Loss of any of these trees would have a moderate adverse impact on the historical and aesthetic significance of St Lukes Park and reduce its contribution to the streetscape. The entry gates would not be affected by the works.	Potential impact on significant trees – moderate adverse

Area 4 − Haberfield and Ashfield

Heritage impacts in Haberfield would be related to the demolition of buildings and gardens. Visual impacts would arise from new motorway infrastructure and the loss or reduction of significant streetscapes. Temporary visual impacts would also result from the establishment of the construction ancillary facility sites. The impact of the project on the heritage significance of the Haberfield heritage conservation area and individual heritage items within it would be major, and could not be effectively mitigated.

In Ashfield, the potential for heritage impacts would arise from the demolition of heritage items and construction of new motorway infrastructure, including dive structures, cut-and-cover tunnels, driven tunnels, noise barriers and construction ancillary facility sites in the vicinity of heritage items. There would also be possible damage from the effects of construction vibration, discussed in **Chapter 11** (Noise and vibration).

Table 19.25 describes the impacts on listed heritage items and potential heritage items in Area 4.

Table 19.25 Assessment of impacts on heritage items and potential heritage items in Area 4 − Haberfield and Ashfield

Figure Ref.	Item name and location	Impact assessment description	Impact type
Listed heritage items			
117	Yasmar, 185 Parramatta Road	During project development, options were considered that would have resulted in major adverse impacts on Yasmar. Due to these impacts, these options were not selected as the preferred option. For the preferred option, the significance of the State-heritage listed house and garden as a rare, intact villa estate along Parramatta Road, and its historically significant access way, would not be affected by the project, as there would be no physical impacts on Yasmar itself or its grounds. However, and tunnel dives proposed in front of Yasmar would increase its separation from the historical road it once faced. The widening of Parramatta Road to accommodation additional traffic lanes and the dive sections of the tunnel and the addition of new landscaping proposed in association with these works has the potential to obscure views of the Yasmar property, its gardens, front fence and entrance gates. These are currently visually prominent landmark elements in the streetscape.	Setting – minor adverse Potential vibration (Parramatta Road section only)
134	Dobroyd Stormwater Channel No. 53	Widening of Dobroyd Parade north of Waratah Street would have a minor adverse impact on Dobroyd Stormwater Channel as it would encroach on the setting of one of the open sections of the channel. The works have the potential to impact on the fabric of the canal, which is reinforced concrete in this section.	Setting – minor adverse
113	House, 9 Wattle Street	The significance of the house, as an example of John Spencer-Stansfield's Design No 1, would be lost through demolition. The realignment of Wattle Street would result in the removal of the curtilage and garden setting. The landscape character of the item contributes to its significance as an intact example of a home and garden within the garden suburb of Haberfield. The loss of this landscape setting would exacerbate the major adverse impact resulting from the item's demolition.	Demolition – major adverse

Figure Ref.	Item name and location	Impact assessment description	Impact type
112	House, 19 Wattle Street	Modern alterations have been made to these items, which have substantially altered their original design. The project would have an adverse impact on these items through demolition. The significance of these items, as part of the Haberfield Conservation Area, would be lost, however their significance has been reduced due to the alterations. The realignment of Wattle Street would result in the removal of the curtilage and garden setting of these items. The loss of this landscape would contribute to the adverse impact of the item's demolition.	Demolition - adverse
111	House, 21 Wattle Street		
110	House, 23-25 Wattle Street	The project would have a major adverse impact on these items through demolition. The significance of these items, as part of the Haberfield Conservation Area, would be lost. The realignment of Wattle Street would result in the removal of the curtilage and garden setting of these items. The loss of this landscape would contribute to the major adverse impact of the item's demolition.	Demolition – major adverse
109	House, 35 Wattle Street		
108	House, 37-39 Wattle Street		
107	House, 41-43 Wattle Street		
106	House, 51 Wattle Street		
105	House 'Bunnia', 53 Wattle Street		
104	House, 164 Ramsay Street		
115	Houses, 146-148 Ramsay Street	Demolition of neighbouring dwellings at 156 to 164 Ramsay Street would disturb the existing rhythm of the semi-detached and freestanding bungalows on the south-western side of Ramsay Street.	Setting – moderate adverse Potential vibration
114	Houses, 150-152 Ramsay Street		
103	Houses, 46 Martin Street	The project would have a major adverse impact on this item through demolition. The significance of the item, as part of the Haberfield Conservation Area, would be lost.	Demolition – major adverse
122	Commercial building	The former Vita-Weat building/Peek Frean Biscuit Factory may be adversely impacted by vibration or settlement due to ground movement resulting from the tunnelling works.	Potential vibration and settlement
125	House, 96 Chandos Street	The project would have a major adverse impact on this item through demolition. This would be a major adverse impact on the Federation-period Chandos Street streetscape.	Demolition – major adverse
126	House, 92-94 Chandos Street	The project would have a major adverse impact on this item through demolition. This would be a major adverse impact on the Federation-period Chandos Street streetscape.	Demolition – major adverse
128	House, 86 Orpington Street	The Parramatta Road civil site (C10) would be located to the rear of this item. There would be a temporary minor visual impact on the property from the Parramatta Road civil site. The project would not have a physical impact on the item.	Setting – minor adverse Potential vibration
129	House, 82 Orpington Street	The project would not have an impact on the heritage significance of the house at 82 Orpington Street.	Setting– neutral

Figure Ref.	Item name and location	Impact assessment description	Impact type
131	Ashfield Park (public reserve)	During project development, options were considered that would have resulted in major adverse impacts on Ashfield Park. Due to these impacts, these options were not selected as the preferred option. The project would not directly impact on Ashfield Park. It would be retained with no works proposed within its boundaries. The heritage significance of the park would therefore not be impacted by the project. The project would result in a minor change to the setting of the area on views from the park to the west, as the realignment of Parramatta Road and the dive into the proposed tunnels would be clearly visible and the introduction of street tree planting along both sides of Parramatta Road.. Much of the project infrastructure would not be visible from within the park due to the topography of the Parramatta Road. The proposed street trees would be visible however this would be beneficial to the character of the park.	Setting – minor adverse
132	Ashfield Bowling Club	The project would not directly impact Ashfield Bowling Club as no works are proposed within its boundaries. The heritage significance of the club, which is historical and social, would not be impacted by the project.	Setting – neutral
Potential heritage items			
P6	House, 162 Parramatta Road	The historical, representative and aesthetic significance of these houses would be lost, along with their contribution to the Parramatta Road streetscape. The demolition would also result in the loss of rare examples of late-nineteenth century residential development along Parramatta Road in the Ashfield LGA.	Demolition – major adverse
P7	House, 170 Parramatta Road		
P8	House, 172 Parramatta Road		
P9	Pair of Victorian filigree terrace houses, 174-176 Parramatta Road	The historical, representative and aesthetic significance of the pair of terrace houses would be lost. The demolition would also result in the loss of a rare example of late-nineteenth century residential development along Parramatta Road in the Ashfield LGA.	Demolition – major adverse
P10	Group of interwar flat buildings, 178-182 Parramatta Road	The historical, representative and aesthetic significance of the flat buildings would be lost, along with the contribution they make to the often unattractive Parramatta Road streetscape.	Demolition – major adverse

Table 19.26 describes the impacts on heritage conservation areas in Area 4.

Table 19.26 Assessment of impacts on heritage conservation areas in Area 4 – Haberfield and Ashfield

Figure Ref.	Item name	Impact assessment description	Impact type
116	Haberfield Conservation Area	The project would require the demolition of 53 dwellings within the Haberfield Conservation Area. Of these, 29 have been identified as contributory. Two of the suburb's intact tree-lined streets would also be affected. All of these elements contribute to the heritage values of the conservation area. These impacts would be localised around Wattle Street; however, the demolition of this number of individually listed and contributory items would result in a major adverse impact on the heritage significance of the Haberfield Conservation Area. The project would affect the legibility of the original layout and would effectively fragment the suburb, with the area north of Wattle Street separated from the remainder of the conservation area. This fragmentation may also have an impact on the social significance of the Haberfield Conservation Area, particularly for the residents who live north of Wattle Street, who would be visually and spatially separated from the remainder of the suburb by the project. The project would result in a change in the visual character of the conservation area, with a high visual impact. The project would have an impact on the streetscapes where properties are proposed to be demolished, and would disturb the existing rhythm of the semi-detached and freestanding houses. The properties to be retained along Walker Avenue would lose an important part of their setting through the loss of the houses and gardens behind them (along Wattle Street). The repetition and rhythm of brick Federation houses with terracotta or slate roofs set in verdant gardens is important in defining the Haberfield Conservation Area. The demolition of residential properties on the east side of Wattle Street for the development of the interchange would also result in the truncation of Allum Street, which would have a minor impact on the historical arrangement of this street. There would be moderate adverse impacts on the aesthetic values of the conservation area with the construction of new infrastructure elements, which would not be sympathetic to the existing built environment or landscape character. The ventilation facility would be out of character with the conservation area. Noise barriers (up to five metres high along the south-eastern side of Wattle Street) would be visible over the back fences of the retained properties along Walker Street and would have an adverse impact on their setting. The removal of some back fences along Walker Avenue would result in minor adverse impacts through the loss of a small area of landscape setting.	Partial demolition – major adverse

19.4 Management of impacts

Environmental mitigation and management measures relating to non-Aboriginal heritage, pre-construction, during construction and operation are provided in **Table 19.27**. These include general measures for non-Aboriginal heritage, measures to avoid significant impacts, where feasible and reasonable, specific mitigation for individual heritage items and where relevant, an evaluation of the effectiveness of the mitigation/management measure. These measures have considered the policy and guidance listed in section 19.1.2.

The project would predominantly impact on potential historical archaeological resources with local heritage significance. Locally significant archaeological resources, while still important, are able to be managed in a greater variety of ways and are less likely to require any redesign of the project to avoid or mitigate proposed impacts, depending on the extent, nature and intactness of the resource found.

The identified level of significance for areas of archaeological potential will influence the degree of impact that may be acceptable or the level of investigation and recording that may be required. Consequently, the management guidelines and recommendations have been formulated in accordance with the heritage significance of the potential archaeological resources. For this project, archaeological test excavation would not alter the outcome of the assessment in terms of identifying previously unknown and unassessed archaeological relics, and is not recommended at this stage.

The mitigation measures for known and potential historical archaeological resources set out below are designed to mitigate the heritage impact on these resources to the extent possible within the project area. The anticipated levels of effectiveness for the mitigation measures proposed are set out below:

- Highly effective – this mitigation measure would effectively completely mitigate the impact on the item/area's heritage significance
- Moderately effective – this mitigation measure would substantially mitigate the impact on the item/area's heritage significance, however the impact would not be mitigated completely
- Somewhat effective – this mitigation measure would only partially mitigate the impact on the item/area's heritage significance
- Least effective – this mitigation measure would be of minimal effect in mitigating the impact on the item/area's heritage significance.

Potential vibration impacts in the context of heritage items would be managed in accordance with the recommendations in **Chapter 11** (Noise and vibration). Heritage advice would be sought if proposed architectural treatments would have the potential to impact on the heritage significance of a property. Appropriate monitoring and protection of the physical fabric of heritage items to be retained would be provided during construction of the project. Potential settlement impacts would be managed in accordance with the recommendations in **Chapter 18** (Groundwater) (highly effective).

Table 19.27 Environmental management measures – non-Aboriginal heritage

Impact	No.	Environmental mitigation and management measure	Responsibility	Timing
Detailed design	NAH1	Where practical, heritage specialists (built and landscape heritage and historical archaeology) and urban designers will provide input into the detailed design and documentation phase to assist in identifying opportunities to enhance the conservation options for heritage items and archaeological sites and ensure adverse impacts are avoided or minimised. This will include, but not be limited to, the alignment and design of noise barriers to avoid or minimise impacts on heritage items. (moderately effective).	Construction contractor	Pre-construction

Impact	No.	Environmental mitigation and management measure	Responsibility	Timing
	NAH2	New structures will be of a high quality, sympathetic design to minimise visual impacts on the setting of heritage buildings and landscapes taking into account a range of design considerations. (somewhat effective).	Construction contractor	Pre-construction
	NAH3	As part of the construction heritage management plan, an overarching historical archaeological research design will be prepared prior to commencement of construction. It will describe clear significance thresholds to possible archaeological items that may be uncovered during works and designate when monitoring, testing and/or salvage and excavation should occur in relation to the project works and timing. Post-excavation reporting, including artefact analysis and additional historical research (where necessary), would be required for any historical archaeological investigations undertaken. (moderately effective).	Construction contractor	Pre-construction
General	NAH4	A construction heritage management plan would be prepared prior to construction detailing how construction impacts on heritage will be minimised and managed including training and induction processes for construction personnel. Inductions are to cover built heritage, landscape and historical archaeological sites and their management, and provide heritage guidance on how to avoid/manage impacts. The induction would be prepared in consultation with a suitably qualified heritage specialist and historical archaeologist (highly effective).	Construction contractor	Pre-construction
	NAH5	Impacts to built heritage, heritage landscapes and historical archaeological sites, will to the greatest extent practicable, be avoided and minimised. Where impacts are unavoidable, works shall be undertaken in accordance with the strategy outlined in the construction heritage management plan. (moderately effective).	Construction contractor	Pre-construction and construction

Impact	No.	Environmental mitigation and management measure	Responsibility	Timing
	NAH6	The Roads and Maritime *Standard Management Procedure—Unexpected Heritage Items* (2015) will be applied in the event any unanticipated archaeological remains are discovered during the project. The procedure covers identification of heritage items and archaeological sites; recording and reporting on items including guidelines for photography; key environmental contacts; and procedural information for example on uncovering human remains. (moderately effective) If human remains were discovered during any phase of works associated with the project, works will cease immediately in the surrounding area. The findings will be reported immediately to the NSW Coroner's Office and/or the NSW Police. (moderately effective).	Construction contractor	Construction
Impacts on heritage items – general	NAH7	An Interpretation Plan will be developed and implemented for the project, in accordance with the NSW Heritage Division guidelines. The Interpretation Plan will focus on the Powells Estate heritage conservation area, Thornleigh House gates and driveway, Longbottom Stockade (Concord Oval) and the Haberfield Conservation Area, and will include interpretive initiatives in new public reserves and walkways. Artefacts and archaeological remains will be considered for their interpretative value when identified or recovered by excavation. (somewhat effective).	Construction contractor	Pre-construction
	NAH8	Photographic recording would be undertaken of heritage items, contributory items, groups/streetscapes comprising combinations of heritage items and contributory items, and potential heritage items that would be directly impacted by the project. The recording methodology would be generally in accordance with the NSW Heritage Office guidelines *Photographic Recording of Heritage Items Using Film or Digital Capture* (2006b), but the detail of the recording required would be determined by the significance of the items/groups/streetscapes (least effective).	Construction contractor	Pre-construction and construction
	NAH9	During demolition, where practical, recycle elements of heritage fabric from items of heritage significance using recycling agents. (least effective).	Construction contractor	Construction

Impact	No.	Environmental mitigation and management measure	Responsibility	Timing
Impacts on archaeology - general	NAH10	Where required by the historical archaeological research design and prior to the commencement of pre-construction and/or construction activities that will impact historical archaeological sites identified in the EIS, an archaeological excavation program in accordance with the *Heritage Council of NSW Archaeological Assessment Guidelines* (1996). This work will be undertaken by an appropriately qualified archaeological consultant (moderately effective).	Construction contractor	Pre-construction and construction
	NAH11	Mitigation methodologies for the management of impacts on known and potential significant historical archaeological resources will be further developed at the detailed design stage, once key ground disturbance impacts have been finalised (in terms of exact depth, width, extent and type of impact). This would ensure that the archaeological mitigation strategies are streamlined and reduced in scope to target the key areas of unavoidable impact on significant archaeological resources (moderately effective).	Construction contractor	Pre-construction
	NAH12	All archaeological mitigation measures including archaeological monitoring, testing and/or salvage excavation, as required, would be undertaken in accordance with standards and processes stipulated by the NSW Heritage Division, Office of Environment and Heritage with respect to the archaeological resource (moderately effective).	Construction contractor	Pre-construction and construction
	NAH13	The construction heritage management plan would include detailed procedures/ strategies for the conservation and curation of any historical artefacts recovered during works (moderately effective).	Construction contractor	Pre-construction and construction

Impact	No.	Environmental mitigation and management measure	Responsibility	Timing
State-significant archaeology	NAH14	In the event that historical archaeological relics of State significance are identified (eg HAMU 8), they will be managed in accordance with the following measures: • An excavation director who meets the NSW Heritage Branch requirements for directing State significant archaeological investigations must monitor the works • In situ retention of the archaeological resource may be required, unless it is highly disturbed and/or of a fragmentary nature—or if the impacts are assessed by the excavation director to be minor in nature • A work method statement or historical archaeological research design will be prepared by a qualified historical archaeologist in accordance with Heritage Division requirements, prior to the commencement of works. This will outline a methodology for the investigation, salvage and/or conservation of archaeological resources • Where required, an archaeological excavation program will be implemented in accordance with the *Heritage Council of NSW Archaeological Assessments Guideline* (1996). This work will be undertaken by an appropriately qualified archaeological consultant • The NSW Heritage Division and Roads and Maritime must be notified when intact State significant relics are discovered • Public engagement such as media releases, public open days during the works program, and/or post-works heritage interpretation may be warranted • If relics are found, post-excavation reporting, artefact analysis and conservation of relics. (moderately effective). In the event that State significant historical archaeology remains are identified within Cintra Park (HAMU 8) rearrangement of elements within the site compound will be considered and other conservation measures applied as necessary. Ground works in the existing carpark north of Concord Oval would be avoided (highly effective).	Construction contractor	Construction

Impact	No.	Environmental mitigation and management measure	Responsibility	Timing
Locally significant archaeology	NAH15	In the event that historical archaeological relics of local significance are identified, they will be managed in accordance with the following measures: • A work method statement or heritage archaeological research design will be prepared by a qualified historical archaeologist in accordance with Heritage Division requirements, prior to the commencement of works. The Work Method Statement or Archaeological Research Design will outline a methodology for the investigation, monitoring and/or salvage of archaeological resources • Archaeological monitoring will be led by a suitably qualified Excavation Director for the works. Monitoring will be followed by open-area excavation as required. This will depend on the nature, extent and integrity of the archaeological resource to be impacted, and the level of impact proposed • Where required, an archaeological excavation program will be implemented in accordance with the *Heritage Council of NSW Archaeological Assessments Guideline* (1996). This work will be undertaken by an appropriately qualified archaeological consultant • If unexpected State significant relics were to be discovered, such relics may need to be managed in accordance with State significant requirements as listed above. The Excavation Director should determine if the unexpected relics are likely to be reassessed as State significant, and then determine appropriate mitigation • The NSW Heritage Division and Roads and Maritime are to be notified if intact State significant relics are discovered • Public engagement, such as heritage interpretation and/or public open days may be warranted, depending on the nature and significance of the archaeological resource • If relics are found, post-excavation reporting, artefact analysis and conservation (moderately effective).	Construction contractor	Construction

Impact	No.	Environmental mitigation and management measure	Responsibility	Timing
Welfare Street Conservation Area	NAH16	Where feasible and reasonable, a vegetated buffer will be retained between the conservation area and the widened M4 off-ramps to Homebush Bay Drive (highly effective).	Construction contractor	Pre-construction and construction
Powells Estate Conservation Area, North Strathfield	NAH17	Where feasible, the size and form of the proposed distribution substation to be located near the corner of Sydney Street and Concord Road will be designed to be as recessive as possible and incorporate sensitive landscaping treatment to reduce permanent visual impacts on the remaining portion of Powells Estate Conservation Area (somewhat effective).	Construction contractor	Pre-construction and construction
House, 99 Concord Road, Concord	NAH18	The front garden and fence will be re-established on completion of construction works (highly effective).	Construction contractor	Construction
House and garden, 10 Thornleigh Road, Concord	NAH19	A landscape buffer will be established between the house and the widened Concord Road (highly effective).	Construction contractor	Pre-construction and construction
Wesley Uniting Church and hall, Concord	NAH20	Subject to agreement with the landowner, the church grounds, entrance gates and boundary fence will be re-established along the new Concord Road boundary (moderately effective).	Construction contractor	Pre-construction and construction
	NAH21	A photographic archival recording of the entrance gates with measured drawings will be undertaken before construction, to assist with their relocation. The sandstone cobble driveway will be included in the recording (moderately effective).	Construction contractor	Pre-construction and construction
	NAH22	The condition of the church and tower and its vulnerability to construction vibration will be confirmed prior to works commencing, and appropriate strategies will be implemented to avoid or minimise impacts if required. This will include, as a minimum, vibration monitoring (highly effective).	Construction contractor	Pre-construction and construction
Street trees: Sydney Street, Concord and Edward Street, Concord	NAH23	Where feasible and reasonable, the detailed design and construction stages will seek to maximise the number of trees retained (highly effective).	Construction contractor	Pre-construction
	NAH24	Significant trees in the vicinity of the project along Sydney Street and Edward Street will be protected during construction works, on the advice of a suitably qualified and experienced arborist (highly effective).	Construction contractor	Construction
	NAH25	New trees planted at the western end of Sydney Street will be brush box or a similar, sympathetic species (highly effective).	Construction contractor	Construction

Impact	No.	Environmental mitigation and management measure	Responsibility	Timing
St Luke's Park gateway/entrance − gates and trees only, Concord	NAH26	If feasible, the Moreton Bay fig trees along the Loftus Street boundary of Concord Oval, within the car park, will be retained and protected during construction works, in accordance with the advice of a suitably qualified and experienced arborist (highly effective).	Construction contractor	Pre-construction and construction
Haberfield Heritage Conservation Area	NAH27	The vents and motorway facilities would be sited as close as possible to Parramatta Road to minimise their intrusion into the conservation area. An orientation that is more consistent with the Haberfield built form and subdivision would also be investigated. Where feasible, the proposed ventilation outlet and motorway facilities will be as recessive as feasible and reasonable to reduce permanent visual impacts on the Haberfield Conservation Area. They will be of high-quality design and materials (somewhat effective).	Construction contractor	Pre-construction
	NAH28	The urban design and landscape plan will include planting strategies for the impacted area of the Haberfield Heritage Conservation Area to guide the landscaping along the project, around the ventilation facility and motorway facilities and along streets. The planting strategies would be developed with a view to complementing the existing historic streetscape plantings where relevant, with particular focus on Martin Street, Walker Avenue and Northcote Streets (moderately effective).	Construction contractor	Pre-construction and construction
	NAH29	The photographic archival recording of the affected areas of the Haberfield Conservation Area will include the streetscapes affected by the demolition of individual buildings (least effective).	Construction contractor	Pre-construction and construction
Yasmar, Parramatta Road, Haberfield	NAH30	The urban design and landscape plan would ensure views to the front gates and landmark Moreton Bay figs within Yasmar's mature garden are not obscured (highly effective).	Construction contractor	Pre-construction and construction
	NAH31	If required, the front entrance gates and mature trees along Yasmar's front (Parramatta Road) boundary will be protected during construction works (highly effective).	Construction contractor	Pre-construction and construction
	NAH32	If impacted by construction works, the access way from Parramatta Road into Yasmar would be re-instated (highly effective).	Construction contractor	Pre-construction and construction
	NAH33	Significant trees in the vicinity of the project will be protected during construction works (highly effective).	Construction contractor	Pre-construction and construction

Impact	No.	Environmental mitigation and management measure	Responsibility	Timing
Dobroyd Stormwater Channel No. 53, Haberfield	NAH34	The fabric of the channel would be protected during construction works on the advice of a suitably qualified civil engineer (highly effective).	Construction contractor	Pre-construction and construction

20 Biodiversity

This chapter provides a summary of the biodiversity impacts associated with the M4 East project (the project). A detailed biodiversity assessment has been undertaken for the project and is included in **Appendix T**.

The Secretary of the NSW Department of Planning and Environment (DP&E) has issued a set of environmental assessment requirements for the project; these are referred to as Secretary's Environmental Assessment Requirements (SEARs). **Table 20.1** sets out these requirements as they relate to biodiversity and identifies where they have been addressed in this environmental impact statement (EIS).

Table 20.1 Secretary's Environmental Assessment Requirements – biodiversity

Secretary's Environmental Assessment Requirement	Where addressed in the EIS
Biodiversity – including, but not limited to: An assessment of the potential ecological impacts of the project, with specific reference to vegetation and habitat clearing, connectivity, edge effects, weed dispersal, riparian and aquatic habitat impacts and soil and water quality impacts. The assessment must:	**Section 20.3** and **20.4**
• Make specific reference to impacts on threatened species and endangered ecological communities,	**Sections 20.3.1**, **20.3.2** and **20.4**
• Have reference to the *Draft Guidelines for Threatened Species Assessment* (Department of Environment and Conservation (DEC)/Department of Primary Industries (DPI) 2005), *Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities* (DEC 2004), *Guidelines for Aquatic Habitat Management and Fish Conservation* (DPI 1999) and any relevant draft or final recovery plans.	**Section 20.1.1** and Section 4.1 of the Biodiversity Assessment in **Appendix T**. Please note that due to no potential impacts on aquatic habitat or fish passage as a result of the Project (refer to **Section 20.3.1**), reference to the *Guidelines for Aquatic Habitat Management and Fish Conservation* (DPI 1999) was not required.
• Include details of any offset measures that may be required, including demonstration that the measures are consistent with the *Principles for the use of biodiversity offsets in NSW* (Department of Environment, Climate Change and Water (DECCW) 2008).	**Section 20.6**
Note: The Department encourages you to undertake this assessment in accordance with the *Framework for Biodiversity Assessment* (OEH 2014a) and the *NSW Biodiversity Offsets Policy for Major Projects* (OEH 2014b).	**Section 20.1.5** and Section 4.1 of the Biodiversity Assessment in **Appendix T**.
Soil and Water – including, but not limited to: • Consideration of waterways likely to be affected by the project, including existing riparian vegetation and rehabilitation of riparian land	Waterways likely to be affected by the project – **Chapter 15** (Soil and water quality) Impacts on riparian vegetation – **section 20.3.1**.

20.1 Assessment methodology

20.1.1 Overview

The key components of the biodiversity assessment were:

- Desktop assessment to describe the existing environment and landscape features of the study area (ie the project footprint and surrounding areas which could be impacted by the project (generally within 150 metres of the project)) and to identify threatened biota potentially affected by the project
- Field surveys to describe the biodiversity values of the construction footprint (refer to **Figure 20.1** to **Figure 20.5**) and to determine the likelihood of threatened biota and their habitats occurring in the project footprint or being affected by the project
- Assessment of potential impacts of the project on threatened biota and biodiversity values.

A summary of the tasks undertaken can be found in **sections 20.1.2** to **20.1.4**, while a detailed description of the methods for the assessment can be found in section 4.2 of **Appendix T**.

20.1.2 Desktop assessment

A desktop review was undertaken to identify threatened species, populations and ecological communities listed under the *Threatened Species Conservation Act 1995* (NSW) (TSC Act) and *Fisheries Management Act 1994* (NSW) (FM Act), as well as matters of national environmental significance (MNES) listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EBPC Act). The desktop review included a review of the following databases:

- NSW Office of Environment and Heritage (OEH) Atlas of NSW Wildlife (OEH 2014a)
- DPI online Protected Species Viewer for record of threatened aquatic species listed under the EPBC Act (DPI 2014)
- MNES Protected Matters Search Tool (Australian Government Department of the Environment) 2014a)
- OEH Threatened Species Profiles Database (Australian Government Department of the Environment 2014b)
- Australian Government Department of the Environment online Species Profiles and Threats database (DotE 2014c).

A number of documents were also reviewed to assist with identifying biodiversity values within the study area. These documents included:

- Mason Park Plan of Management (Parkland Environmental Planners et al. 2008). Report prepared for Strathfield Council
- Upper Duck River Wetlands and Riparian Plan of Management (Applied Ecology 2012). Report prepared for Parramatta Council
- Native Vegetation of the Cumberland Plain Map 8 of 16 (NSW National Parks and Wildlife Service 2002a)
- Interpretation Guidelines for the Native Vegetation of the Cumberland Plain, Western Sydney (NSW National Parks and Wildlife Service 2002b)
- The native vegetation of the Sydney metropolitan area (OEH 2013)
- Policy and guidelines for fish habitat conservation and management (DPI 2013)
- Powells Creek Masterplan (Clouston Associates 2008)
- Aerial photography of the study area.

20.1.3 Likelihood of occurrence assessment

Based on the results of the desktop assessment outlined in **section 20.1.2**, an assessment was undertaken to determine how likely a particular species is to occur within the study area based on existing information. A likelihood ranking was then assigned to each species, according to whether the species was 'known', 'likely', 'possible', 'unlikely' or 'absent'. These rankings are described in detail in Table 4.1 of the Biodiversity Assessment in **Appendix T**.

20.1.4 Field surveys

Field surveys were undertaken on 12 February 2014, while nocturnal surveys were undertaken on 27 February 2014. Two additional surveys were also undertaken on 12 March and 26 June 2015 to investigate areas not covered by the previous surveys.

Due to the highly modified nature of the project footprint, the field survey only focused on areas which were identified as potentially having value to more mobile threatened species. This generally involved surveying areas containing vegetation (however did not include detailed survey of vegetation on private property) (refer **Figure 20.1** to **Figure 20.5**). Regardless of the above, all areas within the construction footprint were considered during the desktop assessment.

Flora surveys were undertaken throughout the study area, targeting areas where the project would involve the removal of planted vegetation, as well as any downstream wetland habitat areas. Surveys focused on the identification of dominant flora species and any potential habitat for threatened flora.

The presence of habitat suitable for fauna species was determined by assessing the type and quality of habitat present within the study area. Habitat quality was based on the level of breeding, nesting, feeding and roosting resources available.

A search of the study area was undertaken to identify key habitat features, such as hollow-bearing trees, feed trees for the Grey-headed Flying-fox (*Pteropus poliocephalus*) and watercourses. This included inspection of areas of planted trees that would potentially be habitat for fauna.

Wetlands within Mason Park, to the north of the project near Powells Creek, were inspected with any species present recorded. The underside of bridges over Saleyards and Iron Cove creeks were also inspected to confirm the presence of bat roosting sites.

Anabat call detectors were also placed within the study area on two separate days:

- Two detectors on 27 February 2014 at the M4 near Ismay Avenue and at Saleyards Creek at Homebush
- One detector on 18 May 2014 within the Yasmar Estate on Parramatta Road at Haberfield.

Spotlighting for nocturnal fauna, including the Grey-headed Flying-fox, was carried out in areas around the anabat detector locations. Opportunistic observations of fauna species were recorded at all times during field surveys.

Due to the modified nature of the project footprint, targeted fauna surveys (such as trapping) were not undertaken, with the focus of the assessment being on the presence of habitat for highly mobile species such as the Grey-headed Flying-fox. Due to the short duration of surveys, it is possible that seasonal species were not identified. Where species are considered unlikely to be present because of the time of the year, the habitat assessment was considered a useful guide to the species that may occur within the project footprint or its surrounds at other times of the year.

20.1.5 Legislation and policy framework

Table 20.2 Legislation and policy framework

Legislation	Relevance to project
TSC Act	The TSC Act provides for listing of 'threatened species, populations and ecological communities', 'Key Threatening Processes', and the preparation and implementation of Recovery Plans and Threat Abatement Plans. As detailed in **section 20.3**, the project is not expected to have a significant impact on any species or communities listed under the TSC Act.
FM Act	The object of the FM Act to conserve, develop and share the fishery resources of the State. It provides for listing of 'threatened species, populations and ecological communities', 'Key Threatening Processes', and the preparation and implementation of Recovery Plans and Threat Abatement Plans. Sections 201, 205 and 219 of the FM Act require permits to be obtained for dredging or reclamation work (includes any excavation in a waterway), harming marine vegetation and blocking of fish passage respectively. A permit would not be required under section 201 as the project is being undertaken by a public authority (ie NSW Roads and Maritime Services (Roads and Maritime)). Permits under sections 205 and 219 would not be required as works would not impact marine vegetation or block fish passage.
Native Vegetation Act 2003 (NSW) (NV Act)	The NV Act regulates clearing of remnant native vegetation or vegetation regrowth. The Act is intended to protect and promote the conservation of native vegetation, but excludes National Park, State Forest and urban areas. The project footprint does not include any naturally occurring native vegetation that meets the definition in the NV Act.
Noxious Weeds Act 1993 (NSW) (NW Act)	The NW Act provides for the declaration of noxious weeds. Noxious weeds may be considered noxious on a national, State, regional or local scale. All private landowners, occupiers, public authorities and councils are required to control noxious weeds on their land under Part 3 Division 1 of the NW Act. Impacts in relation to weeds are discussed in **section 20.3.2**.
EPBC Act	Under the EPBC Act, an action includes a project, undertaking, development, activity, series of activities or alteration. An action that 'has, will have or is likely to have a significant impact on a matter of national environmental significance' is a 'controlled action' and may not be undertaken without approval from the Australian Government Minister for the Environment. The project would not have a significant impact upon any Matters of National Environmental Significance.

Policies and guidelines

The biodiversity assessment has been prepared to assess the impacts of the project on biodiversity values in accordance with the *Draft Guidelines for Threatened Species Assessment* (DEC/DPI 2005). Field surveys were undertaken in accordance with *Threatened Biodiversity Survey and Assessment Guidelines for Developments and Activities* (DEC 2004).

The biodiversity assessment was not prepared in accordance with the *Framework for Biodiversity Assessment* (OEH 2014a) and *NSW Biodiversity Offsets Policy for Major Projects* (OEH 2014b). These policies were released after the issue of the original Director General's requirements (7 January 2014) and were encouraged to be used in the revised SEARs (16 June 2015). Prior to the release of these policies, the majority of the ecological surveys and associated assessments required by DEC/DPI (2005) had already been undertaken. In addition, as discussed in **section 20.2.1**, no native vegetation communities are present within the project footprint and therefore cannot be entered into the Framework for Biodiversity Assessment.

The use of the Framework for Biodiversity Assessment was not considered for the Grey-headed Flying-fox. This species is required to be assessed as a 'species credit species' under the Framework for Biodiversity Assessment where breeding habitat is present. The project footprint does not include any breeding or roosting habitat for this species, and as such this species is not considered a species credit species for the purpose of this project. All vegetation is planted and there are no plant community types identified in the NSW native vegetation database in the project footprint. Therefore no ecosystem credits can be calculated for impacts on foraging habitat for this species.

The project therefore does not include any impacts that require further consideration by a consent authority, impacts for which the assessor is required to determine an offset, or impacts that require further assessment in accordance with the key thresholds for assessing and offsetting impacts contained in the Framework for Biodiversity Assessment.

The project would not result in any impacts on aquatic habitat or fish passages and the *Guidelines for Aquatic Habitat Management and Fish Conservation* (DPI 1999) were not considered as part of the assessment.

20.2 Existing environment

20.2.1 Vegetation communities

Desktop

The desktop survey identified 23 threatened ecological communities listed under the TSC Act and 12 threatened ecological communities listed under the EPBC Act, which have been recorded within a 10 kilometre radius of the project footprint. Cumberland Plain vegetation mapping (National Parks and Wildlife Service (NPWS) 2002a) does not identify any native or threatened vegetation communities within the project footprint. No native vegetation is mapped within the project footprint by NPWS (2002a), Tozer (2010) or OEH (2013).

Field surveys

Planted vegetation within the footprint is found in patches and comprises private gardens, landscaped parks, reserves and strips of vegetation predominantly used as screening from major infrastructure.

These areas were identified as planted (rather than regrowth or remnant vegetation according to the NV Act). Vegetation in the project footprint cannot be assigned to any intact native remnant vegetation or plant community types identified in the NSW Native vegetation database (OEH 2014c).Vegetation within the project footprint and wider study area is also highly fragmented as a result of past development. This means that any vegetation (which is all planted) has limited connectivity between patches. Vegetation within the project footprint may be used for mobile fauna species as 'stepping stones' to move across the urban landscape.

Threatened ecological communities that would have existed in the area have been removed or modified by historical clearing for development. Coastal Saltmarsh, an endangered ecological community (EEC) under the TSC Act, is located downstream of the project footprint at the Mason Park wetland. Characteristic species of a number of threatened ecological communities (TECs) occur in isolation or in small areas within the project area; however, there are no characteristic understorey or groundcover species present.

In the absence of intact native vegetation, the following vegetation types were identified during the assessment:

- Planted/landscaped screening vegetation: This vegetation type is located along the M4 and has primarily been planted to provide a visual screen between the roadway and the adjacent properties. Vegetation consists of a mixture of species, with some canopy species (such as eucalypts) located along the road corridor. Understorey in areas with a canopy storey is either absent or dominated by exotic herbaceous annuals or climbers.
- Private gardens: This vegetation type is located throughout much of the study area in residential properties and comprise common native, exotic and cultivar species. These gardens typically have mown lawns, with hedges and scattered small shrubs or trees

- Grassland with scattered trees: Vegetation consisting of grassland with scattered trees within the project footprint generally consists of canopy species within mown lawn areas. Such areas include Ismay Reserve, Reg Coady Reserve, Concord Oval, Cintra Park, Jegorow Reserve, Bill Boyce Reserve, Wentworth Reserve and Ashfield Park. Some of these reserves include some vegetation that is also identified as screening vegetation.

Planted/landscaped screening vegetation and grassland with scattered trees is mapped in **Figure 20.1** to **Figure 20.5**.

Conservation significance

No TECs are present within the project footprint. One EEC listed under the TSC Act, Coastal Saltmarsh, is present downstream of the project footprint within the Mason Park wetland. This community is also listed as a vulnerable community (VC) under the EPBC Act. The project is not expected to have an impact on these wetlands, as there is limited hydrological connection between Powells Creek (only likely during flood periods), which is adjacent to the wetland but in a concrete channel at a lower level.

20.2.2 Flora species and populations

Desktop

The Atlas of NSW Wildlife database identified 28 threatened flora species and four flora populations which have been recorded within 10 kilometres of the project footprint in the past 20 years. There are 21 threatened flora species listed under the EPBC Act that are predicted to potentially occur within a 10 kilometre radius of the project footprint.

Field surveys

A total of 83 flora species were recorded within the study area. Because of access issues, this number does not include all species located within private properties. Where possible, classification of species on these private properties was undertaken from public areas. Trees and shrubs of the Myrtaceae family (17 species) were the most abundant, followed by five grass species of the Poaceae family and three shrub species of the Proteaceae family.

One threatened species, the Wallangarra White Gum (*Eucalyptus scoparia*), was identified within Reg Coady Reserve with the construction footprint and would be removed. Discussion about the significance of this species is included below under the conservation significance heading.

Conservation significance

No threatened flora species native to the area were recorded or are considered likely to occur within the project footprint or its surrounds. One threatened species was identified within the project footprint (Wallangarra White Gum (*Eucalyptus scoparia*)) and one has the potential to be within the project footprint (Magenta Lilli Pilly (*Syzygium paniculatum*)). Both species are listed under both the TSC Act and EPBC Act.

The presence of the Wallangarra White Gum within the project footprint is considered to be well outside its natural range of northern NSW and southern Queensland. The removal of one planted specimen from a recreation reserve in inner Sydney would not threaten the persistence of the species in the wild. The presence of the Magenta Lilli Pilly is also considered to be outside its natural range and is a very common species used in landscaping in Sydney. For the above reasons both of these specimens are not considered to be threatened species for the purpose of this assessment.

Two threatened species listed under the TSC Act have been recorded within the Mason Park wetland and/or wetlands at Sydney Olympic Park:

- Narrow-leafed Wilsonia (*Wilsonia backhousei*), listed as a vulnerable species
- *Zannichellia palustris*, listed as an endangered species.

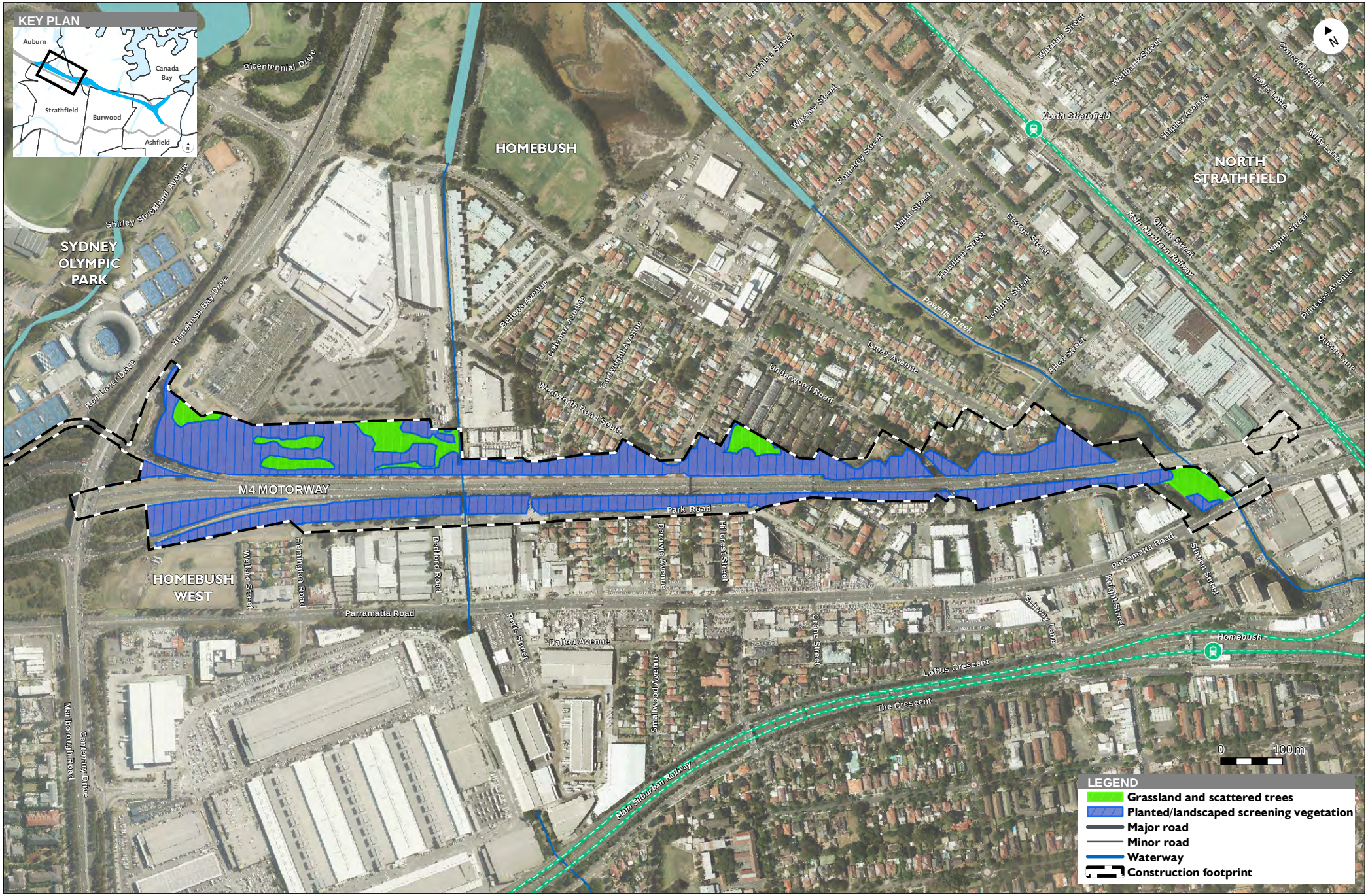

Figure 20.1 Vegetation types to be removed - Map 1 (Homebush)

Figure 20.2 Vegetation types to be removed - Map 2 (North Strathfield)

Figure 20.3 Vegetation types to be removed - Map 3 (Cintra Park)

Figure 20.4 Vegetation types to be removed - Map 4 (Haberfield)

Figure 20.5 Vegetation types to be removed - Map 5 (Ashfield)

20.2.3 Fauna species and populations

Desktop

The Atlas of NSW Wildlife database identified 46 threatened fauna species and two threatened fauna populations that have been recorded within 10 kilometres of the project footprint in the past 20 years. Fifty-one threatened fauna species listed under the EPBC Act are predicted to potentially occur within a 10 kilometre radius of the project footprint. A number of the abovementioned species are pelagic or marine species (eg albatrosses and whales) and therefore have been excluded from further consideration as part of the assessment.

Three threatened aquatic species listed under the FM Act have been previously recorded within 10 kilometres of the project footprint. Two aquatic species listed under the EPBC Act were also identified.

Field surveys

The project footprint and the adjacent areas contain limited habitat value for native fauna species, with the exception of highly mobile species typical of urban areas. A total of 26 fauna species were identified during the field surveys. These comprised mainly birds (23 species), although one mammal and two reptile species were also recorded.

The Grey-headed Flying-fox, which is listed as threatened under both the TSC Act and EPBC Act, is considered to be present within the area because individuals were heard calling during nocturnal surveys and one dead individual was identified on power lines within the project footprint, at Wentworth Road near Pomeroy Street.

Microbats have potentially been recorded during anabat surveys; however, identification of species was not feasible due to the low number of calls and poor recording quality.

The following fauna habitat types were identified as part of the field surveys:

- Cleared land: the majority of the project footprint consists of hardstand areas, including roads, pavements and buildings. These areas have negligible habitat value for native fauna and are used by common species
- Planted trees and gardens: parkland and gardens within the project footprint provide some habitat resources for native fauna. No hollow-bearing trees were identified during the field surveys; however, trees have the potential to provide nesting and shelter habitat for common birds and possums. Foraging habitat is located throughout the project footprint, and common species were seen using this habitat. The Grey-headed Flying-fox is likely to forage throughout planted trees, particularly when eucalypts are in flower and figs and palms are in fruit. Microbats may also frequent these areas for foraging; however, limited roosting areas were found. The endangered population of the Long-nosed Bandicoot (*Perameles nasuta*) covers the study area, but no sighting of this species has occurred in the vicinity of the project
- Wetlands: the Mason Park wetland is located to the north of the project and just to the east of Homebush Bay Drive. These wetlands are important habitat for migratory wetland birds. The wetlands are not hydrologically connected to Powells Creek, except during flood periods or very high tides (eg king tides). The wetland is currently experiencing low water levels and poor water quality, which have resulted in a reduction in the number of species using the wetland. This habitat has the potential to be used by a number of TSC Act and EPBC Act listed species, including the Black-tailed Godwit (*Limosa limosa*) and Little Tern (*Sterna albifrons*), both of which have been recorded, and a number of other species that may occur on occasion. Habitat for the Green and Golden Bell Frog (*Litoria aurea*) is located 500 metres to the north of the project within Sydney Olympic Park; however, there would be no direct or indirect impacts on these areas

- Creeks and canals: four creek lines are located within the study area. These are Saleyards Creek and Powells Creek which flow to Homebush Bay, St Lukes Park Canal in Concord which flows to Canada Bay, and Dobroyd Canal (Iron Cove Creek) in Five Dock which flows to Iron Cove. These creeks have all been channelised and are therefore highly modified environments with limited value as a riparian corridor. Some downstream sections of Powells Creek have increase value as riparian corridors. All the above creek lines only have planted vegetation within their riparian corridors, with no trailing vegetation or emergent aquatic vegetation present within the canals. Planted vegetation does provide some riparian connectivity for mobile fauna species, however in the vicinity of the project this is limited due to minimal vegetation. There are no natural creek banks within these canals and planted vegetation within the riparian corridors does not contribute to bank stability.

  Water quality with the creeks is largely influenced by stormwater, aquatic weeds and erosion from upstream. Sewer overflows, particularly during high rainfall events, also influence water quality in these catchments, providing additional sources of nitrogen, phosphorus, suspended solids and faecal coliforms. Water and sediment quality within the Parramatta River estuary is also generally poor, largely due to polluted stormwater runoff in these and other canals. The habitat value for fish present in these is limited due to the land of exposed roots and woody debris. Some small common fish may forage in the canals on occasion, however threatened species are not likely. No bat species have been identified within these canals or the associated bridges; however, some threatened bat species may forage in these areas. They are not likely to roost or breed in these areas due to a lack of suitable habitat. The locations of these watercourses are shown on Figure 15.2 in **Chapter 15** (Soil and water quality).

Conservation significance

One threatened fauna species, the Grey-headed Flying-fox, was recorded in the study area. This species would forage in planted trees within the study area and broader locality when suitable trees are in fruit or flower. No breeding camps were located within the project footprint.

Two threatened microbat species may occur in the study area:

- Eastern Bentwing Bat (*Miniopterus schreibersii oceanensis*)
- Large-footed Myotis (*Myotis macropus*).

These species are known to roost under bridges and in culverts and could roost temporarily under bridges in the study area. The Eastern Bentwing Bat is known to forage in urban areas, and the Large-footed Myotis may forage along canals in the study area.

Three threatened wetland birds have been recorded or are likely to occur in the Mason Park wetland, located about one kilometre to the north of the project (downstream). These are the Curlew Sandpiper (*Calidris ferruginea),* Black-tailed Godwit (*Limosa limosa*) and Little Tern (*Sterna albifrons*). The listing of each of these species under the TSC Act and EPBC Act is outlined in **Table 20.4** in **section 20.3.1**. In addition, an endangered population of the White-fronted Chat (*Epthianura albifrons*) is known to occur in the area. No other threatened wetland species known or predicted to occur in the locality has been recorded within the Mason Park wetland.

No key fish habitat defined within *Policy and guidelines for fish habitat conservation and management* (DPI 2013) was identified within the project footprint.

20.2.4 Migratory species

Desktop

Seventy-six migratory species (or their habitats) listed under the EPBC Act are predicted to occur within 10 kilometres of the project footprint, including:

- 18 migratory marine birds
- 33 migratory wetland species
- seven migratory terrestrial species
- 17 migratory marine species (excluding birds).

An additional six species not identified by the Protected Matters search tool were identified on the Atlas of NSW Wildlife database.

In the past 20 years five migratory marine bird species, 27 migratory wetland bird species and six migratory terrestrial species have been recorded within 10 kilometres of the project footprint. A number of migratory species use the Mason Park wetland, which is located about one kilometre to the north of the project footprint. The project would be upstream of the wetland and would involve works in the vicinity of Powells and Saleyards creeks, which both flow towards the wetland. However, the project is not expected to have any direct impact on the wetland. Indirect impacts on the wetland are discussed in **section 20.3.2**.

Conservation significance

Migratory marine species

The project would not have any direct or indirect impacts on marine environments, and therefore migratory marine species and the majority of the migratory marine bird species (eg albatrosses) previously recorded or predicted to occur in the locality are not considered relevant to the assessment.

Migratory species likely to occur in the project footprint

No migratory terrestrial or wetland species are likely to occur within the project footprint, given the lack of native vegetation and natural wetlands, the restricted nature of planted trees and shrubs, and generally highly modified environment in surrounding areas.

Migratory species known or likely to occur at Mason Park wetland

Up to 30 migratory wetland bird species could occur in the Mason Park wetland, which is located about one kilometre downstream of the project. Of these, at least 20 have been recorded at the wetland previously (Department of the Environment 2014).

A full list of these species can be found in **Table 5.2** in the Biodiversity Assessment in **Appendix T**.

20.3 Assessment of construction impacts

20.3.1 Direct impacts

Loss of native vegetation

The project would only impact on highly modified areas, which provide limited habitat for biodiversity values. Any potential impacts are further reduced because the majority of the project would be within a tunnel, resulting in minimal disturbance of biodiversity values present.

Impacts on threatened ecological communities

The project would not result in the loss of any TECs or naturally occurring plant community types.

One TEC (listed under both the TSC Act and EPBC Act), Coastal Saltmarsh, occurs downstream of the study area. The project has the potential to indirectly affect the Coastal Saltmarsh, as there is limited hydrological interaction between Powells Creek and the Mason Park wetland during very high tides and at times of flood. Given the potential for indirect impact, a precautionary assessment was conducted of the likely significance of impacts on Coastal Saltmarsh (and two other threatened species discussed below) and is presented in **Appendix T**. Given that this community would not be directly affected, and that indirect impacts on wetland habitat are unlikely, it is unlikely that the project would have a significant impact on this community.

Impacts on threatened flora

The project would not involve the removal of any naturally occurring threatened flora species listed under the TSC Act or EPBC Act. The project would have an impact on two threatened species; however, as they are not naturally occurring in the area, these were not considered in the assessment as threatened.

Two threatened flora species are present within the Mason Park wetland and the adjacent wetlands within Sydney Olympic Park. The project is not expected to affect these wetlands, as there is limited hydrological connection between Powells Creek. **Table 20.3** provides a summary of the results of the significance assessments undertaken for these species. Further details of the significance assessments are provided in **Appendix T**.

Table 20.3 Threatened flora within the biodiversity study area

Species	Potential for impact	Likely significant impact
Wilsonia backhousei TSC Act – Vulnerable	Low. Potential for indirect impacts from changes to water quality in Powells Creek and Mason Park wetland if not mitigated.	No
Zannichellia palustris TSC Act – Endangered	Low. Potential for indirect impacts from changes to water quality in Powells Creek and Mason Park wetland if not mitigated.	No

Impacts on riparian vegetation

No natural creek lines occur in the study area; all creeks occur as concrete canals. Sydney Water Corporation proposes to naturalise the banks of Powells Creek in the future, although this is unlikely to occur prior to the construction of this project. Any construction works in the vicinity of canals would involve the construction of culverts or bridges similar to those currently present. No canals would be realigned. There would be no impact on fish passage or large woody debris.

Some limited planted riparian vegetation is present above the concrete-sided canals. This planted vegetation does not contribute to the health of the canals as it is located above the concrete edges.

Some planted vegetation would be removed from adjacent to Saleyards Creek where it is crossed by the M4 and from the Powells Creek civil site adjacent to Powells Creek. There would be very limited clearing of planted trees from the Cintra Park civil site adjacent to St Lukes Park canal and from Reg Coady Reserve adjacent to Dobroyd Canal. There would be no direct impact as a result of the project at or near Barnwell Park Canal.

The limited removal of planted vegetation at these locations would have a negligible impact on the ecological value of riparian corridors, given that this vegetation is planted above the concrete sides of the canals and does not contribute to the health of water quality of the creeks. The loss of small areas of vegetation at Saleyards Creek and Powells Creek would not impact the movement of mobile fauna along the riparian corridor.

Loss of planted vegetation

The project would result in the loss of about 15.7 hectares of vegetation, comprising about 12.9 hectares of planted trees and screening vegetation (mainly along the M4), and about 2.8 hectares of grassland with scattered trees (eg Cintra Park and Reg Coady Reserve).

Scattered trees located within private gardens and some street trees would also be removed, this vegetation is not included in the above calculations. Impacts would be focused along the M4 corridor (including Bill Boyce Reserve); however, impacts would also be experienced at the Concord Road and Wattle Street interchanges,at the Cintra Park and Powells Creek on-ramp construction ancillary facilities.

The location of the vegetation to be removed is shown on **Figure 20.1** to **Figure 20.5**. It is noted that vegetation within private land has not been mapped. All vegetation within the project footprint (including on private land) is assumed to be removed, however where possible, existing vegetation would be retained or impacts would be limited to trimming.

Impacts on fauna and fauna habitat

The clearance of planted vegetation as a result of the project would reduce the amount of foraging and shelter habitat for common species such as birds and possums. The removal of planted vegetation would result in minimal fragmentation (ie loss in connectivity between vegetation), given the already fragmented state of vegetation.

The project would result in the removal of about 12.9 hectares of planted trees and screening vegetation which may provide foraging resources for the threatened Grey-headed Flying-fox. These planted trees do not constitute habitat critical to the survival of the Grey-headed Flying-fox. The project would not result in the removal of any roosting or breeding habitat for this species and would also not isolate any potentially foraging habitat. The project would not affect the movement of the Grey-headed Flying-fox in the area.

Construction of the project near existing culverts would potentially temporarily disrupt the roosting habitat of the Large-footed Myotis and the Eastern Bentwing Bat if these bat species are using these features as temporary roost sites. There is no breeding habitat for these species in the study area. Following construction, these species could continue to roost in culverts within the study area. There would be no impact on foraging habitat for the Large-footed Myotis. 15.7 hectares of potential foraging resources for the Eastern Bentwing Bat would be removed. The project would not affect the movements of these species between foraging areas and breeding sites.

The project would not have an impact on wetland habitat at Mason Park, and would not result in any fragmentation of habitat for migratory wetland species. The project would not affect the movements of any wetland birds between foraging areas and breeding sites.

The project may result in the mortality of small, common fauna that are resident in vegetation to be removed, such as skinks in leaf litter and common nesting birds. Mortality of threatened fauna is unlikely, given that no threatened species would be resident in habitats to be removed. The project would not remove any hollow-bearing trees or other roost sites for bats, any roosts or camps for the Grey-headed Flying-fox or any habitat for migratory birds or other wetland birds.

Impacts on threatened fauna

Seven threatened fauna species have the potential to occur within the biodiversity study area. **Table 20.4** provides a summary of the results of the significance assessments undertaken for these species. Further details of the significance assessments are provided in **Appendix T**.

Table 20.4 Threatened fauna within the biodiversity study area

Species	Potential for impact	Likely significant impact
Grey-headed Flying-fox (*Pteropus poliocephalus*) TSC Act and EPBC Act – Vulnerable	Low. Project would remove a small area of planted trees that may be used for foraging when flowering or fruiting.	No
Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*) TSC Act – Vulnerable	Low. Project would remove a small area of planted vegetation that may be used for foraging habitat on occasion. The project may temporarily disturb potential artificial roosting sites. No evidence of roosting bats was observed during the survey.	No
Large-footed Myotis (*Myotis macropus*) TSC Act – Vulnerable	Low. The project may temporarily disturb potential artificial roosting sites. No evidence of roosting bats was observed during the survey.	No
Black-tailed Godwit (*Limosa limosa*) TSC Act – Vulnerable EPBC Act – Migratory	Low. Potential for indirect impacts from changes to water quality in Powells Creek and Mason Park wetland if not mitigated.	No
Curlew Sandpiper (*Callidris ferruginea*) TSC Act – Endangered EPBC Act – Critically endangered and migratory	Low. Potential for indirect impacts from changes to water quality in Powells Creek and Mason Park wetland if not mitigated.	No
Little Tern (*Sterna albifrons*) TSC Act – Endangered EPBC Act – Migratory	Low. Potential for indirect impacts from changes to water quality in Powells Creek and Mason Park wetland if not mitigated.	No

Species	Potential for impact	Likely significant impact
White-fronted Chat (*Epthianura albifrons*) TSC Act – Vulnerable and endangered population	Low. Potential for indirect impacts from changes to water quality in Powells Creek and Mason Park wetland if not mitigated.	No

Impacts on migratory species

No migratory species are expected to occur in the project footprint given the absence of suitable habitat. A total of 30 migratory species are either known to occur, or have been assessed as likely to occur, within the wider study area.

Assessments of significance have been prepared for all migratory species that would potentially be indirectly affected by the project because of to the presence of the Mason Park wetland to the north of the project.

The project is unlikely to have a significant impact on migratory wetland birds for the following reasons:

- No important habitat for migratory birds would be directly affected
- There would be no direct mortality of birds as a result of the project
- Indirect impacts on wetland habitat are unlikely, given the distance of the wetland from the project, and the limited hydrological interaction between the wetland and Powells Creek
- The project is unlikely to disrupt the breeding cycle of an ecologically significant proportion of the population of any migratory species
- The project is unlikely to lead to degradation or increased disturbance of habitat at Mason Park wetland such that there would be a substantial reduction in migratory shorebirds using the wetland, this is largely due the wetlands not being directly connected to the Mason Park wetland except during periods of flood or very high tides.

Aquatic habitats and riparian corridors

The project would not result in any impacts on any natural watercourses, since all watercourses within the project footprint consist of concrete lined channels. The project would not result in modification to any watercourses. The project would not affect fish passage or large woody debris which provides fish habitat. For this reason consideration of *Guidelines for Aquatic Habitat Management and Fish Conservation* (DPI 1999) was not required.

The widening of the M4 would further increase the existing gap in the planted riparian vegetation. Some planted vegetation would be removed from adjacent to Saleyards Creek where the M4 crossing is located and from the Powells Creek civil site. There would be very limited clearing of planted trees from the Cintra Park civil site adjacent to St Lukes Park canal and from Reg Coady Reserve adjacent to Iron Cove Creek Canal. No planted vegetation would be removed from Barnwell Park Canal.

The limited removal of planted vegetation at these locations would have a negligible impact on the ecological value of riparian corridors, given that this vegetation is planted above the concrete sides of the canals and does not contribute to the health of water quality of the creeks. The loss of small areas of vegetation at Saleyards Creek and Powells Creek would not impact the movement of mobile fauna along the riparian corridor.

20.3.2 Indirect impacts

Edge effects are described as an ecological impact at two or more interfacing habitat types. Removal of vegetation causes a number of new environmental conditions to develop along the edges of the cleared environments. This can include some of the impacts which are outlined below. The likelihood of edge effects are considered to be minimal as most vegetation within the project footprint would be removed, and given the lack of connectivity or any other large patches of vegetation in the vicinity, there would be no new edges created.

Erosion and sedimentation

Poor management of topsoil can result in erosion and sedimentation, which in turn can have impacts on biodiversity. The erosion of topsoil could result in the following impacts:

- Deposition of sediment into adjacent native vegetation or freshwater creek could cause weed infestation and stifle plant growth
- Reduced water quality within adjacent watercourse could have an adverse impact on aquatic life
- Deposition of sediment into downstream areas such as the Mason Park wetland, particularly during large rainfall events, represents a potential impact but is considered to be minimal due to the limited hydrological connections between the Mason Park wetland and Powells Creek. Such a connection is only considered likely during flood periods or king tides.

Canals within the footprint currently already have poor water quality as a result of stormwater run-off, which has resulting in high levels of sediment being present. This is reflected by poor water quality within the Parramatta River estuary which is down stream of the canals.

Proposed works in riparian areas and removal of vegetation associated with the construction of the project have the potential to reduce soil stability (eg along Saleyards Creek). As described in **Chapter 15** (Soil and water quality), combined with the high erosive potential of runoff passing through the waterway crossings, there is the potential for the release of large sediment loads into the downstream receiving environment, particularly during significant rainfall events.

Mitigation measures outlined in **Chapter 15** (Soil and water quality) would be implemented to minimise the risk of erosion and sedimentation during construction of the project.

Groundwater impacts

No groundwater dependent ecosystems are present within or immediately adjacent to the project footprint. Coastal Saltmarsh located in the Mason Park wetland is mainly reliant on seawater, but is also likely to be somewhat reliant on groundwater for ecological processes. Mason Park wetland is located about 500 metres north of the project footprint. There would be no tunnelling under or in the immediate vicinity of the wetland. As such, the project is unlikely to impact any groundwater dependent ecosystems. Further assessment of the impact on groundwater dependent ecosystems is provided in **Chapter 18** (Groundwater).

Pollution

The project has the potential to pollute waterways as a result of chemical spills from construction. All creeks in the study area are located in canals, and have no natural aquatic habitat. Canals in the project footprint currently have poor water quality as a result of stormwater runoff. High levels of heavy metals, faecal matter and other nutrients are present. Pollution could potentially impact wetland bird habitats downstream at the Mason Park wetlands. Given the limited hydrological relationship between the wetland and the creek, the project poses a limited risk of indirect impacts from pollution at the wetland.

Mitigation measures outlined in **Chapter 15** (Soil and water quality) would be implemented to minimise incidents and the risk of pollution entering watercourses during construction of the project.

Weeds

The project has the potential to facilitate the spread of weeds into cleared and planted areas in the absence of effective weed control measures. Given the lack of native vegetation communities in the study area, and the presence of many environmental weeds in the study area, the potential impact of this is negligible. Watercourses could potentially transport weed propagules from the project to downstream areas. Mitigation measures to be implemented during the construction and operational phases of the project include strategies for the management and control of noxious and environmental weeds.

Pathogens

The infectious disease *chytridiomycosis*, caused by the chytrid fungus, is known to affect Green and Golden Bell Frog populations in NSW. There is a risk of this disease being introduced or spread on machinery, clothing and in soil/fill during construction of the project. Given that there is no hydrological link between the project and habitat areas for the Green and Golden Bell Frog, the transfer of chytrid fungus as a result of the project is highly unlikely.

Light and noise

The project is located in a highly modified environment which is also heavily affected by light and noise impacts. The construction of the project is not considered to result in any substantial increase of light and noise impacts.

Impacts on relevant key threatening processes

The project has the potential to contribute to 'key threatening processes' as defined in the TSC and EPBC Acts in relation to threatened species, communities, populations and their habitats, as summarised in **Table 20.5**. These impacts would be reduced through the implementation of mitigations in **section 20.6** and in **Chapter 15** (Soil and water quality).

Table 20.5 Key threatening processes of relevance to the proposal

KTP	Status	Comment
Clearing of native vegetation	TSC Act EPBC Act	No naturally occurring stands of native vegetation are located in the study area. The project would remove planted trees and landscaped gardens only.
Clearing of hollow-bearing trees	TSC Act	No trees with suitable hollows for birds or mammals are likely to be removed by the project.
Removal of dead wood and dead trees	TSC Act	The project footprint generally contained very little fallen timber at the time of the field survey, with few occurrences of terrestrial woody debris. The project may result in the removal or disturbance of the small amount of fallen timber or woody debris that does occur within the project footprint.
The degradation of native riparian vegetation along NSW water courses	FM Act	Unlikely. There are no natural watercourses located in the project footprint. Construction activities could have indirect impacts on riparian vegetation downstream of the study area.
Human-caused climate change	TSC Act EPBC Act	Combustion of fuels associated with construction and operation of the project would contribute to anthropogenic emissions of greenhouse gases. The project does not pass through any areas mapped as coastal corridors for climate change that provide for the latitudinal movement of species. The increase in greenhouse gases as a result of the project may affect climatic habitat elsewhere in NSW over the long term.
Invasion of plant communities by perennial exotic grasses	TSC Act	Exotic perennial grasses are already established throughout the study area, including around the Mason Park wetland. There is negligible risk of weeds being spread to native vegetation as a result of the project. Weed management and control would be undertaken in accordance with the *Biodiversity Guidelines* (RTA 2011) to minimise the risk of spread of weeds.

20.4 Assessment of operational impacts

Threatened and migratory species listed under the TSC Act or EPBC Act that may occur in the study area are unlikely to be affected by the operation of the road. There would be little change in the existing level of risk associated with vehicle strike and/or habitat modification (eg weed spread, light and noise) as a result of the project.

The proposed Powells Creek on-ramp would encroach on Powells Creek between Parramatta Road and the M4. Planted trees at this location currently comprise exotic trees over a groundcover of introduced grasses which have limited biodiversity value. These exotic trees would be removed to allow construction of the proposed on-ramp. Given the lack of native species and the presence of the concrete canal, removal of this vegetation would have negligible impact on the riparian corridor at this location.

Sydney Water is proposing to naturalise Powells Creek in the future which has the potential to improve the riparian habitat along the creek corridor in the longer term. In addition Strathfield Council has a masterplan to develop the land adjacent to Powells Creek between Parramatta Road and the M4 as public open space. Consultation would be undertaken with Sydney Water and the Strathfield Council to ensure that an appropriate landscaping treatment is agreed upon adjacent to the proposed on-ramp along this section of the creek.

A permanent water quality basin is proposed at the motorway operations complex immediately to the west of Saleyards Creek. The water quality basin is to be setback from the boundary of the creek and should be designed to avoid any impact on the creek corridor. The setback area along this boundary should be appropriately landscaped.

The increase in impervious area from the above ground sections of the project would result in an increase in the quantity of stormwater flows into the canals during operation. This in turn could result in increased pollutants entering the watercourses. It is expected that these impacts would be relatively minor as the surface component of the project would not differ substantially from the current land uses and footprint.

During operation, water quality within nearby watercourses would potentially be impacted as a result of spills and run-off from the project. These impacts are discussed in detail in **Chapter 15** (Soil and water quality), however in summary the project includes water quality management facilities (water treatment facility, spill basins and gross pollutant traps) which would capture the majority of spills and other pollutants resulting from the project. Water would then be treated prior to discharge to any watercourses therefore reducing any potential impacts on biodiversity within and along the watercourses including any downstream areas.

Mitigation measures outlined in **Chapter 15** (Soil and water quality) would be implemented to minimise the risk of impacts to water quality during construction of the project.

20.5 Assessment of cumulative impacts

The study area is located within the Sydney urban area dominated by an extensive and complex road network, as well as residential and industrial areas. The project would only involve the removal of small patches of highly fragmented planted vegetation. Additional road projects such as the New M5 and the possible future M4–M5 Link (both subject to planning approval) and the M4 Widening (under construction) would also result in removal of mainly planted vegetation and associated fauna habitats. The loss of biodiversity is likely to be restricted in area, given the highly modified environment. Together, these projects and other developments would result in the further loss of habitat from an already modified environment with only limited natural biodiversity values.

20.6 Management of impacts

Environmental management measures relating to biodiversity during construction and operation are provided in **Table 20.6**. Mitigation and management measures relevant to biodiversity are also located in **Chapter 15** (Soil and water quality) in relation to erosion and sedimentation control measures and water quality control measures.

Table 20.6 Environmental management measures – biodiversity

Impact	No.	Environmental management measure	Responsibility	Timing
Construction				
General	B1	A Construction Flora and Fauna Management Plan will be developed for the construction phase of the project to confirm potential impacts and provide details of biodiversity management measures and procedures to be undertaken during construction to minimise and manage impacts on biodiversity.	Construction contractor	Pre-construction
Impact on adjacent vegetation	B2	The project footprint will be clearly delineated to minimise impacts on adjacent vegetation.	Construction contractor	Construction
	B3	Investigate opportunities to retain perimeter plantings where feasible at construction ancillary facilities at Cintra Park and Powells Creek.	Construction contractor	Pre-construction
Impact on fauna	B4	A pre-clearing survey will be carried out to identify any habitat trees or other features that require the presence of an appropriately qualified fauna handler during clearing.	Construction contractor	Construction
Impact on threatened microbats	B5	An appropriately qualified fauna handler will be present during removal of habitat trees identified during pre-clearing surveys to guide clearing activities and undertake rescue and relocation of fauna.	Construction contractor	Construction
Impacts on Grey-headed Flying-fox	B6	Landscaping should incorporate planting of Grey-headed Flying-fox feed trees where feasible.	Construction contractor	Construction
Spread of weeds and pathogens	B7	Weed and pathogen management and control will be undertaken in accordance with the *Biodiversity Guidelines* (Roads and Traffic Authority (RTA) 2011).	Construction contractor	Construction
Saleyards Creek	B8	The water quality basin at Saleyards Creek will be designed to minimise impacts on the creek corridor and the setback area along this boundary should be appropriately landscaped.	Construction contractor	Pre-construction and construction
Rehabilitation	B9	At the completion of construction, complementary landscaping using locally endemic species will be undertaken in areas of construction ancillary facilities abutting creeks, canals and open space areas, where feasible.	Construction contractor	Post-construction
Operation				
General	OpB1	Weed management and control will be undertaken in accordance with the *Biodiversity Guidelines* (RTA 2011).	Motorway operator and Roads and Maritime	Operation

20.6.1 Biodiversity offsets

The project would result in some minor residual adverse impacts, namely the removal of planted native trees and the possible mortality of some common native fauna species during clearing and construction. These residual impacts are not expected to have a significant negative effect on any local populations of native biota, including any threatened fauna species, that may occur in the study area or adjoining areas on an occasional, transient basis. No native vegetation communities, threatened flora species or TECs would be directly affected. There would be no residual impacts on migratory species or their habitats downstream of the project.

The project would remove 12.9 hectares of planted vegetation that is foraging habitat for the Grey-headed Flying-fox. Landscaping would include planting of trees and shrubs at a number of locations, including along the M4 on- and off- ramps, the Concord Road interchange, and the Parramatta Road interchange, which would replace some of the planted vegetation that would be lost, thus replacing habitat for fauna, including in particular for the Grey-headed Flying-fox. Species recommended for planting include Spotted Gum, other eucalypts and figs.

The project is located in a highly modified urban landscape, and impacts on biodiversity have generally been avoided as no native vegetation communities would be removed. Mitigation measures, including the preparation of a Flora and Fauna Management Plan, have been recommended to minimise the impacts of the project on biodiversity values. Given the low conservation value of the site and the minor nature of impacts on biodiversity arising from the proposal, formal biodiversity offsets are not considered necessary to address any residual adverse impacts.

21 Greenhouse gas

Greenhouse gases (GHGs) are gases in the atmosphere that absorb and re-radiate heat from the sun, thereby trapping heat in the lower atmosphere and influencing global temperatures. Emissions of GHGs into the atmosphere are caused by both natural processes (eg forest fires) and human activities (eg burning of fossil fuels to generate electricity).

Since the industrial revolution there has been an increase in the amount of GHGs emitted from human activities, which has increased the global concentration of GHGs in the atmosphere. This has led to an increase in the Earth's average surface temperature (IPCC 2013). Further discussion on climate change, including the identification and assessment of climate change risks to the project, is provided in **Chapter 24** (Climate change).

21.1 Assessment methodology

The methodology for this GHG assessment for the M4 East project (the project) has been based on relevant GHG reporting legislation and international reporting guidelines, including:

- *Greenhouse Gas Protocol: A Corporate Accounting and Reporting Standard* (World Council for Sustainable Business Development and World Resources Institute 2005)
- *National Greenhouse and Energy Reporting Act 2007* (Clth)
- AS/ISO 14064.1:2006 *Greenhouse Gas Part 1: Specification with guidance at the organisational level for quantification and reporting of greenhouse gas emissions and removals*
- The current Australian National Greenhouse Accounts: National Greenhouse Accounts Factors (NGA Factors) (Department of the Environment 2014)
- Greenhouse Gas Assessment Workbook for Road Projects (the TAGG Workbook) (Transport Authorities Greenhouse Group (TAGG) 2013).

The TAGG Workbook provides a consistent methodology for estimating the GHG emissions from activities that may contribute significantly to the overall emissions associated with the construction, operation and maintenance of road projects. The TAGG Workbook has been adopted for the project.

To calculate the potential GHG emissions associated with the project, the following steps were followed:

1. Define the assessment boundary and identify potential sources of GHG emissions associated with the project
2. Determine the quantity of each emission source (fuel and electricity consumed, vegetation cleared, construction materials used and waste produced)
3. Quantify the potential GHG emissions associated with each GHG source, using equations and emission factors specified in the NGA Factors and the TAGG Workbook
4. Present the potential GHG emissions associated with the project.

Appendix U provides a detailed description of the GHG assessment methodology, including the emissions factors used for all emission sources, and detailed calculation methods used to estimate the GHG emissions from fuel combustion, electricity consumption, vegetation clearing, materials use and the decomposition of waste.

GHG emissions are reported in this assessment as tonnes of carbon dioxide equivalent (t $CO_{2\text{-}e}$). While there are numerous GHGs, this standard metric takes account of the different global warming potentials of different GHGs, and expresses the cumulative effect in a common, universal unit of measurement. This allows for all GHGs associated with the project to be combined into one emissions calculation.

21.1.1 Greenhouse gas assessment boundary

The assessment boundary defines the scope of GHG emissions and the activities to be included in the assessment. The assessment boundary includes all emissions sources that can be influenced by decisions made by designers, constructors, managers or operators of the project and accounts for emissions anticipated to be generated during the construction and operation stages of the project. While the operational road use by vehicles has been included within the assessment, maintenance activities during the operation of the project are not included within the scope of the assessment.

The guiding principles for GHG accounting and reporting, including an assessment of materiality, are provided in **Appendix U**.

Emissions sources are categorised into the following three 'scopes':

- Scope 1 – direct emissions: GHG emissions generated by sources owned or controlled by the project, for example emissions generated by the use of diesel fuel in project-owned construction plant, equipment or vehicles
- Scope 2 – indirect emissions: GHG emissions from the consumption of purchased electricity in project-owned or controlled equipment or operations. These GHG emissions are generated outside the project's boundaries, for example the use of electricity purchased from the grid
- Scope 3 – indirect upstream/downstream emissions: GHG emissions generated in the wider economy due to third party supply chains and road users as a consequence of activity within the boundary of the project, for example GHG emissions associated with the mining, production and transport of materials used in construction.

Table 21.1 summarises the emission sources and activities considered within the project's GHG assessment boundary for construction and operation, according to scope.

Table 21.1 Emission sources and activities included in the assessment

Emission source category	Emission source	Emission scope		
		Scope 1 (direct)	Scope 2 (indirect)	Scope 3 (indirect upstream)
Construction				
Fuel use	Mobile construction equipment	✓		✓
	Site vehicles	✓		✓
	Delivery of plant, equipment and construction materials			✓
	Spoil and waste removal			✓
Electricity consumption	Electricity used to power construction plant (road headers, ventilation, lighting towers etc) and site offices		✓	✓
Vegetation removal	Clearance of vegetation as a result of the project	✓		
Materials	Embodied energy of construction materials			✓
Waste	Decomposition of waste generated during project construction			✓
Operation				
Electricity consumption	Electricity used to power tunnel lighting and ventilation, project offices and other electrical systems		✓	✓
Fuel use	Operational road use by light and heavy vehicles			✓

Some emissions sources are categorised into two scopes; for example, the use of fuel by mobile construction equipment onsite would generate Scope 1 direct emissions from the combustion of fuel as well as Scope 3 indirect upstream emissions associated with the extraction, production and transport of the purchased fuel. Consumption of electricity purchased from the grid would generate Scope 2 indirect emissions from the use of electricity to power project equipment and facilities, as well as Scope 3 indirect upstream emissions associated with transmission and distribution losses within the electricity network.

21.2 Existing environment

The Kyoto Protocol to the United Nation Framework Convention on Climate Change (the Kyoto Protocol) (UNFCCC 1998) was signed in 1997 and Australia ratified the protocol in December 2007. The Kyoto Protocol serves to give effect to the UNFCC's objective of reducing global GHG emissions by setting reduction targets and reporting requirements for certain ratifying countries. These targets are set using the relevant ratifying countries' 1990 baseline emissions. Australia committed to a target of 108 per cent of its 1990 GHG emission levels by the end of 2012. In December 2012, Australia signed the Doha Amendment to the Kyoto Protocol (UNFCCC 2012), agreeing to a second commitment period, from 1 January 2013 until 2020.

The Australian Government recently announced it is committed to a target of reducing GHG emissions by 26 to 28 per cent below 2005 levels by 2030, building on its previous target of five per cent below 2000 emission levels by 2020, irrespective of what other countries do. The Government has submitted this new target to the UNFCC as its intended nationally determined contribution to the proposed new agreement to be negotiated at United Nations Climate Change Summit held in Paris in December 2015.

21.2.1 Policy setting

The Emissions Reduction Fund, as part of the Direct Action Plan, aims to reduce Australia's GHG emissions by creating positive incentives to adopt better technologies and practices to reduce GHG emissions.

In August 2013, the NSW Office of Environment and Heritage (OEH) released the NSW Energy Efficiency Action Plan (OEH 2013), which provides a strategic management approach to improving energy efficiency, with a target for annual energy savings of 16,000 gigawatt-hours by 2020.

The NSW Government Resource Efficiency Policy (OEH 2014) 'aims to drive resource efficiency by NSW Government agencies in three main areas – energy, water and waste – and also reduce harmful air emissions from government operations.'

The *NSW Long Term Transport Master Plan* (Transport for NSW 2012) (Transport Master Plan) includes an objective to 'Improve sustainability – by maintaining and optimizing the use of the transport network, easing congestion, growing the proportion of travel by sustainable modes such as public transport, walking and cycling, and becoming more energy efficient.' An action of the Transport Master Plan is also to 'continue to explore opportunities to reduce vehicle emissions, improve air quality and lower GHG emissions from the NSW transport sector.'

In addition the Environment and Sustainability Policy Framework (Transport for NSW 2013) includes an energy management objective 'To use Transport's energy sources more efficiently and reduce its greenhouse gas emissions'.

21.2.2 GHG emissions reporting

The Clean Energy Regulator and the Department of the Environment are responsible for administering the Australian Government's GHG emission policies, regulations and initiatives. The National Greenhouse and Energy Reporting (NGER) Scheme is a national framework for obligated corporations to report on GHG emissions, energy use and energy production. The NGER Scheme operates under the *National Greenhouse and Energy Reporting Act 2007* (NGER Act).

The most recently published Australian National Greenhouse Accounts estimate Australian GHG emissions for 2014 to be 535.9 Mt CO_2-e as reported under the Kyoto Protocol (Department of the Environment 2015a). For 2013, annual NSW GHG emissions totalled 146.7 Mt CO_2-e (Department of the Environment 2015b).

The transport sector contributes approximately 17 per cent of Australia's total GHG emissions (Department of the Environment 2015a). Around 90 per cent of these emissions are considered to be attributed to the combustion of fuel for road transport (Climate Change Authority 2014; Maddocks et al. 2010). Reducing the contribution of emissions from road transport would therefore have a significant impact on emissions reduction for the transport sector, and for Australia's overall emissions profile.

21.3 Assessment of construction impacts

The data used to estimate the GHG emissions associated with construction of the project is provided in **Appendix U**. Assumptions have been made, where necessary, to provide a quantitative estimate of emissions.

It is estimated that the project would generate about 382,100 t CO_2-e. The breakdown of emissions by scope is shown in **Figure 21.1** and summarised as:

- 92,300 t CO_2-e of Scope 1 (direct) GHG emissions
- 65,650 t CO_2-e of Scope 2 (indirect) GHG emissions
- 224,150 t CO_2-e of Scope 3 (indirect upstream/downstream) GHG emissions.

Key emissions sources during project construction are shown in **Table 21.2** and **Figure 21.1**. Detailed GHG emissions results are provided in **Table U-7** of Appendix U.

Table 21.2 Construction GHG emissions results

Emissions source		GHG emissions (t CO_2-e)				
		Scope 1	Scope 2	Scope 3	Total	% of total
Fuel use (diesel) – mobile plant and equipment		31,301	-	2,376	33,677	8.81%
Fuel use (diesel) – transport of materials and waste to/from site		53,893	-	4,092	57,985	15.17%
Fuel use (petrol) – mobile plant and equipment		62	-	5	67	0.02%
Fuel use (petrol) – project light vehicles		2,747	-	217	2,964	0.78%
Vegetation clearance		4,268	-	-	4,268	1.12%
Electricity consumption		-	65,651	9,924	75,575	19.78%
Construction materials	Concrete	-	-	150,978	150,978	39.51%
	Cement	-	-	299	299	0.08%
	Steel	-	-	33,359	33,359	8.73%
	Aggregate	-	-	2,450	2,450	0.64%
	Asphalt	-	-	2,320	2,320	0.61%
	Copper	-	-	7,210	7,210	1.89%
	Plastic	-	-	1,627	1,627	0.43%
	Water	-	-	1,300	1,300	0.34%
Waste	Construction and demolition waste	-	-	8,000	8,000	2.09%
Total		92,271	65,651	224,157	382,079	100%
% of total		24%	17%	59%	100%	

The results demonstrate that the majority of GHG emissions associated with the construction of the project are attributed to indirect Scope 3 emissions (59 per cent), followed by direct Scope 1 emissions (24 per cent).

The embodied energy associated with the offsite mining, production and transport of materials that would be used for the construction of the project contributes the largest proportion of indirect Scope 3 emissions, accounting for 89 per cent of these emissions (**Figure 21.1**). The use of concrete and, to a lesser extent, steel would contribute significantly to Scope 3 emissions. The high proportions of emissions associated with these materials are attributed not only to the quantity required for the construction of the project, but also the emissions-intensive processes involved in the extraction and production of these materials.

Figure 21.1 illustrates the breakdown of construction emissions by emission source and scope. The consumption of diesel fuel associated with heavy vehicle movements for the haulage of construction materials, spoil and waste contributes the largest proportion of Scope 1 emissions (58 per cent), followed by the consumption of fuel for the operation of mobile construction plant and equipment (34 per cent).

Indirect Scope 2 emissions from the use of electricity are estimated to account for 17 per cent of total emissions during construction.

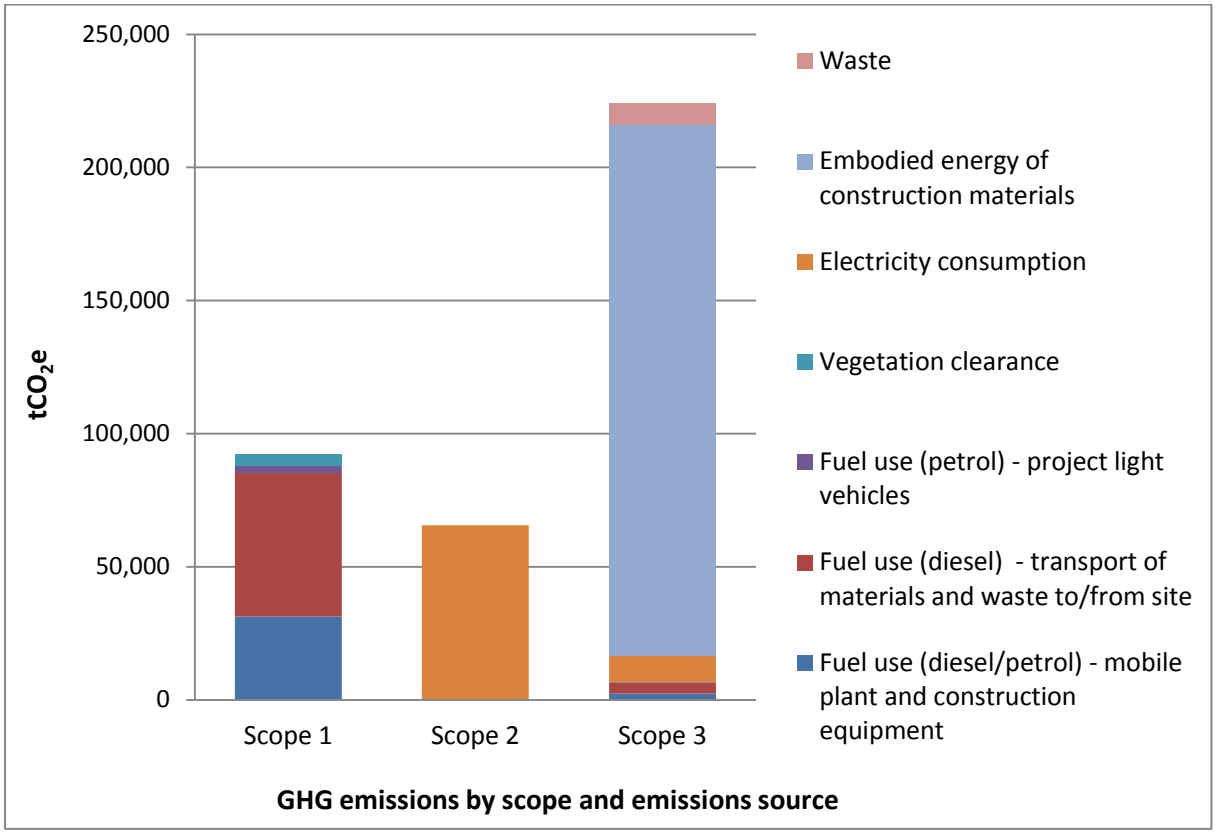

Figure 21.1 Construction GHG emissions by scope and emissions source

Mitigation and management measures to reduce GHG emissions for the project are provided in **section 21.6**.

21.4 Assessment of operational impacts

Activities that would generate GHG emissions during operation of the project include:

- Road infrastructure operation: the use of electricity for powering tunnel lighting and ventilation, operation of ventilation facilities, the motorway control centre and maintenance facility, water treatment, substation cooling, street lighting, electronic signage and other associated electrical systems.
- Vehicles using the tunnel during operation: use of the tunnel by traffic currently using Parramatta Road and the existing M4 between Homebush Bay Drive and Wattle Street (the operational traffic impact footprint) and the potential reduction of traffic volumes on Parramatta Road.

GHG emissions that would be generated by ongoing motorway maintenance activities during operation of the project have not been included in the assessment boundary. A benchmarking exercise was undertaken to estimate the likely proportion of emissions from maintenance works, based on emissions estimated for other road projects of a similar scale. Maintenance emissions were found to be below the materiality threshold of five per cent of the project's total emissions and were therefore excluded from the assessment.

The GHG assessment results are presented in the following sections. The emission source data, and any assumptions used to estimate the GHG emissions associated with operation of the project, are provided in Appendix U.

21.4.1 Emissions from road infrastructure operation

The estimated GHG emissions that would be generated each year of operation of the project are presented in **Table 21.3**.

Table 21.3 Annual road infrastructure operation GHG emissions results

Emissions source	GHG emissions (t CO_2-e per year)			
	Scope 1	Scope 2	Scope 3	Total
Electricity consumption	-	24,188	3,656	27,845

Annual use of electricity for powering tunnel lighting and ventilation, operation of ventilation facilities, the motorway control centre and maintenance facility, water treatment, substation cooling, street lighting, electronic signage and other associated electrical systems are estimated to generate 24,188 t CO_2-e of Scope 2 (indirect) emissions and 3,656 t CO_2-e of Scope 3 (indirect upstream) emissions per year of operation.

21.4.2 Emissions from vehicles during operation

GHG emissions generated from the operation of road infrastructure are relatively small in comparison with the indirect emissions associated with the fuel consumed by vehicles using the road.

To assess the Scope 3 (indirect downstream) emissions associated with the fuel consumed by vehicles using the project, and to evaluate any potential GHG emissions savings as a result of the project, four road use scenarios were considered:

- Operation 'do minimum' (2021):
  - The primary 'do minimum' case assumes that the King Georges Road Interchange Upgrade and the M4 Widening are complete, but the remainder of the WestConnex projects are not built. It is called 'do minimum' rather than 'do nothing' as it assumes that infrastructure schemes currently incomplete but scheduled for opening prior to the assessment year are operational
- Operation 'do something' (2021):
  - As per the primary 'do minimum' with the project complete and open to traffic, but without any other subsequent WestConnex projects (note: the NSW Government has committed to achieving completion of the project by 2019)
- Operation 'do minimum' (2031):
  - A future network including the WestConnex King Georges Road Interchange Upgrade and the M4 Widening and some upgrades to the broader transport network over time to improve capacity and cater for traffic growth but does not include the other subsequent WestConnex projects
- Operation 'do something' (2031):
  - All WestConnex projects complete and also includes the Sydney Gateway and the Southern Extension (note: the NSW Government has committed to achieving completion of the New M5 and M4–M5 Link projects by 2023).

Traffic volumes were modelled in line with the traffic and transport assessment provided in Chapter 8 (Traffic and transport).

The results are detailed in **Table 21.4** and **Appendix U**. As shown in **Table 21.4** the difference between total GHG emissions generated in the 'without project' (do minimum) and 'with project' (do something) scenarios was used to calculate the net GHG emissions savings attributable to operation of the project.

Table 21.4 Scope 3 operational road use GHG emissions results (t CO_2-e)

Route	GHG emissions				GHG savings	
	Without project		With project		Difference between scenarios	
	2021	2031	2021	2031	2021	2031
M4 and Parramatta Road	293,124	392,216	186,878	227,391	-106,246	-164,826
M4 East (the project)	NA	NA	49,481	119,389	49,481	119,389
Totals	293,124	392,216	236,359	346,780	-56,764	-45,437

Note: negative values indicate a savings in GHG emissions for the 'with project' compared to the 'without project' scenario.

The results demonstrate the benefits of road tunnel usage in urban areas, where travel along a more direct route at a higher average speed results in fewer GHG emissions being generated by road users, as reduced congestion and stop-start driving reduces the fuel used by vehicles. The assessment results indicate the project would reduce annual GHG emissions by around 56,800 t CO_2-e in 2021 and around 45,400 t CO_2-e in 2031. The predicted reduction in GHG emissions as a result of the project is due to an improvement in vehicle fuel efficiency for most sections of Parramatta Road as well as the operational efficiency of the project tunnels.

Vehicle fuel efficiency is anticipated to improve as part of the project based on:

- Increased average speeds on Parramatta Road due to reduced congestion
- Increased average speeds as a result of the operational efficiency of the tunnels, which would minimise the number of intersections and the frequency of stopping
- Reduced length of travel between the Homebush Bay Drive and Wattle Street/Parramatta Road interchanges.

Mitigation and management measures to reduce GHG emissions for the project are provided in **section 21.6**.

21.5 Combined GHG emissions

The GHG emissions saving of 56,800 t CO_2-e in the year 2021 would represent around 0.01 per cent of the Australian National inventory for 2014, and 0.03 per cent of the NSW inventory for 2013 as discussed in **section 21.2**.

Figure 21.2 shows the combined emissions profile for the project, from the completion of construction in 2019 to the operational road use in 2031. **Figure 21.2** demonstrates that emissions estimated to be generated during construction and the annual emissions from the operation of road infrastructure would be offset against emissions savings as a result of improved road performance. Emissions were not able to be extrapolated beyond the operational traffic impact footprint for the project, which was assessed up to 2031. However, it is expected that the savings in emissions from improved road performance would reduce over time as traffic volumes increase.

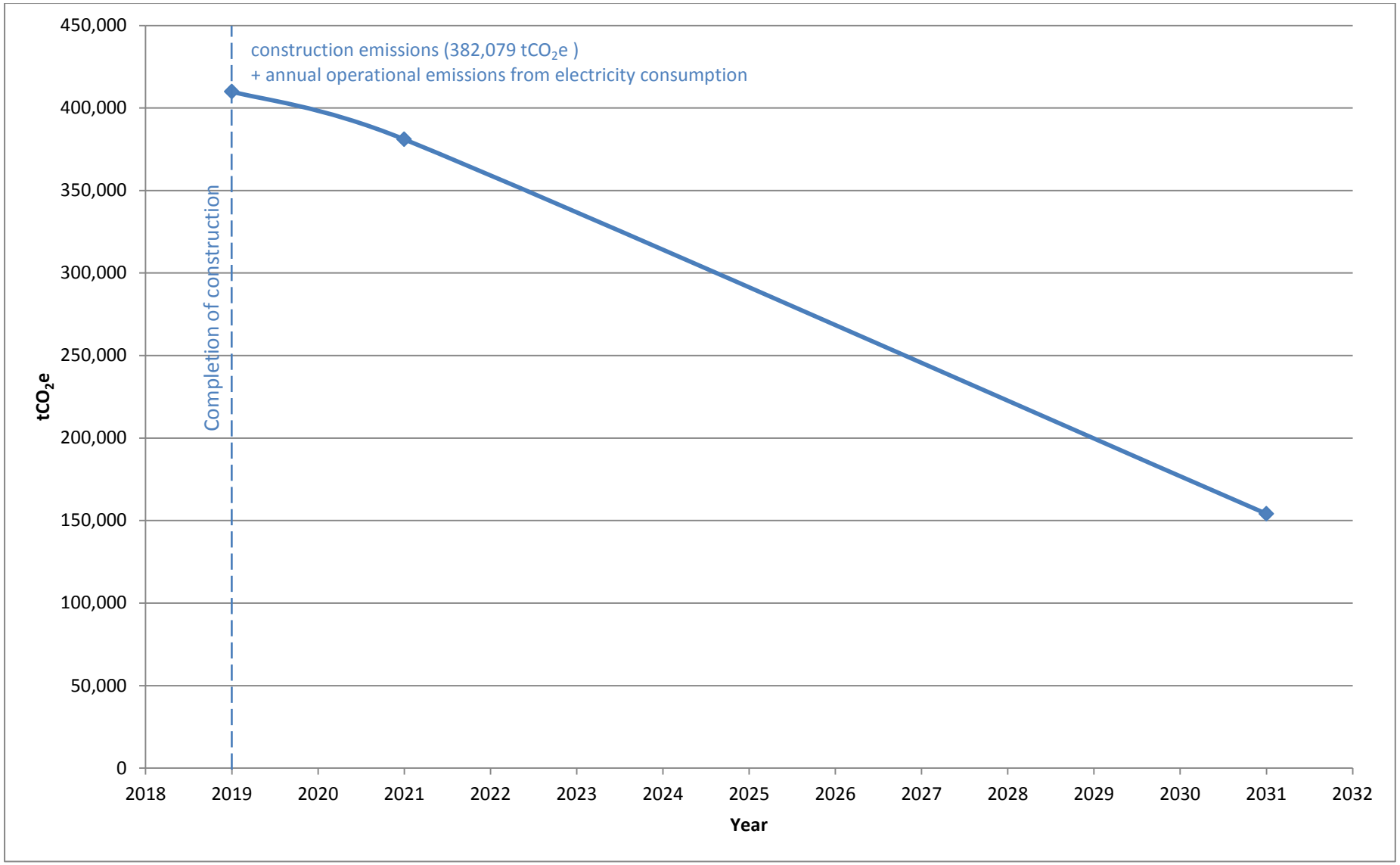

Figure 21.2 Combined GHG emissions profile for the project: construction and operational emissions offset against emissions savings

21.6 Management of impacts

The preferred design of the project has been optimised such that measures to reduce energy and resource requirements, and therefore GHG emissions, are inherent in the design. The preferred design has been optimised to:

- Straightening of the alignment to reduce the length of the tunnel, thereby reducing the volume of spoil generated, materials used, ventilation required, and emissions generated from operational road use by vehicles
- Pass through a higher proportion of sandstone rock, as opposed to shale, reducing the number of rock bolts required and providing increased opportunities for the reuse of sandstone spoil at other developments
- Reduce power consumption associated with tunnel ventilation by locating the ventilation facilities close to the main alignment tunnel portals thereby optimising the piston generated vehicle effect
- Provide enhanced reflectivity and luminance so as to reduce the required level of lighting and associated power requirements within the tunnel
- Provide large radius curves within the tunnel in order to allow consistent vehicle speeds to be maintained and reduce the need for vehicles to slow down on the approach to corners
- Provide for long term performance and durability of the main tunnel alignments, Parramatta Road and the associated local road network, increasing asset design lives and reducing the frequency of maintenance activities.

Table 21.5 provides a list of mitigation measures to further reduce the GHG emissions generated by the project.

Table 21.5 Management measures

No.	Environmental management measure	Responsibility	Timing
Construction			
GHG 1	Prepare an Energy Efficiency and GHG Emissions Strategy for the project.	Construction contractor	Detailed design
GHG 2	Undertake an updated GHG assessment (Scope 1 and Scope 2) based on detailed design.	Construction contractor	Detailed design
GHG 3	The emissions intensity of significant construction materials specified in the design of the project would be assessed and, where feasible and in compliance with technical specifications, purchasing power would be used to drive the procurement and use of low emission construction materials.	Construction contractor	Detailed design
GHG 4	Where feasible, recycled content road construction materials such as recycled aggregates in road pavement and surfacing, or similar, would be used.	Construction contractor	Detailed design
GHG 5	The fuel efficiency of construction plant and equipment would be assessed before selection and, where feasible and reasonable, equipment with the highest fuel efficiency or equipment that uses lower GHG intensive fuel such as biofuels (eg biodiesel, ethanol) would be used.	Construction contractor	Pre-construction and construction
GHG 6	Project planning would be undertaken to ensure that the site vehicle movements and construction activities are efficient, to avoid double handling of materials and unnecessary fuel use where possible.	Construction contractor	Detailed design
GHG 7	Locally produced goods and services would be procured where feasible and cost effective to reduce transport fuel emissions.	Construction contractor	Detailed design and construction

No.	Environmental management measure	Responsibility	Timing
GHG 8	A minimum of six per cent of the project's estimated electricity consumption would be sourced from a renewable energy source or GreenPower, where reasonable and feasible.	Construction contractor	Detailed design and construction
GHG 9	Waste would be diverted from landfill, including diversion of spoil, construction and demolition waste, and commercial and industrial waste, where reasonable and feasible.	Construction contractor	Detailed design and construction
Operation			
GHG 10	The tunnel would be designed to minimise fuel consumed by vehicles using the road, for example through the provision of a vertical alignment that allows consistent vehicle speeds to be maintained.	Construction contractor	Detailed design
GHG 11	A life cycle assessment would be undertaken as part of the detailed design in order to select mechanical and electrical systems with increased energy efficiencies, where reasonable and feasible, such as the tunnel ventilation system, tunnel lighting, water treatment systems and electronic toll and surveillance systems.	Construction contractor	Detailed design
GHG 12	Low carbon energy generation options would be investigated as part of the design process in order to reduce the demand on mains electricity and generate renewable energy onsite, where feasible.	Construction contractor	Detailed design
GHG 13	A portion of the project's estimated electricity consumption would be sourced from a renewable energy source or GreenPower, where reasonable and feasible.	Motorway operator	Detailed design/ operation

22 Aboriginal heritage

This chapter outlines the potential Aboriginal cultural heritage impacts associated with the M4 East project (the project). A detailed Aboriginal cultural heritage assessment has been undertaken for the project and is included in **Appendix V**.

The Secretary of the NSW Department of Planning and Environment has issued a set of environmental assessment requirements for the project; these are referred to as Secretary's Environmental Assessment Requirements (SEARs). **Table 22.1** sets out these requirements that relate to Aboriginal heritage, and identifies where they have been addressed in this environmental impact statement (EIS).

Table 22.1 Secretary's Environmental Assessment Requirements – Aboriginal heritage

Secretary's Environmental Assessment Requirements	Where addressed in EIS
• Impacts to Aboriginal heritage (including cultural and archaeological significance), in particular impacts to Aboriginal objects and potential archaeological deposits (PAD), should be assessed. Where impacts are identified, the assessment shall:	**Chapter 22** (this chapter)
• outline the proposed mitigation and management measures (including measures to avoid significant impacts and an evaluation of the effectiveness of the measures) generally consistent with the Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (Department of Environment and Conservation (DEC) 2005a)	**Section 22.4**
• be undertaken by a suitably qualified heritage consultant(s),	**Appendix V**
• demonstrate effective consultation with Aboriginal communities in determining and assessing impacts and developing and selecting options and mitigation measures (including the final proposed measures),	**Section 22.1**
• assess and document the archaeological and cultural significance of cultural heritage values of affected sites, and	**Section 22.3**
• develop an appropriate assessment methodology, including research design, in consultation with the Department and the Office of Environment and Heritage, to guide physical archaeological test excavations of the sites and areas of PAD identified in a manner that establishes the full spatial extent and significance of any archaeological evidence across each site/area of PAD, and include the results of these excavations.	Not applicable – no physical excavations are recommended

22.1 Assessment methodology

22.1.1 Overview

The methodology for the Aboriginal cultural heritage assessment undertaken for the project was developed in accordance with the requirements of the NSW Roads and Maritime Services (Roads and Maritime) *Procedure for Aboriginal Cultural Heritage Consultation and Investigation* (PACHCI) (Roads and Maritime 2011a). PACHCI sets out a consultation process that is consistent with the NSW Office of Environment and Heritage (OEH) *Aboriginal cultural heritage consultation requirements for proponents* (2010).

A PACHCI Stage 1 Aboriginal heritage assessment was undertaken by AECOM in March 2015. This concluded that the project had the potential to harm items of Aboriginal cultural heritage. As a result, a PACHCI Stage 2 Aboriginal heritage assessment has been undertaken (refer to the PACHCI flowchart in the Aboriginal heritage assessment in **Appendix V**).

This assessment is in accordance with PACHCI Stage 2 procedures and aims to identify potential Aboriginal cultural heritage values within the study area.

The assessment methodology generally involved:

- A desktop assessment including
  - A review of publicly available databases
  - A review of relevant archaeological and ethnohistorical information for the study area
  - Development of a predictive model for Aboriginal site type and distribution within the study area
  - Identification of areas of Aboriginal archaeological sensitivity within the study area
- An archaeological survey of investigation areas (identified by the desktop assessment) within the study area
- Consultation with Metropolitan Local Aboriginal Land Council (MLALC) undertaken by Roads and Maritime
- A targeted archaeological survey
- Preparation of a Stage 2 PACHCI assessment report.

Consultation with the Aboriginal community was undertaken in accordance with the Roads and Maritime Stage 2 PACHCI process. This involved identification of key Aboriginal stakeholders and the relevant Local Aboriginal Land Council (LALC), engagement of identified Aboriginal stakeholders to participate in the archaeological survey, and preparation (by identified Aboriginal stakeholders) of a cultural heritage survey report. The assessment has identified that a Stage 3 PACHCI would not be required. As such, the level of consultation with Aboriginal communities is considered appropriate and further consultation would not be required at this stage.

22.1.2 Legislation and policy framework

The Aboriginal heritage assessment has been prepared to assess the impacts of the project in accordance with relevant legislation and policy as described in **Table 22.2**.

Table 22.2 Legislation relevant to the project – Aboriginal heritage

Legislation	Relevance to project
National Parks and Wildlife Act 1974 (NSW) (NPW Act)	The NPW Act is the primary legislation for the protection of Aboriginal cultural heritage in NSW and provides for the proper care, preservation and protection of 'Aboriginal objects' and 'Aboriginal places', defined under the Act. Under Part 6 of the NPW Act it is an offence to harm or desecrate Aboriginal objects or places. It is a defence to prosecution for such an offence if the harm was authorised by an Aboriginal Heritage Impact Permit issued under section 90 of the NPW Act. As discussed in this chapter, the project would not impact on any known Aboriginal objects or places, and an Aboriginal Heritage Impact Permit would not be required.
Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Commonwealth) (ATSIHP Act)	The ATSIHP Act provides for the preservation and protection of places, areas and objects of particular significance to Indigenous Australians. Under the ATSIHP Act, the Australian Government Minister for the Environment, in consultation with the State/Territory minister, may make a declaration to protect an Aboriginal area or object.

The assessment has also considered the following guidelines:

- *Draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (DEC 2005)
- *Interim Community Consultation Requirements for Applicants* (NSW Department of Environment and Conservation 2004)

- *Aboriginal Cultural Heritage Standards and Guidelines Kit* (NSW National Parks and Wildlife Service 1997)
- *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (Department of Environment, Climate Change and Water (DECCW) 2010)
- *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW 2010b)
- *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW* (OEH 2011).

22.2 Study area

The study area (see **Figure 22.1**) for this assessment comprised the project footprint including surface areas above the tunnel alignment. However, it also conservatively included a wider area that was located parallel to the existing M4 and Parramatta Road in the area between Homebush and Haberfield/Ashfield. The study area also included the locations of potential ancillary facilities such as construction ancillary facilities and ventilation facilities.

The project is located in the inner west region of Sydney within the Auburn, Strathfield, Canada Bay, Burwood and Ashfield local government areas (LGAs).

22.3 Existing environment

22.3.1 Landscape context

The study area is located on the Cumberland Plain, a large topographic feature that lies at relatively low elevation within the Sydney Basin. Historically, the area would have been predominantly coastal marshland before reclamation works during the past 200 years, and would have been highly attractive as a resource zone, both pre- and post-European settlement. However, such areas of marshland would not have been conducive for sustained occupation, and archaeological evidence that may have existed in the area before disturbance is expected to have been reflective of transient or short-term occupation.

The present day study area has been highly modified by urban development. Creeks within the study area include Saleyards Creek, Powells Creek, Dobroyd Canal (Iron Cove Creek) and several unnamed drainage channels, including a single channel which runs adjacent to Concord Oval and St Lukes Park. All of these creeks and drainage channels are highly modified, having been channelised and lined with concrete.

22.3.2 Ethnographic and archaeological context

Available radiocarbon determinations indicate that generations of Aboriginal people have occupied the Cumberland Plain for at least 36,000 years. The study area falls within the boundaries of the Darug (also spelt Dhaŕ-rook, Dharrook, Dhaŕook, Dharruk and Dharug) linguistic group, which is known to have stretched from the Hawkesbury River in the north, to Appin in the south, and from the coast west across the Cumberland Plain into the Blue Mountains.

Distribution of Aboriginal occupation across the Cumberland Plain has been linked to a variety of environmental factors, with proximity to water, stream order, landform and geology all highlighted as key determinants. Most surface sites occur on landform elements within 200 metres of a watercourse, with larger, more complex artefact assemblages associated with higher order streams.

Most areas, irrespective of the presence or absence of associated surface evidence, can contain subsurface archaeological deposits, albeit of highly variable character and extent. These subsurface artefact distributions across the northern Cumberland Plain tend to vary significantly in relation to landform and stream order.

Existing data suggest that artefact scatters and isolated artefacts are the dominant site type for this region, with middens present in the coastal areas further north. Artefact distributions do not form specific ‘sites’, but rather ’landscapes’.

22.3.3 Site predictions

With regard to the environmental and archaeological context of the study area, the assessment made the following predictions about Aboriginal cultural heritage in the area:

- Surface evidence of past Aboriginal occupation within the study area is likely to comprise stone artefact sites in surface and subsurface contexts in areas that have not been subject to gross disturbance
- Aboriginal shell midden sites are most likely to occur in tidal estuarine foreshore zones (that is, within 10 metres of high water level). It is unlikely that any shell midden sites would occur within the study area, because of the gross disturbance of those areas where they may once have occurred. Disturbance has occurred through waterway channelisation, land reclamation and urban development
- Scarred trees may occur in areas of remnant bushland, if mature native vegetation remains extant
- Stone artefact sites are likely to comprise flaked stone assemblages, most likely dominated by silcrete, as well as tuff and petrified wood. Where identified, these sites are likely to be located in areas of remnant landscape. Stone artefact sites may occur in surface or subsurface contexts within the study area
- Aboriginal archaeological sites are highly unlikely to occur in areas previously subjected to significant levels of landscape modification resulting from waterway channelisation, land reclamation and urban development.

22.3.4 Aboriginal Heritage Information Management System

A search of the Aboriginal Heritage Information Management System (AHIMS) database for previously recorded Aboriginal sites within the study area was lodged with OEH on 29 July 2014. Two updated searches were lodged on 5 and 6 May 2015.

The study area and AHIIMS sites can be seen in **Figure 22.1**. However, no registered AHIMS sites were identified within the project footprint. A single AHIMS site (#45-6-2339) was located within the study area (but outside of the project footprint), around 1.6 kilometres west of the Homebush Bay Drive and M4 intersection. The identified site was registered as an artefact scatter, consisting of 10 artefacts and some shell fragments in a grossly disturbed area in Phillips Park at Lidcombe.

22.3.5 Survey results

No surface expressions of Aboriginal objects or places were identified within the project footprint during the field survey. The single registered AHIMS within the study area was inspected. While the site record identified the site as containing 10 artefacts and some shell fragments, the inspection found only shell fragments, but no artefacts, as could be expected in a highly disturbed urban context.

As previously noted, most surface sites would occur on landform elements within 200 metres of a watercourse. All inspected waterways within the study area were generally highly modified from their natural state, currently comprising concrete-lined, channelised open drains and subsurface piped drains.

Two areas of potential Aboriginal archaeological sensitivity were identified during the survey:

- Mason Park, off Underwood Road in Homebush
- Queen Elizabeth Park, between Broughton Street and Addison Avenue in Concord.

However, both of these are located outside of the project footprint.

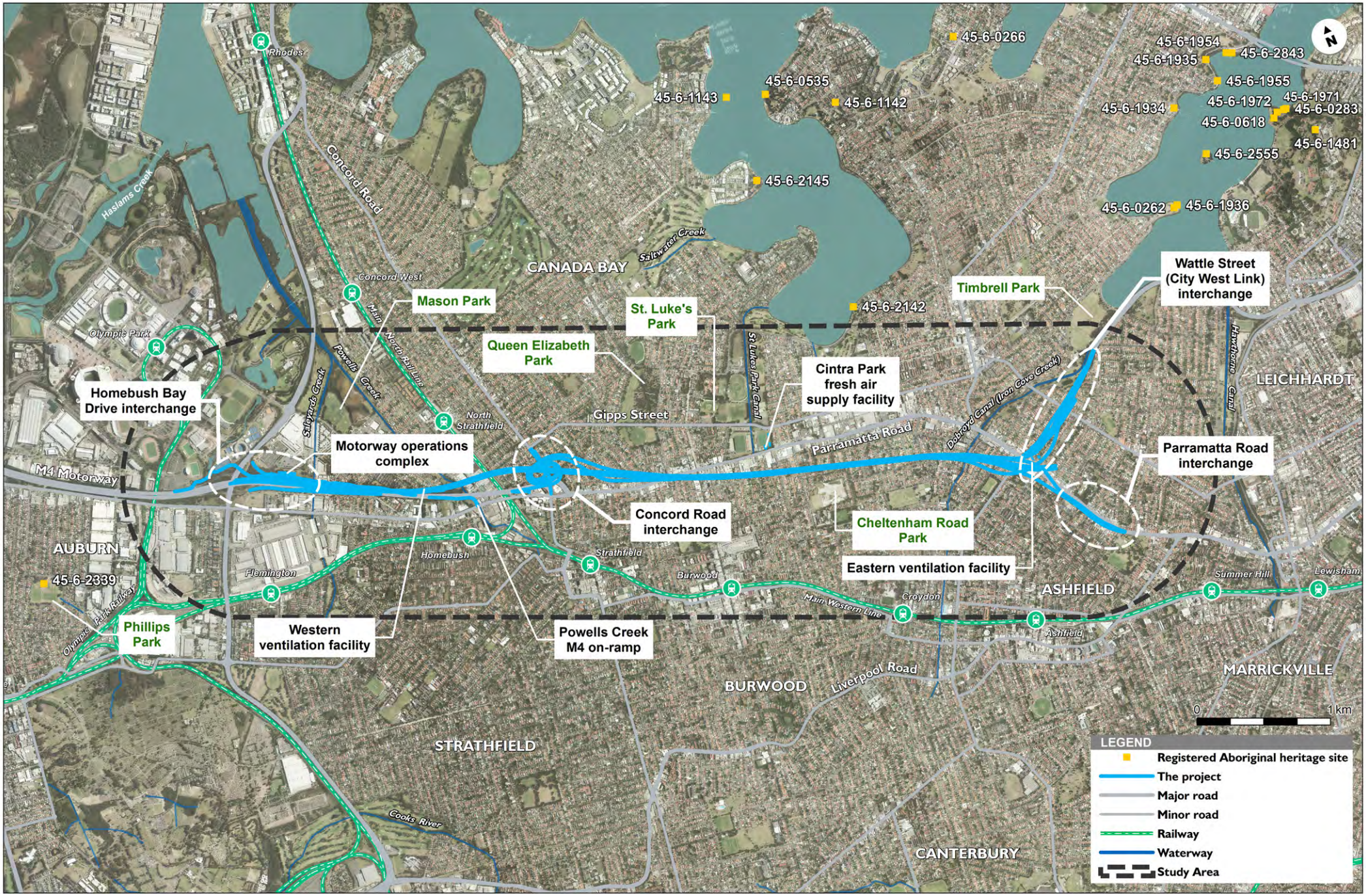

Figure 22.1 Study area and AHIMS sites

22.4 Assessment of potential impacts

No surface expressions of Aboriginal objects or places were identified within the project footprint.

The terrain within the study area is grossly disturbed and is unlikely to contain unidentified Aboriginal archaeological objects in either a surface or subsurface context. Waterways within the study area (typically the most sensitive archaeological locations) were identified during the field survey as being highly modified from their natural state.

Given the significant distance to the nearest AHIMS registered site (around 1.6 kilometres to the west of the project footprint) an impact on this site from the project is not anticipated.

Neither of the two areas of potential Aboriginal cultural heritage sensitivity identified during the field survey would be affected, either directly or indirectly, by the construction or operation of the project.

Based on the results of the field survey and desktop assessment, no further assessment would be required.

22.5 Environmental management measures

As described in the preceding sections, the project is not anticipated to have any impact on identified objects or places of Aboriginal cultural heritage. Mitigation and management measures would be implemented to avoid, minimise or mitigate impacts on unidentified Aboriginal cultural heritage objects or places. These mitigation and management measures are outlined in **Table 22.3**.

Table 22.3 Environmental management measures – Aboriginal heritage

Impact	No.	Environmental management measure	Responsibility	Timing
Construction				
Unexpected identification of Aboriginal objects	AH1	If an Aboriginal object(s) is discovered during construction it will be managed in accordance with the standard management procedure, Unexpected Archaeological Finds (Roads and Maritime 2015a), which includes the following provisions: • Relevant works in the vicinity of the object(s), with the potential to directly or indirectly impact on the object(s), will cease • The construction Environmental Representative, OEH and the Metropolitan Local Aboriginal Land Council will be notified of the discovery • A qualified archaeologist will be engaged to determine the nature, extent and scientific significance of the object(s) • Management recommendations will be developed in consultation with the qualified archaeologist, OEH and the Metropolitan Local Aboriginal Land Council.	Construction contractor	Construction

Impact	No.	Environmental management measure	Responsibility	Timing
Unexpected identification of human remains	AH2	If human remains are discovered during construction, the find will be managed in accordance with the standard management procedure, Unexpected Archaeological Finds (Roads and Maritime 2015a), which includes the following provisions: • Relevant works in the vicinity of the remains, with the potential to directly or indirectly impact on the remains, will cease • The construction Environmental Representative, OEH and NSW Police will be notified of the discovery • Directions from the NSW Police and/or OEH, as relevant, will be followed, depending on the nature of the remains and the outcome of forensic investigations.	Construction contractor	Construction

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23 Resource use and waste minimisation

This chapter describes the construction resources and materials, including potential sources and expected quantities that would be used for the M4 East project (the project).

In addition, construction and operation of the project would generate waste streams that would require management and disposal in accordance with relevant NSW policies and guidelines. This chapter also provides a description of each waste stream, expected quantities of waste materials where known, and applicable waste management strategies.

Resource consumption and waste generated by the project would also contribute to the emission of greenhouse gases during construction and operation. The consideration of this impact and emission reduction opportunities are discussed further in **Chapter 21** (Greenhouse gas).

23.1 Assessment methodology

The *Protection of the Environment Operations Act 1997* (NSW) (POEO Act) establishes management and licencing requirements for waste. It also defines offences relating to waste and sets penalties. In accordance with the POEO Act and its regulations, the NSW Environment Protection Authority (EPA) has established guidelines for the classification of waste; these have been considered in the assessment of waste generated by the project and subsequent development of mitigation and management measures.

Indicative quantities and types of wastes that would be generated from the project were provided by the construction contractor and were used as the basis for the preliminary classification in accordance with the *Waste Classification Guidelines: Part 1 Classifying Waste* (EPA 2014). Resource use for the project was assessed by reviewing the indicative scale and extent of the project (**Chapter 5** Project description) and the construction methodology (**Chapter 6** Construction work) and estimating the resources required for construction including their likely source.

Waste types, anticipated quantities of wastes and resource use estimates would be revised as the detailed design of the project progresses and would be finalised as part of the detailed construction planning.

23.2 Legislative framework

There are three main legislative instruments to manage waste in NSW:

- *Waste Avoidance and Resource Recovery Act 2001* (NSW) (WARR Act)
- POEO Act
- *Protection of the Environment Operations (Waste) Regulation 2014* (NSW) (POEO Regulation).

The WARR Act is the primary legislation for managing waste. It aims (amongst other things) to achieve a reduction in waste generation and the conversion of waste into a recoverable resource. Resource and waste management for the project would be prioritised according to the principles of the resource management hierarchy as defined in the WARR Act, namely (in order of preference):

- Avoidance of unnecessary resource consumption
- Resource recovery (including reuse, reprocessing, recycling and energy recovery)
- Disposal.

The POEO Act defines 'waste' for regulatory purposes and establishes management and licensing requirements for its transport, storage, disposal and reuse.

Under the POEO Regulation, the EPA may grant exemptions from some of the requirements under the POEO Act in the form of either a ’resource recovery order’ or a ’resource recovery exemption’ (see clauses 91 and 92 of the POEO Regulation). There are a number of resource recovery orders and resource recovery exemptions currently in force which are relevant to a range of materials that are commonly used in road construction activities.

23.3 Assessment of construction impacts

23.3.1 Construction resource consumption

Construction materials

Significant quantities of materials would be required for the construction of the project. Construction material would generally be sourced from off-site suppliers. This would include the balance of fill material to address shortfalls in required volumes, in the event that material sourced from the site is unsuitable. Wherever practical, local sources of construction materials would be preferred in order to minimise haulage distances.

Indicative quantities and the major sources of materials required for construction are detailed in Table 6.26 in **Chapter 6** (Construction work).

Construction resource requirements for the project are typical for a tunnelling project of this scale. Resource requirements may have an impact on resource availability within the local area over the construction period. The impact would be minor and limited to the construction period.

Water resources

Water would be required during construction activities, including for:

- Tunnelling activities such as cooling water and dust suppression
- Surface works, such as pavement construction, concrete works and dust suppression
- Site offices and ablutions.

The total volume of water required for construction of the project is estimated to be around 1,300 megalitres.

Water would be sourced from:

- The mains supply (potable water)
- Non-potable sources including
  - Stormwater harvesting
  - On-site construction water treatment and reuse
  - Alternative sources of reclaimed water from the area, such as Sydney Water, in the event that the above two non-potable water sources are inadequate for the project's needs.

Preference would be made for the use of non-potable water over potable water. The extent to which non-potable water sources can be used will be governed by workplace health and safety considerations, economic feasibility and the functional specifications of the design. Examples of non-potable water uses during construction include environmental controls, such as dust suppression, and end of project landscaping.

The volume of water required would be typical for tunnelling projects of this scale. It is anticipated that the local water supply network would have sufficient capacity to accommodate project construction water requirements.

Power

Power supply would be required during construction to the construction ancillary sites. It is estimated that the total energy requirements for the construction of the project would be around 76,400,000 kilowatt hours. Around six per cent of the total energy requirements would be from renewable sources and/or accredited Green Power as required by the *WestConnex Sustainability Strategy* (WestConnex Delivery Authority (WDA) 2015).

The following tunnel sites would require direct high voltage feeds from local substations outside the project corridor, as described in **section 6.10.2** of **Chapter 6** (Construction work), to supply power for ventilation and roadheaders:

- Underwood Road civil and tunnel site (C3)
- Concord Road civil and tunnel site (C5)
- Cintra Park tunnel site (C6)
- Northcote Street tunnel site (C7)
- Eastern ventilation facility site (C8).

Construction power demand for site offices, facilities, tools and small plant at the following sites would be within the capacity of the existing local distribution network:

- Homebush Bay Drive civil site (C1)
- Pomeroy Street civil site (C2)
- Powells Creek civil site (C4)
- Wattle Street and Walker Avenue civil site (C9)
- Parramatta Road civil site (C10).

Initial discussions with power supply authorities have confirmed that local substations have the required capacity to supply the construction ancillary facilities without affecting the local supply network.

23.3.2 Construction waste management

Various waste streams would be generated during construction of the project, including construction and demolition waste, vegetation waste, packaging materials and liquid wastes. All wastes would be managed using the hierarchy approach of waste avoidance and waste reuse before consideration of waste disposal.

Should the generation of wastes be unavoidable or wastes unsuitable for reuse, disposal methods would be selected based on the classification of the waste material in accordance with the *Waste Classification Guidelines: Part 1 Classifying Waste* (EPA 2014). The *Waste Classification Guidelines* provide direction on the classification of waste, specifying requirements for management, transportation and disposal of each waste category.

All wastes would be managed in accordance with the waste provisions contained within the POEO Act and, where reused off-site, would comply with relevant EPA resource recovery exemptions and requirements.

Solid wastes

Solid waste streams anticipated to be generated during construction of the project include:

- Excavated wastes, such as soil and rock, primarily from tunnelling and cutting including virgin excavated natural material (VENM)
- Demolition wastes from existing structures that require removal (eg residential and commercial buildings) – concrete, bricks, tiles, timber (untreated, treated), metals, plasterboard, carpets, electrical and plumbing fittings and furnishings (doors, windows)
- Hazardous waste (including asbestos and contaminated spoil (refer to **Chapter 16** (Contamination))
- Vegetation waste from the removal of trees, shrubs and ground covers that are unable to be mulched and reused within the project
- General construction waste – timber formwork, scrap metal, steel, concrete, plasterboards and packaging material (crates, pallets, cartons, plastics and wrapping materials)
- Waste from operation and maintenance of construction vehicles and machinery – adhesives, lubricants, waste fuels and oils, engine coolant, batteries, hoses and tyres
- General wastes from site offices – putrescibles, paper, cardboard, plastics, glass and printer cartridges.

Potential adverse impacts arising from waste management associated with the project include:

- Excessive volumes of spoil directed to landfill due to inadequate recycling and reuse
- Dust impacts due to incorrect storage, handling and disposal of spoil
- Excessive volumes of waste directed to landfill due to excessive resource consumption and inadequate collection, classification and disposal of waste
- Contamination of soil, surface and/or groundwater from the inappropriate storage, transport and disposal of liquid and solid waste.

Waste types and volumes generated during construction of the project would be typical of that produced on tunnel construction projects of this scale. About 40,000 tonnes of construction and demolition waste would be generated. This and other waste during construction would be appropriately managed through the implementation of standard management and mitigation measures (provided in **section 23.5**). Excavated wastes (spoil), such as soil and rock, primarily from tunnelling and cutting would constitute the majority of solid waste which would be generated by the project. Spoil would be managed in accordance with a spoil management strategy which is presented in **section 6.9** of **Chapter 6** (Construction work), and which includes details of likely volumes, likely nature and classification of excavated material, opportunities for recycling, potential disposal sites, stockpile management, and method and route of transportation.

Existing metropolitan waste management facilities would have capacity to receive the other anticipated waste streams generated by the project.

Demolition waste generated by the project has the potential to contain hazardous materials, in particular asbestos containing material. Management and disposal of asbestos containing material would be undertaken in accordance with:

- *Work Health and Safety Act 2011* (NSW)
- Code of Practice for the Safe Removal of Asbestos 2nd Edition (National Occupational Health and Safety Commission (NOHSC) 2005a)
- Code of Practice for the Management and Control of Asbestos in Workplaces (NOHSC 2005b)
- Protection of the Environment Operations (Waste) Regulation 2005 – clause 42 special requirements relating to asbestos waste
- National Environment Protection (Assessment of Site Contamination) Measure 1999
- AS2601:2001 Demolition of Structures.

Removal of asbestos containing material would generally involve the following:

- Development of an asbestos management plan
- Establishing asbestos removal boundaries with appropriate security signage and barriers
- Preparation of the work area
- Use of the wet removal method where feasible and reasonable
- Removal of asbestos containing material in sections and placement in suitably labelled and properly sealed asbestos waste containers
- Decontamination of the workplace, tools and personal protective equipment
- Disposal of asbestos waste at an appropriately licensed facility.

Waste management activities associated with the construction of the project are not considered to pose a significant risk to the environment, with the implementation of standard measures (provided in **section 23.5**) to adequately address waste generation, storage, disposal and reuse.

Wastewater

During construction, tunnelling works would result in significant volumes of wastewater requiring treatment and disposal. Anticipated water treatment and discharge volumes at the construction ancillary facilities are summarised in **Table 6.28** in **Chapter 6** (Construction work). Water treatment methods and discharge water quality and associated impacts are described in **Chapter 15** (Soil and water quality) and **Chapter 18** (Groundwater).

Some wastewater from water treatment plants would be reused during construction for:

- Dust suppression
- Wheel washes
- Plant washing
- Earthworks soil treatment

Wastewater not used on site would be discharged into the local stormwater system in accordance with the requirements of the local council, the EPA and Sydney Water.

Spoil

A spoil management strategy is presented in **section 6.9** of **Chapter 6** (Construction work), including details of likely volumes, likely nature and classification of excavated material, opportunities for recycling, potential disposal sites, stockpile management, and method and route of transportation.

It is estimated that the project would generate about 2.4 million bank cubic metres of spoil, the majority from excavation of the tunnels. As such, the primary facilities for receipt and dispatch of spoil would be the four tunnel sites as described in **Chapter 6** (Construction work):

- Underwood Road tunnel site (C3)
- Concord Road tunnel site (C5)
- Cintra Park tunnel site (C6)
- Northcote Street tunnel site (C7).

Relatively smaller quantities of spoil would be generated by site preparation activities, excavation of dive structures, excavation of ventilation shafts, and earthwork activities for the above ground components of the project.

Based on the depth of the tunnel and the local geology, the majority of excavated spoil material would be uncontaminated crushed sandstone and shale, classified as VENM. This would generally consist of mixed size crushed rock, ranging from shale and sand to lumps of rock.

A contamination assessment has been undertaken as part of this environmental impact statement. This assessment identified the potential for contamination to be present along the entire corridor based on existing or past land uses. There is also a number of locations where testing has identified some soil or groundwater contamination being present either within or adjacent to the project footprint. Further details are provided in **Chapter 16** (Contamination).

There is also the potential to discover further contaminated soil during construction of the project, either during surface works or from tunnelling activities. In the event of discovery of previously unidentified contaminated material, all relevant work would cease in the vicinity of the discovery. Relevant works would not recommence until the scope of remedial action(s), if required, were identified in accordance with the requirements of the *Contaminated Land Management Act 1997* (NSW).

Spoil, including contaminated spoil, would be classified in accordance with the *Waste Classification Guidelines: Part 1 Classifying Waste* (EPA 2014). Depending on the extent of contamination, spoil would be considered for reuse either on the project site or at other approved development in line with resource recovery exemptions. Where reuse is not possible, spoil would be disposed of lawfully at an appropriate location.

23.4 Assessment of operational impacts

23.4.1 Operational resource consumption

Water resources

During the operation of the project, water would be required for:

- Tunnel deluge system (testing and operation)
- Tunnel wall washing
- Motorway operations complex ablutions
- Landscape irrigation at the interchanges (for establishment post construction).

The anticipated volume, source, management and treatment of operational water are detailed in Table 5.6 of **Chapter 5** (Project description).

The tunnel deluge system has been designed to operate at 350 litres per second at full capacity. Other than during testing, which would require relatively minor water volumes, the deluge system would only operate during emergencies. As such, water for the deluge system would be sourced from the mains supply.

The volume of water required would be typical for tunnelling projects of this scale. It is anticipated that the local water supply network would have sufficient capacity to accommodate project operational water requirements.

Power

Operational electricity supply would be required to supply power to the mainline tunnels and associated mechanical and electrical equipment. As described in **section 5.10** of **Chapter 5** (Project description) and shown on **Figure 5.2** to **Figure 5.8**, nine substations would be constructed to provide operational power supply to the project. The anticipated energy consumption of each operational component of the tunnel is summarised in **Table 5.5** of **Chapter 5** (Project description).

The project has been designed to minimise energy consumption and maximise energy efficiency. Measures to improve energy efficiency are detailed in **Chapter 21** (Greenhouse gas). Initial discussions with power supply authorities indicate that there is sufficient capacity to supply the project's power requirements without negative impacts on the local power supply.

23.4.2 Operational waste management

Solid waste

Additional wastes would be generated during routine maintenance and repair activities required over time, as well as from the operation of the motorway operations complex. The type and volume of wastes generated would be dependent on the nature of the activity, but would predominantly consist of minor volumes of general office waste (paper, plastics, food waste), green waste, oil and road materials, as well as contaminated waste resulting from potential fuel spills and leaks. The volume and types of wastes would be typical of these types of facilities and could be accommodated by existing metropolitan waste management facilities.

With the implementation of standard work practices during routine maintenance and repair activities, the overall impact of operational waste streams would be minimal.

Wastewater

The project would require the capture, removal, treatment and discharge of groundwater inflows during operation. Ongoing inflow of groundwater into the tunnels is anticipated to be around one litre per second, per kilometre. This equates to around 536 megalitres per year in total. Captured groundwater would be treated at the water treatment facility located at Cintra Park. The operational water treatment facility would have a capacity to treat and dispose of up to 17 litres per second.

23.5 Environmental management measures

Resource use and waste management impacts are commonly encountered on all road projects and can be managed and mitigated through the development of construction management plans and implementation of standard approaches.

Measures to avoid, minimise or manage resource consumption and waste streams generated as a result of the project are detailed in **Table 23.1**.

Table 23.1 Environmental management measures

Impact	No.	Environmental management measure	Responsibility	Timing
Construction				
Resource consumption	RW1	Wherever feasible and reasonable, construction material will be sourced from within the Sydney region.	Construction contractor	Pre-construction/ Construction
	RW2	Unnecessary resource consumption will be avoided by making realistic predictions on the required quantities of resources, such as construction materials.	Construction contractor	Pre-construction/ Construction
Management of waste	RW3	Wastes will be managed and disposed of in accordance with relevant State legislation and government policies.	Construction contractor	Construction
	RW4	A Waste Management Plan will be prepared for the construction phase of the project, detailing appropriate procedures for waste management.	Construction contractor	Construction
	RW5	Wastes will be managed using the waste hierarchy principles of: • Avoidance of unnecessary resource consumption to reduce the quantity of waste being generated. • Recover of resources for reuse on site or off site for the same or similar use, without reprocessing • Recover of resources through recycling and reprocessing so that waste can be processed into a similar non-waste product and reused • Disposal of residual waste.	Construction contractor	Construction
	RW6	Residual waste will be classified, handled and stored on site in accordance with the *Waste Classification Guidelines: Part 1 Classifying Waste* (EPA 2014) until collection by a contractor for disposal.	Construction contractor	Construction
	RW7	Off-site reuse of waste will comply with relevant EPA resource recovery exemptions and requirements.	Construction contractor	Construction
Management of asbestos	RW8	An asbestos survey will be undertaken of buildings to be demolished as part of the project. The survey will be conducted by a suitably qualified person.	Construction contractor	Construction
	RW9	Asbestos handling and management will be undertaken in accordance with an Asbestos Management Plan and relevant State legislation, government policies and Australian Standards	Construction contractor	Construction

Impact	No.	Environmental management measure	Responsibility	Timing
Excess spoil	RW10	A spoil management plan will be developed in accordance with the spoil management strategy prior to the commencement of tunnelling works. The plan will identify spoil disposal site/s and describe the management of spoil on site and during off-site transport.	Construction contractor	Pre-construction
Operation				
Management of waste	OpRW1	Wastes will be manage and disposed of in accordance with relevant State legislation and government policies.	Motorway operator	Operation
Operational water requirements	OpRW2	Opportunities for reuse of wastewater will be considered including irrigation of landscaped areas within the project or local parks in preference to discharge to the local stormwater system.	Motorway operator	Operation
	OpRW3	In order to reduce demand on local water supplies, options will be investigated to provide water for the deluge system from wastewater produced through the tunnel drainage system where it meets appropriate quality parameters.	Motorway operator	Operation

24 Climate change risk and adaptation

The NSW Government has acknowledged that, despite efforts to reduce greenhouse gas emissions, some climate change is now inevitable. Adapting to these changes is necessary and it is the Government's goal to minimise the impacts of climate change on natural and built environments and on the NSW communities and economy.

Road networks and infrastructure assets are exposed and vulnerable to climate change because of their long design life, during which many impacts of climate change are likely to become more significant.

For the M4 East project (the project), the WestConnex Delivery Authority (WDA) and NSW Roads and Maritime Services (Roads and Maritime) determined that the assessment of the potential impact of climate change on the project is warranted due to the significant investment required for the project, the long design life of the project, and its exposure to potential flooding impacts.

This chapter outlines the assessment methodology adopted to assess the impacts of climate change on the project and adaptation measures that could be implemented on the project.

The assessment addresses the below requirements of the Secretary of the Department of Planning and Environment (**Table 24.1**).

Table 24.1 Secretary's Environmental Assessment Requirements – climate change risk and adaptation

SEAR	Where addressed
Identification of potential impacts of the proposal on existing flood regimes….. demonstrating consideration of the changes to rainfall frequency and/or intensity as a result of climate change…	Changes to rainfall frequency and/or intensity as a result of climate change are discussed in Appendix A and **section 24.5**.

During detailed design, a detailed Climate Change Risk Assessment would be undertaken (in accordance with the standard AS 5334-2013 *Climate change adaptation for settlements and infrastructure - A risk based approach*), informed by this initial Climate Change Risk Assessment.

24.1 Assessment methodology

Roads and Maritime is currently in the process of finalising a Climate Change Adaptation Practice Note (Practice Note). The Practice Note is aligned with existing Roads and Maritime processes, such as risk management and environmental planning, as well as broader NSW Government initiatives and programs that are designed to respond to climate change impacts. Although the Practice Note is not yet published, this assessment adopts the approach of the latest draft of the Practice Note. This ensures the assessment is consistent with Roads and Maritime's approach to climate change adaptation.

This assessment considers the impact of future climate change on the project, rather than the impact of the project on the future of climate change. Impacts of the project on climate change relate to greenhouse gas emissions generated from the construction and operation of the project. Greenhouse gas emissions have been assessed in **Chapter 21** (Greenhouse gas).

The climate change risk assessment has been undertaken in line with the following relevant standards and current guidelines:

- The risk assessment approach set out in AS/NZS ISO 31000:2009 *Risk Management – Principles and Guidelines* and ISO/IEC 31010 *Risk Management – Risk assessment techniques*
- AS 5334-2013 *Climate change adaptation for settlements and infrastructure − A risk based approach*, which follows ISO 31000:2009 *Risk Management – Principles and guidelines*
- Australian Green Infrastructure Council's *Guideline for Climate Change Adaptation*, Revision 2.1 (2011)
- Draft *Climate Change Adaptation Practice Note* (unpublished) (Roads and Maritime 2015).

The overall approach is focused on risk management and is closely aligned with AS/NZS 31000:2009 *Risk Management* and complements Roads and Maritime's *Guidelines for Risk Management*. The approach comprises the following steps:

- Pre-screening
- Screening
- Detailed risk assessment
- Risk evaluation
- Adaptation (risk treatment).

Each of these steps is described in the following sections.

24.1.1 Pre-screening

Pre-screening was undertaken by WDA and Roads and Maritime prior to this assessment to determine whether the project is likely to be impacted by climate change. As previously mentioned, it was determined that the assessment of the impact of climate change on the project is warranted due to the significant investment required, the long design life of the project, and its exposure to potential flooding impacts.

24.1.2 Screening

Screening aims to identify potential exposure to relevant climate change impacts. Each roads project has a range of engineering components and service provisions and is subject to different climate change impacts, and therefore different risks. It is therefore not appropriate to consider a generic list of climate change risks.

For the project, specific risks were identified using a screening matrix, which plots relevant elements of the project on one axis and key climate change variables relevant to the region on the other axis. By identifying the intersection between the climate change variables and the elements of the project, relationships can be identified and used to form the basis of potential risk scenarios for further analysis. This step forms part of the 'risk identification' of a typical risk management process as described in Roads and Maritime's *Guidelines for Risk Management*.

The climate change risk screening for the project is provided in **Appendix W**.

24.1.3 Detailed risk assessment

The first step of the detailed risk assessment is the formulation of risk scenarios for each of the relationships identified in the screening stage. Each risk scenario is then analysed in detail by assigning a likelihood and consequence rating. The criteria used for likelihood and consequence (following the Roads and Maritime *Guidelines for Risk Management*) are shown in Table W1 and Table W2 of **Appendix W**. The consequence rating considers the potential consequence in terms of the physical asset (damages) and in terms of service provision (loss).

By combining the likelihood and consequence rating for each risk scenario, using the risk ranking matrix in **Table 24.2**, the level of risk can be determined. These are the original risk levels before any mitigation treatments are applied. For example a risk with medium likelihood and low consequence results in a risk level of low.

The detailed risk assessment for the project is provided in **Appendix W**.

Table 24.2 Risk level matrix

		Consequence				
		Negligible	**Low**	**Medium**	**High**	**Extreme**
Likelihood	**Extreme**	Medium	High	Extreme	Extreme	Extreme
	High	Low	Medium	High	Extreme	Extreme
	Medium	Negligible	Low	Medium	High	Extreme
	Low	Negligible	Negligible	Low	Medium	High
	Negligible	Negligible	Negligible	Negligible	Low	Medium

24.1.4 Risk evaluation

The purpose of risk evaluation is to identify which of the risks require treatment. Treatments designed to mitigate the risks should be applied to those risks evaluated as extreme or high. Risks evaluated as negligible or low do not require any further consideration. As this is a preliminary climate change risk assessment and a subsequent detailed risk assessment will be undertaken, medium risks have been retained for consideration.

The risk evaluation for the project is provided in **Section 24.4.1**.

24.1.5 Adaptation (risk treatment)

This step involves the development of risk treatments that can reduce the original unmitigated risk rating. Some adaptation options have been presented in **Table 24.6** in **section 24.5** for consideration during detailed design.

24.2 Existing environment

An increase in global concentrations of greenhouse gases has led to an increase in the Earth's average temperature (surface temperature) (IPCC 2013). The most recent Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) (IPCC 2013) states that 'human influence on the climate system is clear. This is evident from the increasing greenhouse gas concentrations in the atmosphere, positive radiative forcing, observed warming, and understanding of the climate system'.

In 2015, the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and the Australian Bureau of Meteorology (BoM) released an assessment of observed climate change and projected future changes in Australia over the 21st century (CSIRO and BoM 2015a). This recent assessment confirms the long term warming trend, showing that in Australia, the average surface air temperature has increased by 0.9˚C since records began in 1910, with most of the warming occurring since 1950. Australia's warmest year since 1910 was in 2013 (CSIRO and BoM 2015a).

The AR5 states with high confidence that Australia is already experiencing impacts from recent climate change. Observed trends include changes in the frequency of air temperature extremes, changes in mean and extreme rainfall, changes in the frequency and intensity of storm events, ocean warming, ocean acidification and sea level rise.

Due to the long lag times associated with climate processes, even if greenhouse gas emissions are mitigated and significantly reduced, the warming trend and associated impacts of climate change are expected to continue for centuries (IPCC 2007). Key projected trends include:

- Increase in atmospheric carbon dioxide concentrations
- Increase in mean temperature
- Increase in heat extremes
- Decrease in cold extremes
- Changes in mean rainfall
- Changes in the intensity and frequency of extreme rainfall and storm events
- Increase in sea level
- Increase in extreme sea levels (eg storm surges)
- Increase in ocean acidity.
- Increase in bushfire weather.

The magnitude of these projected changes varies both spatially and temporally.

Road networks and infrastructure assets are exposed and vulnerable to climate change because of their long design life, during which many impacts of climate change are likely to become more significant.

The main impacts are associated with an increase in extreme rainfall intensity and frequency (which can exacerbate flooding or landslides risks, and damage to pavement) and from sea level rise (which will worsen damage from coastal erosion, storm surge and coastal flooding and may even eventually lead to long-term inundation and loss of land). The largest impacts are likely to be borne by roads in upland areas with steep topography, and by coastal roads in areas exposed to coastal erosion and storm surge.

Appendix W provides information in the existing climate and historical climate trends of the project area.

24.2.1 Future climate

This section presents climate projections relevant to the project, based on projections published by CSIRO and BoM in 2015. The design life of the project is 100 years to 2119. As such, projections modelled for 2090 (an average of the period 2080−2100) have been selected for the assessment, as these represent the available projections for the time horizon closest to the end of the project design life.

Projections for south-east Australia have also been published by the NSW/ACT Regional Climate Modelling (NARCliM) project (2014) in collaboration with the NSW Office of Environment and Heritage (OEH). However, NARCliM projections are not yet available for a number of key climate variables (extreme rainfall, sea level rise, storm surge, wind speed). This presents limitations when considering climate change impacts in road planning.

Projections provided by CSIRO and BoM are considered most appropriate for this project and are recommended in the Roads and Maritime Climate Change Adaptation Practice Note (Roads and Maritime, unpublished, 2015). It is important that only a single source of projections is used for a climate change risk assessment. This ensures an ‘internally consistent climate future’ approach is used, whereby a consistent set of assumptions, scenarios, and modelling method is applied to each projection. As such, a combination of NARCliM and CSIRO and BoM projections has not been used.

Projections are presented for two emission scenarios or possible pathways, referred to as 'representative concentration pathways' (RCPs), each of which reflects a different concentration of global greenhouse gas emissions. The two RCPs reported here are Intermediate emissions (RCP4.5) and High emissions (RCP8.5). Intermediate emissions projections are only provided in this report for context; the assessment is based on High emissions projections, to account for a worst case scenario based on the precautionary principle.

The ensemble of projections published by CSIRO and BoM (2015b) are spatially broken down into eight natural resource management 'clusters', which largely correspond to broad-scale climate and biophysical regions of Australia. Projections at this scale are considered appropriate for the consideration of future climate for road projects. The project falls within the East Coast cluster. This cluster forms the central part of the eastern seaboard of Australia, straddling the Queensland−NSW border immediately east of the ridgeline of the Great Dividing Range. It extends from south of Sydney in NSW to north of Rockhampton in Queensland.

A summary of projections for the East Coast cluster for 2090 for both the Intermediate and High emissions scenarios is provided in **Table 24.3**, followed by a description of each climate variable.

Table 24.3 Projections for East Coast Cluster for 2090

Climate variable	RCP4.5	RCP8.5
Mean surface temperature	Increase of 1.3˚C to 2.5˚C	Increase of 2.7˚C to 4.7˚C
Extreme temperature (days per year, Sydney)	Increase of 6.0 (over 35˚C) Increase of 0.9 (over 40˚C)	Increase of 11 (over 35˚C) Increase of 2.0 (over 40˚C)
Mean annual rainfall (%)	Decrease by 5% to 15%	Decrease by at least 15%
Extreme Rainfall (one in 20 year, %)	Increase by 10% to +30%	Increase by +10% to +30%
Mean annual wind speed (%)	Between a decrease of 1% and increase of 1%	Between a decrease of 1% and increase of 1%
Bushfire weather (annual cumulative FFDI / number of days with a fire danger rating of severe and above)	Increase of annual cumulative FFDI by 13% Increase of number of days with a fire danger rating of severe and above by 45%	Increase of annual cumulative FFDI by 30% Increase of number of days with a fire danger rating of severe and above by 130%
Sea level (m) (compared to 1986-2005)	Increase of 0.30 m to 0.65 m	Increase of 0.44 m to 0.88 m

Source: CSIRO and BoM 2015b

Mean surface temperature

Mean surface temperature is projected to continue warming during the 21st century, at a rate that strongly reflects the increase in global greenhouse gas emissions (CSIRO and BoM 2015b). By 2090 mean surface temperatures are projected to increase by 1.3˚C to 2.5˚C under RCP4.5 and by 2.7˚C to 4.7˚C under RCP8.5. There is very high confidence in these projections (CSIRO and BoM 2015b).

Extreme temperature

The trend of increasing extreme temperatures is projected to continue, with increases in the annual number of days over 35˚C and 40˚C projected for Sydney. The current number of days over 35˚C in Sydney is 3.1 and the current number of days over 40˚C in Sydney is 0.3. By 2090 under Intermediate emissions, the annual number of days over 35˚C is projected to increase for Sydney by 2.9 days, and the annual number of days over 40˚C is projected to increase by 0.6 days (CSIRO and BoM 2015b). By 2090 under High emissions the annual number of days over 35˚C and 40˚C is projected to increase by 11 and 2.0 days respectively (CSIRO and BoM 2015b).

Mean annual rainfall

By 2090, under Intermediate emissions, the change in mean annual rainfall is projected to range from a 15 per cent decrease to a five per cent increase (CSIRO and BoM 2015b). The direction of trend is more clear under High emissions, projecting a drying by more than 15 per cent by 2090 (CSIRO and BoM 2015b).

Extreme rainfall

Projections of extreme rainfall events (wettest day of the year and wettest day in 20 years) are projected to increase in intensity across Australia. There is high confidence in these projections for Eastern Australia. By 2090, 1 in 20 year events are expected to increase by 10 per cent to 30 per cent under Intermediate emissions and High emissions respectively (CSIRO and BoM 2015b).

Mean annual wind speed

Projections of annual mean wind speed for the East Coast Cluster do not reveal much change for 2090. Under both Intermediate emissions and High emissions, the projected change in mean wind speed is plus or minus one per cent (±1%) (CSIRO and BoM 2015b).

Bushfire weather

Projections of fire weather show that projected warming and drying will lead to fuels that are drier, with increases in the average FFDI and a greater number of days with a severe fire danger rating and above (CSIRO and BOM 2015b). By 2090, under RCP4.5, cumulative FFDI is projected to increase by 13 per cent, and the number of days with severe fire danger is projected to increase by 45 per cent. Under RCP8.5, cumulative FFDI is projected to increase by 30 per cent and the number of days with a fire danger rating of severe and above is projected to increase by 130 per cent. There is a high confidence that climate change will result in a harsher fire weather climate in the future, however there is low confidence in the magnitude of the change, largely due to the uncertainty associated with rainfall projections (CSIRO and BoM 2015b).

Sea level rise

CSIRO and BOM (2015b) state that there is very high confidence that sea levels will continue to rise during the 21st century. By 2090, projections differ significantly between RCPs. Sea levels along the East Coast Cluster shoreline are projected to rise by 0.30 metres to 0.65 metres under RCP4.5, and by 0.44 metres to 0.88 metres under RCP8.5. The continued increase in sea levels along the east coast is projected with very high confidence (CSIRO and BoM 2015b).

Increase in atmospheric carbon dioxide

The current concentration of atmospheric carbon dioxide is approximately 400 parts per million (ppm) (National Oceanic and Atmospheric Administration 2015). RCP8.5 represents a future with little curbing of emissions, with CO_2 concentration continuing to rapidly rise, reaching 940 ppm by 2100. Under RCP4.5 concentrations peak at around 2040 and CO_2 concentrations reach 540 ppm by 2100.

24.3 Assessment of construction impacts

The potential impacts of climate change would be negligible during the construction phase due to its relatively short timeframe. These impacts are therefore not considered further in this assessment and instead the chapter focuses on operational impacts.

24.4 Assessment of operational impacts

24.4.1 Risk evaluation

As discussed in **Section 24.1.4**, high and extreme risks identified in the detailed risk assessment should be treated. The detailed risk assessment (**Appendix W**) did not identify any risks rated as high or extreme. Of the 23 risks that were analysed for the project, a total of 11 risks were identified as being medium. These risks rated as medium are listed in **Table 24.4** for consideration in the subsequent detailed risk assessment to be undertaken during detailed design.

Table 24.4 Climate change risks rated medium

Risk scenario
Increase in atmospheric CO_2 and the frequency and intensity of extreme heat events leads to accelerated deterioration of bridge structures due to corrosion and thermal expansion of steel reinforcement in concrete and thermal expansion of steel, protective cladding, and coatings on bridges.
Increase in the intensity and frequency of extreme rainfall adversely affects performance of surface drainage system due to increased runoff, leading to localised flooding of surface roads, cycle and pedestrian paths, landscaped areas, and within the tunnel.
Increase in the intensity and frequency of extreme rainfall and exacerbated risk of failure of water treatment facilities due to water inflow exceeding the capacity of treatment facilities.
Increase in frequency and intensity of extreme heat events causes power outages due to spikes in energy demand across the grid for cooling systems.
Increase in the intensity and frequency of extreme rainfall leads to exacerbated risk of road incidents.
Increase in the intensity and frequency of extreme rainfall leads to exacerbated risk of flooding of tunnels and failure of tunnel dewatering and water treatment facilities, causing release of untreated water and adverse impacts on the road network level of service.
Increase in frequency and intensity of extreme heat events reduces performance of tunnel ventilation.
Increase in frequency and intensity of extreme heat events increases the risk of heat stress conditions for operational personnel.
Increased frequency and intensity of bushfire events due to increased bushfire weather adversely affects performance of tunnel ventilation system as a result of smoke pollution.
Decrease in mean rainfall combined with an increase in mean surface temperature and the frequency and intensity of extreme heat events, leads to exacerbated risk of dust storms adversely impacting the performance of tunnel ventilation system.
Stormwater pipes which drain into Canada Bay become gradually inundated from sea level rise, and deteriorated from saline intrusion, reducing the performance of the drainage network.

24.5 Management of impacts

Table 24.5 provides adaptation options that could be implemented to reduce the medium level risks. No high or extreme risks were identified.

During detailed design, a detailed Climate Change Risk Assessment would be undertaken (in accordance with the standard AS 5334-2013 *Climate change adaptation for settlements and infrastructure - A risk based approach*), which would be informed by this initial Climate Change Risk Assessment. The assessment would identify and implement adaptation measures to comprehensively address high and extreme risks. The decision to implement adaptation measures for medium risks would also be considered during detailed design. **Table 24.6** provides a list of adaptation options which are available for consideration during detailed design and the subsequent detailed climate change risk assessment.

Table 24.5 Environmental management measures

Impact	No.	Environmental management measures	Responsibility	Timing
Construction				
The impacts of climate change to the project during construction are negligible.				
Operation				
Climate change impacts	CC1	The risks of future climate change will be further considered during detailed design.	Construction contractor	Pre-construction
	CC2	Implement adaptation measures to address high and extreme rated risks identified in the subsequent detailed climate change risk assessment.	Construction contractor	Pre-construction
	CC3	Where extreme, high or medium risks have been identified in this assessment or subsequent climate change risk assessments, a review of the existing design policies, specifications or practices will be undertaken to consider the impacts of climate change.	Construction contractor	Pre-construction

Table 24.6 Adaptation options for consideration during detailed design

Impact	Adaptation option	Timing
Increase in atmospheric CO_2 leads to accelerated deterioration of concrete structures due to corrosion of steel reinforcement in concrete.	In the detailed design of concrete structures, consider options to mitigate the potential impacts to concrete from increasing atmospheric CO_2 (eg thicker concrete, sacrificial layers and protective chemical layers etc).	Detailed design
Increase in the intensity and frequency of extreme rainfall and exacerbated risk of flooding of surface works.	Consider applying 25 per cent (or a minimum of 10 per cent as required by the draft Roads and Maritime Practice Note) sensitivity testing to hydrological/hydraulic modelling on detailed design, including drainage design. In the detailed design of drainage systems, consider the incorporation of additional drainage network features and flood protection measures (e.g. larger drainage network, additional pits, larger pipe diameters, larger sumps etc.) to mitigate a potential increase in flood risks.	Detailed design
Increase in the intensity and frequency of extreme rainfall and exacerbated risk of flooding water treatment facilities.	In the detailed design, consider the capacity for water treatment facilities to cope with the projected increases in extreme rainfall.	Detailed design
Increase in the intensity and frequency of extreme rainfall leads to exacerbated risk of flooding of tunnels and failure of tunnel dewatering and water treatment facilities, causing release of untreated water and adverse impacts on the road network level of service.	In the detailed design, consider the capacity for tunnel dewatering system and water treatment facilities to cope with the projected increases in extreme rainfall.	Detailed design

Impact	Adaptation option	Timing
Increase in frequency and intensity of extreme heat events causes power outages due to spikes in energy demand across the grid for cooling systems.	In the detailed design of the power supply system, consider the potential risk of power outages caused by extreme heat events.	Detailed design
	Consider the implementation of operational procedures for emergency planning and management during power outages.	Operation
Stormwater pipes that drain into Canada Bay become at risk of gradual inundation from sea level rise, and deteriorated from saline intrusion, reducing the performance of the drainage network.	In the detailed design of the stormwater pipes at Canada Bay, consider the potential impacts from sea level rise.	Detailed design
Increased risk of bushfire smoke and dust affecting the performance of tunnel ventilation system.	Consider the implementation of operational procedures for emergency planning and management, in consultation with emergency management services, local governments and other relevant agencies, during bushfire and dust storm events, and other extreme climate events.	Operation
Increase in frequency and intensity of extreme heat events increases the risk of heat stress conditions for operational personnel.	In the refinement of Work Health and Safety Management Plans further consider the increased potential for heat stress among operational personnel (eg a stop work threshold could be implemented for operation and maintenance activities).	Operation
Increase in the intensity and frequency of extreme rainfall leads to exacerbated risk of road incidents.	Consider the implementation of operational procedures to increase safety during extreme rainfall events, such reduced speed limits.	Operation

Note: During the consideration of any of the above adaptation options, analyses of costs and benefits should be undertaken.

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25 Hazards and risk

The construction and operation of the M4 East project (the project) has the potential to create some environmental hazards. Measures to avoid, mitigate or manage these hazards are addressed throughout **Chapter 25** to **Chapter 29** of this environmental impact statement (EIS).

This chapter identifies potential hazards associated with project construction and operation that could pose a risk to the surrounding community or the environment.

25.1 Assessment of construction risks

During construction, the following hazards and risks may be associated with the project:

- Potential hazards resulting from accidental releases or improper handling and storage of dangerous goods and hazardous substances within construction ancillary facilities
- Potential hazards resulting from releases of hazardous substances from vehicles transporting dangerous goods and hazardous substances to and from the construction ancillary facilities in the event of an accident
- Potential rupture of or interference with underground services
- Potential risk of tunnel collapse.

25.1.1 Storage and handling of dangerous goods and hazardous substances

The types of materials and substances that would be stored and used within the construction ancillary facilities include:

- Diesel, stored in self bunded fuel tanks or containers
- Acetylene, stored in cylinders
- Oxygen, stored in cylinders
- Hydraulic oil, stored in containers or drums
- Sulphuric acid, stored in containers
- Sodium hydroxide, stored in containers
- Hypochloric acid, stored in containers
- Sodium hypochlorite, stored in containers
- Coagulant, stored in containers
- Polymer, stored in containers
- Petrol, stored in containers
- Ammonium nitrate, stored in bags
- Flocculants, non-polymer based, stored in tanks
- Detonators, stored in a cool, dry ventilated magazine
- Form oil, stored in drums
- Curing compounds, stored in drums
- Accelerator for shotcrete, stored in containers
- Retardants for concrete, stored in drums
- Cement, stored in bags
- Paints, stored in containers and drums
- Epoxies, stored in drums.

Minor quantities of other materials may also be used at the construction ancillary facilities from time to time. Types and quantities of dangerous goods and hazardous substances stored and/or used within the project would be typical of tunnel construction projects of this scale.

As discussed in **Chapter 2** (Assessment process), *State Environmental Planning Policy No. 33 – Hazardous and Offensive Development* (SEPP 33) does not apply to the project. However, the principles of SEPP 33 have been followed in relation to potential hazards associated with the project. In particular, the screening thresholds specified in *Hazardous and Offensive Development Application Guidelines: Applying SEPP 33* (Department of Planning 2011) (Applying SEPP 33) represent the quantity or distance beyond which dangerous goods may present a credible off-site risk. These screening thresholds have been applied to inventories of dangerous goods to be stored at each construction ancillary facility.

An assessment of inventories of dangerous goods and hazardous substances proposed to be stored at each construction ancillary facility demonstrates that the Applying SEPP 33 screening thresholds would not be exceeded for any material on any site. The storage and use of dangerous goods and hazardous materials on the project construction ancillary facilities would therefore not be potentially hazardous.

The storage, handling and use of dangerous goods and hazardous substances would be undertaken in accordance with the *Work Health and Safety Act 2011* (NSW), the *Storage and Handling of Dangerous Goods Code of Practice* (WorkCover NSW 2005) and relevant Australian Standards.

A register and inventory of the dangerous goods and hazardous substances to be stored on each site would form part of the Pollution Incident Response Management Plan. Material Safety Data Sheets for each substance would be obtained prior to their arrival on site.

Dangerous goods would be stored in accordance with:

- Supplier's instructions
- All relevant Australian Standards
- The *Environment Protection Manual for Authorised Officers: Bunding and Spill Management*, technical bulletin (Environment Protection Authority 1997).

Storage may include bulk storage tanks, chemical storage cabinets/containers or impervious bunds. For liquids, a minimum bund volume requirement of 110 per cent of the volume of the largest single stored container within the bund would be provided. Where practicable, storage areas would be located away from natural or built drainage lines to minimise the potential for pollutants to enter any adjacent watercourses in the unlikely event of a spill or leak escaping the bunded area.

25.1.2 Transport of dangerous goods and hazardous substances

Dangerous goods and hazardous materials would need to be transported to construction ancillary facilities throughout the construction of the project. Potential transportation hazards and risks have been considered by comparing the type, quantity and frequency of dangerous goods and hazardous materials transportation with the thresholds presented in Applying SEPP 33.

Table 25.1 summarises the assessment for transport of dangerous goods for which there are Applying SEPP 33 thresholds during construction. Note that diesel and hydraulic oil are not dangerous goods and would not be transported with Class 3 dangerous goods. Therefore they are not subject to the Applying SEPP 33 transport thresholds.

Table 25.1 Dangerous goods and hazardous substances transported to construction sites

Material	Australian Dangerous Goods Code class	Applying SEPP 33 screening threshold	Maximum transport quantity	Transport frequency	Threshold triggered?
Acetylene	2.1	Two tonnes and more than 30 times per week	20L	Per week	No
Sulphuric acid	8	Two tonnes and more than 30 times per week	3,000L	Per week	No
Sodium hydroxide	8	Two tonnes and more than 30 times per week	3,000L	Per week	No
Hypochloric acid	8	Two tonnes and more than 30 times per week	3,000L	Per week	No
Sodium hypochlorite	8	Two tonnes and more than 30 times per week	3,000L	Per week	No
Petrol	3 PGII	Three tonnes and more than 45 times per week	500L	Per week	No
Accelerator for shotcrete (litres)	3.2	Three tonnes and more than 45 times per week	1,000L	Per week	No

Material	Australian Dangerous Goods Code class	Applying SEPP 33 screening threshold	Maximum transport quantity	Transport frequency	Threshold triggered?
Retardants for concrete	3	One tonne and more than 30 times per week	1,000L	Per month	No
Epoxies	3	10 tonnes and more than 60 times per week	200L	Per month	No

In all cases, the transportation of dangerous goods and hazardous materials to project construction ancillary facilities would be well below the Applying SEPP 33 thresholds. This indicates that risks associated with transport of dangerous goods and hazardous materials are unlikely to be significant. The transport of dangerous goods and hazardous substances would be undertaken in accordance with the *Dangerous Goods (Road and Rail Transport) Act 2008* (NSW) and relevant Australian standards.

25.1.3 Underground services

The potential rupture of underground services during excavation could pose a hazard in the form of electrocution, release of sewage from a sewer main or fire if a gas main is impacted. The risks associated with these hazards would be minimised by:

- Undertaking utility checks (such as 'Dial before you dig')
- Consulting with the relevant service infrastructure providers
- Service and utility identification works(where possible by non-destructive means eg vacuum truck)
- Relocating and/or protecting utilities in and around the project before construction begins, if required.

Consultation with service infrastructure providers would commence during the detailed design, and would continue throughout construction to mitigate the risk of unplanned or unexpected disturbance of utilities.

25.1.4 Risk of tunnel collapse

The mainline tunnels would generally be excavated in good quality Hawkesbury sandstone. The tunnel design includes an arched crown lining to support the existing material. The thickness of the lining and future form of the arch would be determined during detailed design, following additional geotechnical investigations.

Construction of the tunnels would be undertaken in sections. A 'permit to tunnel' system would be implemented, which would require authorisation from the tunnel construction manager (or authorised delegate) and geotechnical engineer before tunnelling is allowed to continue to the next section. The permit to tunnel authorisation considers the anticipated and observed ground support performance, and geotechnical and groundwater conditions. This would minimise the risk of tunnel collapse.

25.2 Assessment of operational risks

During operation, the following potential hazards and risks may be associated with the project:

- Hazards resulting from accidental releases or improper handling and storage of dangerous goods and hazardous substances in the water treatment facility
- Hazards resulting from releases of hazardous substances from vehicles transporting dangerous goods and hazardous substances to and from the water treatment plant in the event of an accident
- Crashes and incidents within the mainline tunnels or on- and off-ramps
- Crashes and incidents on surface roads.

25.2.1 Storage and handling of dangerous goods and hazardous substances

The types of materials and substances that would be stored and used during operation of the operational water treatment facility located at Cintra Park include:

- Sodium hydroxide, stored in a tank in an undercover bunded area
- Coagulant, stored in a tank in an undercover bunded area
- Polymer, stored in bags and in a dosing hopper
- Diesel, stored in bunded tanks in pumps.

Additional small quantities of other materials may be required on site from time to time to support occasional maintenance activities.

Comparison of the types and quantities of dangerous goods and hazardous materials to be stored on site with the thresholds in the Applying SEPP 33 guideline demonstrates that operational inventories would not pose a significant risk of harm beyond the project boundary.

Dangerous goods would be stored in accordance with:

- Supplier's instructions
- All relevant Australian Standards
- The *Environment Protection Manual for Authorised Officers: Bunding and Spill Management*, technical bulletin (NSW Environment Protection Authority 1997).

For liquids, a minimum bund volume requirement of 110 per cent of the volume of the largest single stored container within the bund would be provided.

25.2.2 Transport of dangerous goods and hazardous substances

Dangerous goods and hazardous materials would be transported to the project during operation. Potential transportation hazards and risks have been considered by comparing the type, quantity and frequency of dangerous goods and hazardous materials transportation with the thresholds presented in Applying SEPP 33.

Table 25.2 summarises the assessment for transport of dangerous goods during operation against the Applying SEPP 33 threshold triggers. As noted in **section 25.1.2**, diesel would not be transported with Class 3 dangerous goods and is therefore not subject to the Applying SEPP 33 transport thresholds.

Table 25.2 Dangerous goods and hazardous substances transported during operation

Material	Australian Dangerous Goods Code class	Applying SEPP 33 screening threshold	Maximum transport quantity	Transport frequency	Threshold triggered?
Sodium hydroxide	8	Two tonnes and more than 30 times per week	10,000L	Every six months	No

The transportation of sodium hydroxide would be well below these thresholds. This indicates that risks associated with transport of dangerous goods and hazardous materials during operation of the project are unlikely to be significant. The transport of dangerous goods and hazardous substances would be undertaken in accordance with the *Dangerous Goods (Road and Rail Transport) Act 2008* (NSW) and relevant Australian standards.

25.2.3 Incidents in the tunnels

Any road project carries an inherent risk of vehicle collision associated with its operation. The potential for incidents and accidents to occur is a function of:

- The design of the project
- The type and volumes of traffic using the project
- Driving conditions, including light conditions and meteorology
- Human factors, including compliance with road rules, attention to driving conditions and fatigue
- Vehicle failure and breakdown.

The project has been designed to provide for efficient, free flowing traffic with physical capacity to accommodate predicted traffic volume. The design has incorporated all feasible and reasonable design measures including in relation to geometry, pavement, lighting and signage, consistent with current Australian Standards, road design guidelines and industry best practice. In doing so, the design of the project has been developed to inherently minimise the likelihood of incidents and accidents.

Specific tunnel features designed to minimise the occurrence of incidents and accidents include:

- Height detection system prior to the tunnel portals
- Tunnel barrier gates to prevent access in the event of tunnel closure
- Closed-circuit television (CCTV) throughout the tunnel and approaches.

The project has also been designed to meet appropriate fire and life safety requirements in the event of an incident or accident in the tunnel. Each project tunnel would be one directional, reducing the risk of vehicle accidents through head-on collisions and simplifying smoke management and egress requirements. The transport of dangerous goods and hazardous substances would be prohibited through the mainline tunnels and on- and off-ramps, reducing the risk of very large fires or the release of toxic materials in the tunnel. Other fire and life safety aspects that would be incorporated into the project include:

- State of the art CCTV and audible systems to detect incidents and manage evacuation processes
- Multiple pedestrian cross passages between the main alignment tunnels and longitudinal egress passages along the on- and off-ramps, to allow pedestrians to exit the tunnel and on- and off-ramps in the event of a major incident (refer to **section 5.7.3** in **Chapter 5** (Project description))
- Automatic fire and smoke detection within the tunnels
- Longitudinal ventilation to 'push' smoke in the direction of traffic flow away from the fire source towards a ventilation facility or tunnel portal
- A water deluge system that would be activated manually or automatically at the fire source
- Structures, linings and services that would be fire hardened to protect them from fire damage before the activation of the deluge system, or if the deluge system fails.

In the event of an incident, approaching traffic would be prevented from entering either mainline tunnel. Vehicle occupants at the location of the fire and upstream of the fire source would be instructed to stop their vehicles, and exit in the opposite direction through the section of carriageway that would be protected by the smoke management system, or through an exit door to a cross-passage leading to the other ('non-incident') mainline tunnel.

Occupants downstream of the fire source would be encouraged to continue driving out of the tunnel. If this is not possible and they are forced to evacuate on foot, egress would be provided via an exit door to a cross-passage leading to the non-incident mainline tunnel. Emergency services would be able to reach the fire source via the non-incident tunnel (by vehicle or foot), or from the upstream direction in the affected tunnel (by foot).

25.2.4 Incidents on surface roads

As discussed above, the design of the project has been developed to inherently minimise the likelihood of incidents and accidents. Surface roads and infrastructure have been designed to provide an efficient and safe road network.

An important road safety opportunity facilitated by the project is an overall improvement in the road safety performance of Parramatta Road, as a consequence of reduced traffic volumes between the M4 and Dalhousie Street at Haberfield. A detailed discussion of the impact of the project on traffic volumes is provided in **Chapter 8** (Traffic and transport).

Parramatta Road currently carries large volumes of traffic. Between 1 July 2009 and 30 June 2014, 919 crashes occurred on Parramatta Road, of which the highest proportion was rear-end crashes. This indicates that congestion was a likely factor in these crashes. Due to the anticipated reduction in vehicles on Parramatta Road as a result of the project, travelling conditions on Parramatta Road and the surrounding network between the M4 and Dalhousie Street would generally improve, which would result in the following traffic related benefits:

- Improved traffic flow and intersection performance
- Reduced crash rates
- Improved road safety for pedestrians, cyclists and motorists
- Improved travel times for bus services and motorists.

These traffic related benefits are expected to result in an improved road safety environment.

Further details of the expected changes in traffic volumes on existing and new road infrastructure and improvements to road safety are provided in **Chapter 8** (Traffic and transport). Impacts and improvements to noise, air quality and human health risks are discussed in **Chapter 11** (Noise and vibration), **Chapter 9** (Air quality) and **Chapter 10** (Human health) respectively.

25.3 Environmental management measures

As described in the preceding sections, the design of the project has been developed to inherently minimise the likelihood of incidents and accidents. Environmental management measures relating to hazards and risk for are outlined in **Table 25.3**. In addition to these measures, the project will also include a Work Health and Safety Plan (WHS Plan) which will be implemented during construction. The WHS Plan will support and augment the measures and procedures included in the Construction Environmental Management Plan (CEMP) and will be supplemented by site and activity specific Safe Work Method Statements.

Table 25.3 Environmental management measures – hazards and risk

Impact	No.	Environmental management measure	Responsibility	Timing
Construction				
General	HR1	Site-specific hazard and risk management measures will be included within the CEMP, which will include items such as: • Details of the hazards and risk associated with construction activities for both surface and subsurface works • Procedures to comply with legislative and industry standard requirements • Training for relevant personnel (including subcontractors) and site inductions, including the recognition and awareness of site hazards and locations of relevant equipment.	Construction contractor	Pre-construction/ construction
Storage of dangerous goods and hazardous substances	HR2	Dangerous goods and hazardous materials will be stored in accordance with: • *Work Health and Safety Act 2011* (NSW) • Storage and Handling of Dangerous Goods Code of Practice (WorkCover NSW 2005) • Supplier's instructions • Relevant Australian Standards • The *Environment Protection Manual for Authorised Officers: Bunding and Spill Management*, technical bulletin (Environment Protection Authority 1997). For liquids, a minimum bund volume requirement of 110 per cent of the volume of the largest single stored volume within the bund will be provided.	Construction contractor	Construction
	HR3	Material Safety Data Sheets for dangerous goods and hazardous substances will be obtained before these materials arrive on site.	Construction contractor	Construction

Impact	No.	Environmental management measure	Responsibility	Timing
Transport of dangerous goods and hazardous substances	HR4	Transport of dangerous goods and hazardous substances will be conducted in accordance with relevant legislation and codes, including the *Dangerous Goods (Road and Rail Transport) Act 2008* (NSW), *Dangerous Goods (Road and Rail Transport) Regulation 2014* (NSW) and the Australian Code for the Transport of Dangerous Goods by Road and Rail (National Transport Commission 2008).	Construction contractor	Construction
Operation				
Storage of dangerous goods and substances	HRop1	Dangerous goods and hazardous materials will be stored in accordance with: • *Work Health and Safety Act 2011* (NSW) • Storage and Handling of Dangerous Goods Code of Practice (WorkCover NSW 2005) • Supplier's instructions • Relevant Australian Standards • The *Environment Protection Manual for Authorised Officers: Bunding and Spill Management*, technical bulletin (Environment Protection Authority 1997). For liquids, a minimum bund volume requirement of 110 per cent of the volume of the largest single stored volume within the bund will be provided.	Motorway operator	Operation
	HRop2	Material Safety Data Sheets for dangerous goods and hazardous substances will be obtained before these materials arrive on site.	Motorway operator	Operation
Transportation of dangerous goods and hazardous substances	HRop3	Transport of dangerous goods and hazardous substances will be conducted in accordance with relevant legislation and codes, including the *Dangerous Goods (Road and Rail Transport) Act 2008* (NSW), *Dangerous Goods (Road and Rail Transport) Regulation 2014* (NSW) and the Australian Code for the Transport of Dangerous Goods by Road and Rail (National Transport Commission 2008).	Motorway operator	Operation
Incident response	HRop4	An Incident Response Plan will be developed and implemented in the event of an accident or incident.	Motorway operator	Operation

26 Cumulative impacts

This chapter provides a summary of the cumulative impacts associated with the M4 East project (the project).

The Secretary of the NSW Department of Planning and Environment (DP&E) has issued a set of environmental assessment requirements for the project; these are referred to as Secretary's Environmental Assessment Requirements (SEARs). **Table 26.1** sets out these requirements as they relate to cumulative impacts, and identifies where they have been addressed in this environmental impact statement (EIS).

Table 26.1 Secretary's Environmental Assessment Requirements – cumulative impacts

Secretary's Environmental Assessment Requirement	Where addressed in the EIS
an analysis of the project including an assessment, with a particular focus on the requirements of the listed key issues, in accordance with clause 7(1)(d) of Schedule 2 of the Regulation (where relevant), including an identification of how relevant planning, land use and development matters (including relevant strategic and statutory matters) have been considered in the impact assessment (direct, indirect and cumulative impacts) and/or in developing management/mitigation measures;	**Chapter 26** (this chapter)
Provide an assessment of the cumulative impacts of the project taking into consideration the broader project of WestConnex.	**Chapter 26** (this chapter)

26.1 Nature of cumulative impacts

Cumulative impacts result from a number of projects being constructed or operated at the same time. They typically include:

- Impacts on local, regional and State traffic, transport and road users
- Social and economic effects, including changes to land use, access, settlements, employment and businesses
- Changes to local and regional amenity, including noise, vibration, visual quality and air quality
- Environmental changes including effects on water quality, hydrology and biodiversity.

In isolation, a particular impact from one project may be considered minor, but when the impact of multiple projects on the same receivers is considered, the impacts may be much more substantial.

Another type of cumulative impact is known as construction fatigue. This concept relates to sensitive receivers that experience construction impacts from a variety of projects over a long period of time with few or no breaks between construction periods. Construction fatigue typically relates to amenity impacts from projects that are constructed consecutively or 'back to back'.

The impacts associated with the construction and operation of the project and other relevant projects are the subject of this cumulative impact assessment. Prediction and evaluation of cumulative impacts is not a straightforward process. The following sections provide an assessment based on the most current and publicly available information.

26.2 Assessment methodology

Cumulative impacts have been assessed in two categories: WestConnex related impacts and impacts from other developments in the vicinity of the project.

Impacts associated with WestConnex have been assessed assuming that all components of WestConnex (refer to **section 26.3.1** for discussion) are constructed.

The identification of developments that could occur in the vicinity of the project only included 'major projects', as identified by DP&E. Consideration was also given to other 'strategic projects' being considered by government. This cumulative impact assessment considered projects located within the suburbs of Auburn, Ashfield, Burwood, Canada Bay, Concord, Croydon, Five Dock, Haberfield, Homebush, Homebush West, Lidcombe, North Strathfield, Strathfield and Sydney Olympic Park.

26.3 Existing environment

26.3.1 WestConnex

The project is a component of WestConnex, which is a proposal to provide a 33 kilometre motorway linking Sydney's west and south-west with Sydney Airport and the Port Botany precinct. The location of WestConnex is shown in **Figure 1.2** in **Chapter 1** of this EIS. The individual components of WestConnex are:

- M4 Widening – Pitt Street at Parramatta to Homebush Bay Drive
- M4 East (the subject of this EIS)
- New M5 – King Georges Road at Beverly Hills to St Peters
- King Georges Road Interchange Upgrade (KGRIU) (not shown on **Figure 1.2**, but forms the western extent of the New M5 project)
- M4–M5 Link – Haberfield to St Peters, including the Southern Gateway and Southern Extension.

Separate planning applications will be lodged for each individual component project, and each project will be assessed separately. **Table 26.2** outlines the timing of each of the WestConnex projects, and shows that there is potential for projects to overlap during their respective construction phases.

The two other WestConnex component projects most likely to result in cumulative impacts during construction of the project are M4 Widening and M4−M5 Link, as they are located directly adjacent to the project and would potentially overlap construction periods. Other component projects, such as the New M5 and King Georges Road Interchange Upgrade, are located further from the project and are more likely to utilise the M5 corridor during construction.

Table 26.2 Timing of WestConnex components

Project	Approval	Start of work	Start of operation
M4 Widening	21 December 2014	March 2015	Late 2016
M4 East	Early 2016	Mid 2016	Early 2019
New M5	Early 2016	Mid 2016	Late 2019
King Georges Road Interchange Upgrade	3 March 2015	July 2015	Late 2016/early 2017)
M4−M5 Link	2017/18	2019	2023

The following sections outline the respective environmental impacts identified for the M4 Widening, New M5 and King Georges Road Interchange Upgrade. As the environmental approvals process for M4–M5 Link has not commenced, it is difficult to identify the details of any specific impacts that would potentially contribute to cumulative impacts.

M4 Widening

The EIS for M4 Widening was approved on 21 December 2014. The adverse impacts outlined in the EIS for M4 Widening are summarised below.

During construction of the project, adverse impacts would include:

- Noise and vibration, including potential night-time disturbance associated with out-of-hours work
- Dust and construction vehicle emissions
- Traffic and access impacts
- Impacts on three threatened ecological communities (Swamp Oak floodplain forest, Shale gravel transition forest and Freshwater wetlands on coastal floodplains). This would be limited to a total of approximately 0.17 hectares of moderate condition vegetation and 0.35 hectares of low condition habitat.

Construction impacts would be minimised through further consideration during detailed design and construction planning, application of appropriate management and mitigation measures, and consultation with affected residents.

During operation, adverse impacts would include:

- Traffic noise requiring new noise barriers and property treatments
- Visual impacts associated with new viaducts and bridges
- Increased traffic on Parramatta Road and other roads due to toll avoidance
- Potential minor flooding impacts along A'Becketts Creek.

While substantial travel time benefits are expected along the M4 as a result of M4 Widening, the WestConnex Road Traffic Model has indicated that this component project is expected to increase travel times on Parramatta Road between Church Street and Homebush Bay Drive as drivers seek to avoid the toll. However, even allowing for an increase of 1.5 million people living in Sydney by 2031, there would still be fewer people using Parramatta Road during the morning and afternoon peak periods than there were in 2008, when the M4 had a toll.

King Georges Road Interchange Upgrade

The EIS for the King Georges Road Interchange Upgrade project was approved on 3 March 2015. The adverse impacts outlined in the King Georges Road Interchange Upgrade EIS are summarised below.

During construction of the King Georges Road Interchange Upgrade project, adverse impacts would include:

- Noise and vibration, including potential night-time disturbance associated with out-of-hours work
- Dust and construction vehicle emissions
- Traffic and access impacts
- Changes to existing cycle routes.

Construction impacts would be minimised through further consideration during detailed design and construction planning, application of appropriate management and mitigation measures, and consultation with affected residents.

During operation, adverse impacts would include:

- Traffic noise, requiring a combination of new noise barriers, adjustments to the height of one existing noise barrier, and treatments at six residential properties
- Visual impacts associated with new bridge structures and retaining walls
- Changes to existing cycle routes.

New M5

An EIS for the new M5 has not yet been completed. SEARs were issued for the New M5 project on 5 March 2015. The impacts identified within the State significant infrastructure application report are summarised below.

The following adverse impacts during construction of the New M5 have been identified in preliminary investigations:

- Traffic and access impacts due to construction traffic and changes to the road network
- Construction noise around compounds and work areas
- Construction traffic noise due to increased vehicle movements, in particular heavy vehicles
- Vegetation clearance, including potentially threatened flora species and communities or habitat for threatened fauna species
- Visual impacts due to presence of work areas
- Impacts on non-Aboriginal heritage items located within the project footprint.

The following adverse impacts during operation of the New M5 have been identified in preliminary investigations:

- Increased traffic in the vicinity of the project, including traffic generated by potential toll avoidance
- Air quality impacts associated with ventilation of the tunnels
- Traffic noise impacts due to changes in road alignments
- Visual impacts of new infrastructure, particularly at interchanges
- Property impacts due to acquisition for operational components of the project
- Groundwater impacts due to inflow into tunnels.

M4–M5 Link

The planning approval process for the M4–M5 Link project has not commenced and specific potential impacts of this project are not yet known. Environmental impacts of the whole of WestConnex were identified in the Strategic Environmental Review (Sydney Motorways Project Office 2013b), and the following potential adverse impacts are considered relevant to the M4–M5 Link project:

- Air quality impacts due to tunnel ventilation
- Construction and operation noise and vibration impacts, particularly in a highly urbanised area
- Socio-economic impacts on the surrounding community
- Construction traffic impacts associated with spoil removal
- Visual impacts of construction areas and operational facilities.

26.3.2 Other nearby developments

Columbia Precinct

A concept plan approval was obtained for the establishment of mixed use development at 2−20 Parramatta Road and 11−13 Columbia Lane in Homebush on 7 May 2013. This land is roughly bounded by Parramatta Road to the north, Powells Creek to the west and south and the Goods Loop, located between the Main Western Line and the Main North Line at Homebush, to the east.

The concept plan approval was granted for the following development proposal:

- Development of six mixed use building blocks with a maximum height of 76.50 AHD
- Maximum gross floor areas of the following
  - 60,827 square metres for residential apartments

  - 1,300 square metres for retail
  - 3,460 square metres for showrooms
  - 4,24 square metres for commercial
  - 12,850 square metres for storage facility
  - 920 square metres for community use
- Construction of a new road that would form an intersection with Parramatta Road at George Street in North Strathfield.

The environmental assessment completed for the concept plan made the following conclusions:

- The proposal would not have a material impact on traffic and transport. The new proposed intersection would operate at a Level of Service C, which is satisfactory
- Construction noise and vibration levels would likely meet the recommended management levels. Operational noise emissions would be minor, subject to implementation of an appropriate acoustic design
- The proposal is a sensitive and thoughtful development with respect to urban design considerations. Visual impacts would be positive and in keeping with the surrounding area
- Impacts on soils are considered highly unlikely. Water quality has been addressed through various controls and there is unlikely to be a material impact on receiving water quality
- The primary flood risk is associated with Powells Creek; however, the 100 year ARI flood level was deemed appropriate for development of the site
- The redevelopment of the site − which comprises former industrial and commercial buildings − to mixed use commercial, residential and retail purposes is anticipated to be a positive socio-economic benefit
- Impacts on biodiversity, Aboriginal heritage, historical heritage and air quality are considered unlikely.

Following the approval of the concept plan, a further application was lodged with Strathfield Council to obtain development approval. The development for which approval was being sought included:

- Construction of a mixed use development, which includes eight and 14 storey towers comprising ground level retail and commercial units and 430 residential units
- Construction of an extension to George Street for use as a public road, including intersection works linking Parramatta Road and the rear lane in addition to public domain works
- Two levels of basement car parking with vehicular access from the existing rear lane,

Due to the capital investment value of the development (ie over $20 million), it was referred to the Sydney East Joint Regional Planning Panel, which approved the application on 30 October 2014.

Construction of this development has commenced.

Enfield Intermodal Logistics Centre

The Enfield Intermodal Logistics Centre (EILC) is located at South Strathfield, about 3.5 kilometres south of the western end of the project. The site is located to the east of Roberts Road, which is a continuation of Homebush Bay Drive. The majority of the development has been completed and is currently operational.

The original development approval did not include the construction of warehousing on the site with only the subdivision included to allow for future warehouse development.

An application to modify the existing approval has since been submitted, to allow development of an agriculture commodities storage and handling facility. SEARs for this modification were issued in May 2014. The proposed development is consistent with the use of the land for warehousing within the original approval.

The Preliminary Environmental Assessment accompanying the modification application identified a number of potential environmental impacts. Due to the separation of the EILC and the project, many of these impacts are not considered to contribute to the cumulative impacts.

As highlighted in the Preliminary Environmental Assessment, the new warehousing area would result in up to 186 additional truck movements per day accessing the arterial road network via Roberts Road.

Sydney Olympic Park and Wentworth Point developments

A number of large developments are occurring within the Sydney Olympic Park area located directly north of the western end of the project, on the western side of Homebush Bay Drive. Development within Sydney Olympic Park includes residential, commercial and mixed development.

One major development within Sydney Olympic Park is located along its southern boundary, to the north of the M4. There is currently a strategic proposal to convert existing warehouse areas within the Carter Street Precinct to provide a mix of housing, office-based employment and retail services. The proposed Carter Street Precinct would include:

- More than 5,500 new homes comprising a mix of townhouses and apartments
- Buildings of mainly four to six storeys along east−west streets, six to eight storeys along main streets and parks, and up to 20 storeys on five sites
- A new 1.8 hectare park with recreation uses as well as stormwater management features
- Publicly accessible foreshore along Haslams Creek, with pedestrian and cycle paths linking to the existing network throughout Sydney Olympic Park
- A retail centre with up to 12,000 square metres of shops and services along Uhrig Road, focusing on a village square where residents and workers can meet and socialise, and a village park with an adjacent community centre
- Corporate offices and a business and technology park on 11.4 hectares of highly accessible land along the M4 corridor.

The timing of this development is currently unknown and the details of any development would only be confirmed at a later date.

Further residential development is occurring within Wentworth Point, north of Sydney Olympic Park. This development is accessed via Sydney Olympic Park and Homebush Bay Drive.

Parramatta Road Urban Transformation Program

As outlined in **section 3.1.7** of **Chapter 3**, WestConnex (including the project) is considered to be the catalyst for the implementation of the Parramatta Road Urban Transformation Program. This program aims to renew areas along Parramatta Road that are currently subjected to deteriorated streetscapes due to large traffic volumes and the associated noise and air quality impacts.

The program has identified eight urban renewal precincts along the Parramatta Road corridor. Three of these are located within the extent of the project, with others located both east and west of the project.

The Homebush precinct is generally located between Homebush Bay Drive, Parramatta Road and the Main North Rail Line. It has been identified for significant future growth because of its central location and very good access to transport and employment opportunities, and its ability to complement the adjoining Sydney Olympic Park. The Parramatta Road Strategy identifies that the precinct could accommodate areas of high-rise residential development (average of 14 storeys with a maximum of 25 storeys). The precinct is projected to have between 10,350 and 16,200 additional dwellings by around 2050.

The Burwood precinct is centred on the intersection of Burwood Road and Parramatta Road, extending south towards existing commercial and medium density residential development in Burwood, and north towards Crane Street in Concord. The Burwood precinct has been identified for future growth because of its good access to transport, as well as employment opportunities accessible by rail and bus. The north part of the precinct has also been identified for future growth, because of the amenity offered by Kings Bay and its associated network of foreshore open spaces. The precinct is projected to have between 4,300 and 6,400 additional dwellings by around 2050.

The Kings Bay (Five Dock) precinct is located along Parramatta Road and Queens Road, generally between Regatta Road and Courland Street. The Kings Bay precinct has been identified for future growth because of its very good access to bus services to the Sydney CBD and Burwood. The precinct is projected to have between 3,200 and 4,200 additional dwellings by around 2050.

Development of these areas is currently in the planning stages, with concept plans being prepared. Detailed information about these developments is not currently available; however, it is understood that such developments would likely begin construction following the commissioning of the project and other WestConnex component projects.

26.4 Cumulative impacts of WestConnex component projects

The following sections outline the potential cumulative impacts associated with the construction and operation of all WestConnex component projects. Only those impacts that are considered to be potentially substantial have been discussed below.

26.4.1 Traffic and transport

Construction

The King Georges Road Interchange Upgrade is scheduled for completion by the second quarter of 2017. While there is a small time overlap with the beginning of project construction, heavy vehicle and other access routes are not expected to converge because they are likely to utilise the M5 corridor. There is therefore minimal potential for cumulative impacts with this project.

M4 Widening construction works are scheduled for completion by 2017. Construction haul routes and vehicle access routes are expected to be similar to the project given the location and nature of construction. This would result in a small overlap between the commencement of construction of the project and the completion of construction of the M4 Widening. The workforce demand profile for the project suggests that vehicle movements would increase from about 20 per cent of peak construction in the first quarter of 2016, to 80 per cent in the third quarter. During this period, construction vehicle movements associated with M4 Widening would reduce, as the majority of work sites would be completed by the end of the second quarter. As a result, the combined impact during this period is expected to be less than during the peak construction period for the project alone.

Subject to planning approval, the New M5 currently has a projected construction timetable extending from the third quarter of 2016 to the third quarter of 2019. This is a delay of about six months behind the project. There is therefore a large overlap between the construction periods for the two projects. Preliminary information indicates that the majority of heavy vehicle and other routes associated with the New M5 would use the existing M5 corridor, and would therefore have limited potential for cumulative impact with the project.

Operation

Traffic modelling undertaken for the 2031 ‘do something’ scenario models the impacts on the road network with all components of WestConnex constructed (ie M4 Widening, M4 East, M4–M5 Link, New M5 and the King Georges Road Intersection Upgrade). **Chapter 4** (Project development and alternatives) describes the various alternative scenarios defined for the project. Traffic modelling is discussed in **section 8.4.1** of **Chapter 8** (Traffic and transport). The modelling identified that the project would significantly reduce vehicle delay along the corridor between Homebush Bay Drive in the west and City West Link and Haberfield/Leichardt in the east, and also at the majority of intersections assessed. The assessment identified some higher traffic densities downstream of the project on- and off-ramps on Parramatta Road and Wattle Street, indicating the potential for exit and merge issues.

26.4.2 Air quality

Construction

Cumulative construction air quality impacts are not considered to significantly vary from those discussed in **section 9.6** in **Chapter 9** (Air quality)

Operation

Cumulative operational air quality impacts have been assessed, by including all stages of WestConnex (in particular the M4–M5 Link which is located directly adjacent to the project) in the 2031 'do something' air quality modelling scenario. Discussion of cumulative operational air quality impacts is provided in **section 9.8**.and **Appendix H**.

The inclusion of the M4–M5 Link into modelling showed that results were broadly similar to the concentrations in 2021 with the project only. In general the impacts are beneficial for the majority of both community and residential, workplace and recreational receptors, however it is predicted that there would some significant increases in concentrations of pollutants for a very small number of receptors for some pollutants.

26.4.3 Noise and vibration

Construction

The M4 Widening project includes a construction compound on the southern side of the existing M4, east of Homebush Bay Drive, associated with the G-loop on-ramp works at Homebush Bay Drive. There is some potential for construction of the project to overlap with construction of the M4 Widening project, which is scheduled for completion in 2017. While it is anticipated that the frequency of potential construction noise impacts may increase during this overlapping period, there are no predicted increases in the worst-case construction noise impacts as presented in **section 10.4.1** of **Chapter 10** (Noise and vibration), due to the distances between plant items (for either project) and the affected receivers.

Operation

The operational noise assessment undertaken as part of the project included an assessment of 2031 traffic volumes, which included the cumulative noise impacts of vehicles using WestConnex when all projects are completed. The assessment is discussed in **section 10.5.1** of **Chapter 10** (Noise and vibration).

The results of the operational noise assessment are summarised in **section 10.5.1** in **Chapter 10** (Noise and vibration). In summary, the project as part of WestConnex would result in a reduction in the total number of properties where exceedances are to be experienced when compared with the 'no build' scenario for 2031 (ie without the project). This is largely due to sections of the corridor where vehicles would divert from surface roads (predominantly Parramatta Road) into the M4 East tunnels. Overall, 78 per cent of receivers would see a reduction in noise levels, while a further 19 per cent would only experience a minor increase (less than two dBA), which is barely noticeable to the average person.

Noise impacts would, however, increase in the vicinity of the Concord Road, Wattle Street and Parramatta Road intersections due to changed conditions (ie road closer to homes), increased traffic and a loss of structures that currently provide screening.

Notwithstanding the improvements noted above, there is still a requirement to provide additional noise mitigation at receivers where noise levels are above the criteria. Further discussion of this mitigation and the eligible receivers is located in **section 10.5.1** of **Chapter 10** (Noise and vibration).

26.4.4 Economic impacts

Construction

Cumulative impacts on local businesses and the economy are most likely to result from overlapping construction periods for the project, M4 Widening and the New M5. The economic impacts from multiple simultaneous construction periods are considered to intensify the impacts that have been identified for the project only, and described in **Chapter 14** (Social and economic). In particular, these impacts relate to employment opportunities and economic stimulus.

The labour demand from WestConnex and other major projects within the area (and across wider Sydney) would increase employment opportunities for local residents. An increased demand for construction workers would also potentially increase wages.

The opportunity for local businesses to supply goods or services during the construction of these multiple projects, both to the projects directly and to their construction workforces, has the potential to increase business turnover. By contrast, however, there is the potential for businesses located close to the project and other WestConnex projects to experience extended periods of impacts on amenity, which could result in a downturn in their usual business.

The staggered nature of WestConnex (in particular M4 Widening and M4 East, for which works would occur in a similar location) results in an extension of the period of construction and the impacts experienced in any one area. For example, the area of Homebush around the Homebush Bay Drive interchange would experience a construction period which would potentially last five years.

There is the potential for construction vehicles associated with other projects to contribute further to congestion on the road network and further increase travel times along the M4 and Parramatta Road. This would further affect the movement of freight via these routes during the construction periods, resulting in delays and consequent increased costs. Such impacts would also flow on to on motorists, who would spend longer in transit.

Operation

The operation of WestConnex and the implementation and operation of the Parramatta Road Transformation Program would result in impacts on the economy and businesses in the vicinity of the project.

It is estimated that in 2023, with all stages of WestConnex completed, there would be a significant reduction in traffic on Parramatta Road. This, in combination with the Parramatta Road Transformation Program, would result in improved amenity and increased accessibility to businesses along Parramatta Road. These projects would also facilitate job growth and enable freight to move efficiently through and across Sydney.

The freight industry would benefit from WestConnex enabling the efficient movement of freight from Western Sydney to Sydney Airport and Port Botany (and vice versa), thus improving access to interstate and international markets. WestConnex provides one of the missing links in the Sydney motorway network by creating a connection between the M4 and M5 motorways. The resulting benefits for freight include the opportunity to streamline interstate movements around and through Sydney. This provides businesses with connections to service more diverse and dispersed markets across the Sydney metropolitan area and potentially beyond.

WestConnex would also assist in facilitating active transport options along the Parramatta Road corridor, to improve north−south connectivity and the potential for streetscape improvements. Improvements in public and active transport and in public amenity have the potential to drive residential and mixed use development and the ability to attract new and different types of businesses into the area.

26.4.5 Social impacts

Construction

Construction of the project and M4 Widening would overlap, resulting in extended durations of construction impacts in the vicinity of Homebush Bay Drive. At a local and regional level, for commuters, public transport users, pedestrians and cyclists, social impacts related to travel delays, diversions and inconvenience, exposure to visual and noise amenity impacts would be prolonged.

Additionally, upon construction of the M4–M5 Link (which is subject to planning approval), the Wattle Street precinct would again be subject to construction impacts. However, the project includes works in this location for the M4– M5 Link because of the construction efficiencies in undertaking them as part of the project. This would largely limit impacts to the community to a single construction phase.

Operation

The project and WestConnex are integral to the realisation of the Parramatta Road Urban Transformation Program. One of the key aims of the project is to reduce traffic volumes on Parramatta Road, with consequent amenity improvements facilitating the growth and renewal of the corridor as a place to live, work and recreate. The project would be instrumental to the amenity and accessibility improvements for three of the proposed eight urban renewal precincts; Homebush, Burwood and Kings Bay, identified as part of the program.

26.4.6 Non-Aboriginal heritage

The project includes the construction of the future M4–M5 Link on- and off-ramps, which would result in impacts on the Haberfield heritage conservation area (HCA). While this preparatory work would avoid further works and impacts on the HCA in the vicinity of Wattle Street during construction of the M4−M5 Link, there is the potential for impacts on other areas within the HCA. Details of areas of impact for the M4–M5 Link are yet to be confirmed.

Given the major adverse impacts on the Haberfield HCA resulting from the project, any additional impacts on the HCA from the M4–M5 Link would potentially result in severe cumulative impacts. There would be no cumulative impacts from WestConnex on individual heritage items beyond the impacts on the Haberfield HCA, since no items are likely to be affected by multiple WestConnex projects.

26.4.7 Biodiversity

The project would only involve the removal of small patches of already highly fragmented planted vegetation. WestConnex projects such as the New M5 and possible future M4–M5 Link (both subject to planning approval) would also result in removal of mainly planted vegetation and fauna habitats. These losses in biodiversity are likely to be restricted in area, given their location in highly modified environments. Together, these projects and other developments would result in some further loss of habitat from an already modified environment with only limited natural biodiversity value.

26.5 Cumulative impacts of other nearby developments

As outlined in **section 26.3.2**, there are few major developments in the vicinity of the project that would be under construction at a similar time. The following section outlines the potential cumulative impacts associated with the project and other non-WestConnex developments. Given the nature of these developments and their distance from the project, the main potential cumulative impacts relate to traffic and amenity.

26.5.1 Traffic and transport

Construction

The construction of nearby developments has the potential to result in additional construction traffic on the surrounding road network. Of the developments identified in **section 26.3.2**, works at the Columbia Precinct in Homebush are most likely to overlap with the project and are located close to the project. The development is currently under construction and is therefore only likely to overlap with the early stages of the project; or it may be completed before the start of the project (no known completion date). While this development would result in an increase in the number of vehicles in the locality, particularly along Parramatta Road, the number associated with this development is not considered to significantly contribute to traffic numbers. All movements from this site would be directly on to Parramatta Road and the wider arterial network.

Known developments identified in **section 26.3.2** are generally located away from the project and therefore traffic from these developments is unlikely to contribute substantially to cumulative traffic impacts in the vicinity of the project.

Further strategic level developments at the Carter Street Precinct at Sydney Olympic Park, and urban renewal areas under the Parramatta Road Transformation Program, are only in the initial planning stages and therefore is it unknown whether these developments would be constructed during the construction phase of the project. Due to the proximity of these developments to the arterial road and the relatively low number of vehicles likely to access these sites, traffic from these developments is not considered to substantially contribute to cumulative traffic impacts near the project.

Operation

During operation, the developments outlined in **section 26.3.2** would contribute some traffic to the road network; however, this traffic is likely to disperse via the arterial road network. Where possible, the modelling undertaken (described in **Chapter 8** (Traffic and transport)) has factored in growth in the surrounding area which could lead to increases in vehicle numbers on the road network. The model used to predict future traffic volumes has included the establishment of a southern approach to the Parramatta Road/George Street intersection at North Strathfield/Homebush as a result of the new mixed used development in this location (the Columbia Precinct described above). The results of the modelling are outlined in **section 8.4.1** of **Chapter 8** (Traffic and transport). In summary, the modelling identified that the project would significantly reduce vehicle delays along the corridor between Homebush Bay Drive in the west and City West Link and Haberfield in the east, and also at the majority of intersections assessed. The assessment did however identify some increase traffic densities north and east of the Wattle Street and Parramatta Road interchanges respectively.

26.5.2 Amenity impacts

The timing and positioning of many of the developments outlined in **section 26.3.2** mean that cumulative noise, air quality, traffic and visual impacts would be limited. However, a number of longer term developments, such as the Parramatta Road Transformation Program and the development of the Carter Street Precinct at Sydney Olympic Park, would potentially occur during the later stages of the project or directly after the project is complete. This has the potential to create construction fatigue impacts, which occur when impacts from multiple construction projects extend over a longer period of time than would be experienced from a single project. Such impacts would be most evident in the vicinity of Homebush north of the M4, where the project would include the establishment of a number of construction ancillary facilities, which would potentially affect the adjacent community. This area is also identified within the Parramatta Road Transformation Program as being the largest urban renewal area along the corridor, and is identified for redevelopment for higher density housing. Therefore, following the three-year construction period for the project, there is the potential for the redevelopment of this area to result in extended impacts on the surrounding community over a greater period of time.

26.6 Management of impacts

Environmental management measures relating to cumulative impacts during construction and operation are provided in **Table 26.3**. Measures located in **Chapter 8** (Traffic and transport) would also assist in minimising cumulative impacts, as the majority of potential impacts are traffic related.

Table 26.3 Environmental management measures – cumulative

Impact	No.	Environmental management measure	Responsibility	Timing
Construction				
Cumulative impacts	CI1	Consultation will be undertaken with local communities potentially affected by the impacts of multiple projects in addition to the project.	WDA/Construction Contractor	Construction
	CI2	Where relevant, consultation will be undertaken with proponents of other nearby developments to increase the overall awareness of project timeframes and impacts.	WDA/Construction Contractor	Construction

27 Sustainability

This chapter explains how the principles of ecologically sustainable development would be incorporated into the design, construction and operation of the M4 East project (the project).

The Secretary of the NSW Department of Planning and Environment has issued a set of environmental assessment requirements for the project; these are referred to as Secretary's Environmental Assessment Requirements (SEARs). **Table 27.1** sets out these requirements as they relate to sustainability, and identifies where they have been addressed in this environmental impact statement (EIS).

Table 27.1 Secretary's Environmental Assessment Requirements – Sustainability

Secretary's Environmental Assessment Requirement	Where addressed in the EIS
The Environmental Impact Statement (EIS) must be prepared in accordance with, and meet the minimum requirements of, Part 3 of Schedule 2 of the *Environmental Planning and Assessment Regulation* 2000 (the Regulation) including… • Detail of how the principles of ecologically sustainable development will be incorporated into the design, construction and ongoing operation phases of the project.	**Chapter 27** (this chapter)

27.1 What is sustainability?

Sustainable development was first formally defined in 1987 as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (Brundtland 1987).

In 1992, the Australian Government defined 'ecologically sustainable development' (ESD) as 'using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained, and the total quality of life, now and in the future, can be increased' (Australian Government 1992).

Infrastructure sustainability has recently been defined by the Infrastructure Sustainability Council of Australia (ISCA) as 'infrastructure that is designed, constructed and operated to optimise environmental, social and economic outcomes over the long term' (ISCA 2012).

27.2 WestConnex Sustainability Strategy

The *WestConnex Sustainability Strategy* (WDA 2015) (Sustainability Strategy) describes how sustainability initiatives would be integrated into the design, construction and operation of projects across WestConnex. The Sustainability Strategy outlines WDA's sustainability vision, commitments, guiding principles, objectives and overarching targets across a range of sustainability themes. It was prepared to align with the *Transport Environment and Sustainability Policy Statement* (Transport for NSW 2013f), *Transport Environment and Sustainability Policy Framework* (Transport for NSW 2013e), as well as other relevant NSW Government sustainability policies and guidelines.

Due to the large scale of WestConnex, and because it will be delivered in stages of planning, design and construction over many years, the Sustainability Strategy aims to ensure that sustainability is consistently applied across WestConnex.

The Sustainability Strategy provides a framework that illustrates how WDA's sustainability objectives and targets would be implemented through the project's contract requirements and Sustainability Management Plan during the detailed design and construction stages. It shows the relationship between WDA's sustainability vision, commitments and guiding principles and broader NSW Government sustainability instruments. The WestConnex sustainability framework, as contained in the Sustainability Strategy, is provided in **Figure 27.1**.

The Infrastructure Sustainability (IS) rating scheme provides a third party assurance review of a project's sustainability performance in terms of environmental, social and economic impacts and opportunities. The IS rating scheme is administered by ISCA, a member based, not-for-profit industry (public and private) council. The WestConnex Sustainability Strategy includes a target IS rating of at least 'Excellent' for the design and construction phases of WestConnex projects, as determined by the application of the IS rating tool. This is also a requirement of the construction contract.

Table 27.2 illustrates how the project is consistent with the WestConnex Sustainability Strategy. WDA has committed to achieving or exceeding a number of the sustainability targets identified in the Sustainability Strategy.

27.3 Sustainability management measures

The WestConnex sustainability objectives and targets would be met through the implementation of a project specific Sustainability Management Plan and sustainability initiatives.

The construction contractor would develop and implement a Sustainability Management Plan during detailed design. The Sustainability Management Plan would establish governance structures, processes and systems that ensure integration of all sustainability considerations (vision, commitments, principles, objectives and targets), initiatives, monitoring and reporting during the detailed design and construction phases of the project.

The aims of the Sustainability Management Plan would be to:

- Demonstrate sustainability leadership and continuous improvement
- Protect and enhance the natural environment and local heritage
- Contribute to liveable communities and facilitate urban revitalisation by easing congestion, connecting communities and integrating land use and transport planning
- Optimise resource efficiency (materials, energy, water, land) and waste management
- Increase resilience to future climate
- Design for future transport needs
- Procure sustainably; considering whole of life environmental, social and economic factors
- Maximise equitable/fair training and employment opportunities.

Principles in the Sustainability Management Plan would extend across the whole project, through both the design and construction phases. These principles would also be embedded across all management disciplines in detailed design and the construction contractor's team, ensuring that decision making processes consider whole-of-life, environmental, social and economic costs and benefits over the life of the project.

Figure 27.1 WestConnex Sustainability Strategy framework

Table 27.2 Project consistency with the WestConnex Sustainability Strategy Framework

Objective	Sustainability targets	Project consistency
1: Demonstrate sustainability leadership and continual improvement	1.1: Achieve an IS rating of at least 'Excellent' for the design and construction phases.	The project would achieve 'Excellent' IS Design and As-built ratings for the design and construction phases.
	1.2: Prepare quarterly project progress reports and an annual WestConnex Sustainability Report. Annual review of the WestConnex Sustainability Report and WestConnex Environment and Sustainability Policy by Senior Management.	To facilitate continual improvement, ongoing monitoring and reporting would be undertaken during the construction phase. WDA would prepare an annual sustainability report. The annual report and the WestConnex Environment and Sustainability Policy would be reviewed annually by senior management.
	1.3: Share sustainability knowledge and lessons learnt across the WestConnex projects and stages. Participate in sustainability workshops during design and construction phases and document lessons learnt.	Regular sustainability knowledge sharing workshops would be held during the detailed design and construction phases.
	1.4: Appoint a sustainability representative with relevant experience to drive the achievement of sustainability outcomes.	During detailed design and construction, the construction contractor's Environment and Sustainability Manager and Sustainability Coordinator would drive the achievement of sustainability outcomes.
2: Protect and enhance the natural environment and local heritage	2.1: No serious pollution incidents occur during construction.	Construction activities would be managed in line with the mitigation measures outlined in this EIS to avoid pollution incidents occurring during construction. Measures to address air quality, noise, soil and water quality, and contamination are detailed in **Chapter 9**, **Chapter 10**, **Chapter 15** and **Chapter 16** respectively.
	2.2: Proactively manage any impacts on flora and fauna in accordance with the RTA Biodiversity Guidelines.	The project is located in a highly modified urban area and would not result in the clearing of remnant native vegetation. Small areas of planted vegetation would be removed. No threatened flora and fauna is likely to be significantly affected by the project. Where impacts are unavoidable, mitigation measures have been proposed to minimise the potential for indirect impacts. Any biodiversity impacts resulting from the project would be managed in accordance with the RTA Biodiversity Guidelines (RTA 2011). Further information is provided in **Chapter 20** (Biodiversity).

Objective	Sustainability targets	Project consistency
	2.3: Heritage items are avoided where possible and proactively managed during construction.	Potential items and areas of non-Aboriginal heritage significance were identified early in the design process. While there would be impacts on non-Aboriginal heritage, including the Powell's Estate Heritage Conservation Area (HCA) and the Haberfield HCA, these impacts have been minimised and/or mitigated where practicable. The project also avoids impacts on the State heritage listed Yasmar Estate and on Ashfield Park. There would be no impact on known items of Aboriginal heritage significance. Further information is provided in **Chapter 19** (Non-Aboriginal heritage) and **Chapter 22** (Aboriginal heritage).
3: Contribute to liveable communities (ease congestion, connect communities, integrate land use and transport planning and facilitate urban revitalisation)	3.1: Motorway designed to reduce congestion and travel times.	The project would help reduce congestion and would result in travel time savings of 10 to 18 minutes on strategic corridors. Further detail is provided in **Chapter 8** (Traffic and transport).
	3.2: Ensure appropriate air quality outcomes. WestConnex's tunnel ventilation system will be designed and operated to comply with best-practice criteria for in-tunnel and ambient air quality.	Tunnel ventilation systems for the project would be designed and operated to be consistent with best practice management of in-tunnel and ambient air quality. See **Chapter 9** (Air quality) and **Chapter 11** (Human health) for further discussion on air quality and associated human health risks.
	3.3: Maintain, relocate or improve pedestrian and cycle paths and connections.	Existing cyclist and pedestrian paths and connections would be maintained and, in some locations, improved. This would include re-routing a proportion of the eastbound cycleway on the existing M4 shoulder, and would include some off-road sections. A new on-ramp cycleway connection to the existing M4 shoulder westbound would also be provided from Queen Street at North Strathfield.
	3.4: Create/enhance public open space.	Following construction, there would be a number of locations where there would be residual land (ie land required for construction but not operation), including at the Concord Road, Wattle Street and Parramatta Road interchanges. There would be opportunities for this residual land to be used for open space, which would represent an increase in the amount of open space in the locality. In addition, following construction, the majority of Cintra Park would be returned for use as open space. As the existing hockey field would be relocated to the St Lukes Park and other active open space areas in St Lukes Park would be rationalised, there may be opportunities for Cintra Park to be used for passive open space.

Objective	Sustainability targets	Project consistency
4: Optimise resource efficiency (materials, energy, water, land) and waste management.	**Materials** 4.1: Identify and implement opportunities to reduce material use and maximise the use of materials with low embodied environmental impact. 4.2: Source 100% of all timber products from either reused/recycled timber or sustainably managed forests. 4.3: Optimise the amount of cement replacement material used in concrete. 4.4: Optimise the amount of recycled material used in road base and sub base.	The mainline tunnel alignment has been optimised to reduce their length, which would also reduce the amount of materials required. The project would source 100 per cent of all timber products from either reused/recycled timber or sustainably managed forests. Recycled products would be used throughout construction of the project to reduce the demand on resources, in instances where the use of such materials is cost and performance competitive. This may include the use of fly ash and slag within concrete mixes. Resource recovery principles would be applied to the construction of the project, including recovery of resources for reuse, recycling and reprocessing, where practicable. Additional detail is provided in **Chapter 23** (Resource use and waste minimisation) and **Chapter 21** (Greenhouse gas).
	Energy and carbon 4.5: Prepare an Energy Efficiency and Greenhouse Gas Emissions Strategy, detailing processes and methods to improve energy efficiency and reduce greenhouse gas emissions. 4.6: Minimum of six per cent of energy sourced from renewable energy generated onsite and/or accredited GreenPower (GreenPower is an Australian government accreditation program). 4.7: Optimise the design and operation of the motorway to minimise energy used by vehicles using the motorway.	The construction contractor would prepare an energy efficiency and greenhouse gas emissions strategy during detailed design. The project would seek to minimise operational energy demand through ventilation and lighting strategies. This could include the use of low maintenance, high efficiency LED lighting. The project aims to source six per cent of its energy from renewable energy generated onsite and/or accredited GreenPower. Further, low carbon energy generation options would be investigated as part of the design process in order to reduce the demand on mains electricity where feasible. Additional detail regarding energy efficiency is provided in **Chapter 21** (Greenhouse gas). The mainline tunnels would be designed to minimise vehicle fuel use in operation.
	Water 4.8: Undertake a Water Balance Study and identify opportunities to reduce water use (in particular potable water use) and reuse water (eg stormwater, groundwater) during construction and operation. 4.9: Reuse, recycle or reclaim water (eg stormwater, wastewater, tunnel inflow water) generated/collected.	Water efficiency measures would be implemented with a focus on achieving water savings and targeting water recycling and reuse. During construction, non-potable water sources would be preferred over potable sources where appropriate. Construction water would either be reused on site wherever feasible, or discharged into the local stormwater system in accordance with the requirements of an environment protection licence (if required). Preference would be given to reusing as much water as practicable before discharging. Additional information regarding surface water and water quality is provided in **Chapter 15** (Soil and water quality).

Objective	Sustainability targets	Project consistency
	Land 4.10: Minimise the project's surface land footprint and acquisition of properties. 4.11: Identify contaminated sites within the project's construction footprint and remediate to a standard for post construction use (as applicable).	The acquisition of land for the purpose of the construction and operation of the project has been minimised by optimising the use of land already owned by Roads and Maritime Services (Roads and Maritime), and locating operational elements of the project within existing road corridors where feasible and reasonable. Potentially contaminated sites in the project footprint have been identified (refer to **Chapter 16** (Contamination)). Where applicable, any contaminated areas physically disturbed by construction of the project would be remediated to a standard suitable for the agreed post-construction use.
	Waste and spoil 4.12: Reuse/recycle a minimum of 80 per cent usable spoil (uncontaminated surplus excavated material). 4.13: Reuse/recycle a minimum of 80 per cent of construction and demolition waste (uncontaminated). 4.14: Implement packaging take-back arrangements with suppliers.	A spoil management plan would be developed before the start of tunnelling activities in accordance with the spoil management strategy for the project. It would identify spoil disposal site/s and describe the management of spoil onsite and during off-site transport. Where practicable and fit for purpose, spoil would be beneficially reused within the project before off-site reuse or disposal options are investigated. The project would aim to exceed these targets, and would aim to reuse or recycle at least 95 per cent of spoil and 90 per cent of construction and demolition waste. Where practicable, the construction contractor would negotiate and implement packaging take-back arrangements with suppliers. Additional detail is provided in **Chapter 6** (Construction work) and **Chapter 23** (Resource use and waste minimisation).
5: Increased resilience to future climate	5.1: Undertake a climate change risk assessment. 5.2: Identify and implement adaptation measures to mitigate all high and extreme residual risks.	A climate change risk assessment has been undertaken (refer to **Chapter 24** (Climate change). A further detailed climate change risk assessment would be undertaken by the construction contractor in accordance with AS 5334-2013 and would identify and implement adaptation measures to comprehensively address any 'high' or 'extreme' rated risks.

Objective	Sustainability targets	Project consistency
6: Design allows for future transport needs (transport modes, extensions, access points)	6.1: Preserve opportunities for public transport (eg light rail and/or rapid bus lanes) along Parramatta Road. 6.2: Land preserved for future safe pedestrian and cyclist connectivity across and adjacent to the motorway. 6.3: Design allows for future extensions to the road network and access points.	At the Parramatta Road interchange, the project allows for future provision of a seven metre-wide, central-running mass transit corridor on Parramatta Road. The project has been designed to maintain and improve pedestrian and cyclist paths, and does not preclude potential future upgrades of, or additions to, existing pedestrian and cyclist paths. The project includes tunnel stubs and on- and off-ramps to provide access to the possible future M4–M5 Link (which is subject to separate planning approval). More detail is provided in **Chapter 5** (Project description).
7: Sustainable procurement − whole of life environmental, social and economic considerations	7.1: Incorporate sustainability criteria into project contracts and tender evaluation criteria. 7.2: Prepare and implement an Australian Industry Participation Plan.	The construction contractor would identify and implement sustainable procurement initiatives to enhance the whole-of-life environmental, social and economic sustainability outcomes of the project through the supply chain (including subcontractors). This would include: • Developing, implementing and maintaining a robust system to inform subcontractors of the sustainability procurement requirements • Developing and applying environmental, social and economic criteria in the evaluation and selection of subcontractors • Prioritising procurement from local suppliers and businesses where practical. An Australian Industry Participation Plan would be prepared and implemented.

Objective	Sustainability targets	Project consistency
8: Maximise equitable training and employment opportunities	8.1: Five hundred apprentices/trainees will be employed on the WestConnex motorway project as a whole. To meet the 500 apprenticeships/traineeships target, the current project specific targets are: • M4 East project: employ the equivalent of 115 apprentices/trainees for 18 months during design and construction. 8.2: Maximise employment and training opportunities for young people, Aboriginal and Torres Strait Islanders, disadvantaged groups, long-term unemployed, and people who live in greater Western Sydney and along the project's alignment. 8.3: Provide structured training to 20 per cent of the construction workforce. 8.4: Provide initiatives to improve Aboriginal and Torres Strait Islander participation in construction and provide opportunities to Aboriginal and Torres Strait Islander enterprises.	The construction contractor would comply with the requirements set out in the *NSW Training Management Guidelines* (Department of Premier and Cabinet 2009) and the *NSW Aboriginal Participation in Construction Guidelines* (Department of Commerce 2007). WDA has developed a skills and employment approach which focuses on creating equitable skills and employment opportunities. The approach encourages contractors to provide opportunities to priority groups (including young people, disadvantaged groups, Aboriginal and Torres Strait Islanders, the unemployed, and people who live in greater Western Sydney and along the project alignment) through the use of weighting uplift values. At least 20 per cent of the construction workforce would undertake structured training and 115 apprentices/trainees would be employed on the project.

27.4 Ecologically sustainable development

NSW planning and environmental legislation establishes the requirement for proponents to consider the principles and objectives of ESD when assessing the environmental impacts of a project.

ESD is recognised within the EP&A Act and the *Protection of the Environment Administration Act 1999* (NSW) (PEA Act). The EP&A Regulation and the PEA Act emphasise the need for consideration of biophysical, economic and social considerations within the decision making process for development, including the principles of ESD:

- The precautionary principle
- Inter-generational equity
- Conservation of biological diversity and ecological integrity
- Improved valuation and pricing and incentive mechanisms.

The way in which these principles have been considered during the design development process is outlined in the following sections.

27.4.1 Precautionary principle

The precautionary principle deals with certainty in decision making. It provides that where there is a threat of serious or irreversible environmental damage, the absence of full scientific certainty should not be used as a reason to postpone measures to prevent environmental degradation.

The precautionary principle has been applied throughout the design and development of the project. The alternatives and options analysis described in **Chapter 4** (Project development and alternatives) considered environmental impacts. The design has first aimed to avoid, to the greatest extent practicable, known areas or items of environmental value such as the State heritage-listed Yasmar Estate, through the investigation of alternative route alignments and interchange locations. Best available technical information, including specialist studies, and environmental standards and measures, have been used to minimise environmental risks. Conservative 'worst case' scenarios have been considered as part of the environmental assessment. Where avoidance was not possible, mitigation measures have been identified to avoid or manage the risks.

The threat of serious or irreversible environmental damage is one of the essential preconditions to the engagement of the precautionary principle. This EIS identifies a number of environmental risks associated with the project, and mitigation measures that would result in acceptable residual risks and no significant serious or irreversible environmental harm.

27.4.2 Inter-generational equity

The principle of inter-generational equity, as defined within Clause 7(4) of Schedule 2 of the EP&A Regulation, states that the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.

Social equity is concerned with the distribution of economic, social and environmental costs and benefits. Inter-generational equity introduces a temporal element with a focus on minimising the distribution of costs to future generations.

One of the key objectives of the project is to assist in reducing traffic congestion on Parramatta Road and provide shorter travel times for road users. As part of WestConnex, the project would provide the missing link in the motorway network that supports Sydney's global economic corridor. Improvements to the transport network, including this project, support the global economic corridor by enabling domestic and international trade, and therefore underpin a sustainable NSW economy and Sydney's role as a global city.

The project would also provide the following benefits for current and future generations:

- Reduced air quality emissions along the Parramatta Road corridor. Further information on local air quality improvements is provided in **Chapter 9** (Air quality)

- Improved noise amenity along the Parramatta Road corridor through a reduction in traffic volumes. Further information on local noise improvements is provided in **Chapter 10** (Noise and vibration)
- Improved road safety through the provision of a motorway standard connection. Further information on road safety improvements is provided in **Chapter 8** (Traffic and transport)
- Improvements to local amenity, which would contribute to revitalisation of the Parramatta Road corridor, improving the desirability over the longer term for residential and commercial land uses
- Reduced operational greenhouse gas emissions when compared to the project not being built. For the year 2031, the savings in greenhouse gas emissions with the project are predicted to be around 45,400 t CO_2-e when compared to the 'without project' scenario. Further information on greenhouse gas emissions and savings is provided in **Chapter 21** (Greenhouse gas).

The project would thus provide benefits for current and future generations and is considered to be in the public interest.

27.4.3 Conservation of biological diversity and ecological integrity

The twin principles of biodiversity conservation and ecological integrity have been fundamental considerations during the course of the design and assessment process with a view to identifying, avoiding, minimising and mitigating impacts.

This EIS provides a detailed assessment of ecological issues including impacts on flora and fauna, and provides a range of mitigation measures that would be implemented to avoid and minimise these potential impacts. Potential impacts on biodiversity are detailed further in **Chapter 20** (Biodiversity).

The project would result in the loss of about 13.3 hectares of planted trees and screening vegetation (the majority from along the M4), and about three hectares of grassland and scattered trees. Scattered trees located within private gardens would also be removed. Where impacts are unavoidable, mitigation measures have been proposed to minimise the potential for indirect impacts. No threatened flora or fauna is likely to be significantly affected by the project.

27.4.4 Improved valuation and pricing and incentive mechanisms

Clause 7(4) of Schedule 2 of the EP&A Regulation identifies environmental factors that should be included in the valuation of assets and services including:

- Polluter pays (ie those who generate pollution and waste should bear the cost of containment, avoidance or abatement)
- The users of goods and services should pay prices based on the full life cycle costs of providing the goods
- Environmental goals, having been established, should be pursued in the most cost effective ways.

The principle of internalising environmental costs into decision-making requires consideration of all environmental resources that may be affected by a project, including air, water, land and living things. While it is often difficult to place a reliable monetary value on the residual, environmental and social effects of a project, the value placed on environmental resources within and around the corridor is evident in the extent to which environmental investigations, planning and design of impact mitigation measures are undertaken to prevent adverse environmental impacts as identified in this EIS.

The project would include measures for the abatement, avoidance and/or containment of pollution and waste.

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28 Environmental risk analysis

This chapter of the environmental impact statement (EIS) explains how environmental issues for the project were identified and evaluated through an environmental risk analysis process. **Table 28.1** sets out the relevant Secretary's Environmental Assessment Requirements (SEAR) for the WestConnex M4 East Project (the project).

Table 28.1 Secretary's Environmental Assessment Requirements – environmental risk analysis

SEAR	Where addressed in EIS
The EIS must include an environmental risk analysis to identify potential environmental impacts associated with the infrastructure (construction and operation), proposed mitigation measures and potentially significant residual environmental impacts after the application of proposed mitigation measures. Where additional key environmental impacts are identified through this environmental risk analysis, an appropriately detailed impact assessment of this additional key environmental impact must be included in the EIS.	**Chapter 28** Environmental risk analysis. **Section 28.4** Risk analysis summary.

28.1 Overview

Before lodging the *WestConnex – M4 East State Significant Infrastructure Application Report* (Roads and Maritime, 2013), Roads and Maritime and the WestConnex Delivery Authority (WDA) reviewed the outcomes of preliminary investigations, as well as community and stakeholder consultation, and identified those environmental issues of most importance for the project through a preliminary environmental risk analysis.

The findings formed the basis of the NSW Roads and Maritime Service's (Roads and Maritime) project application, and helped the Director-General formulate the 'key issues' for the project as outlined in the SEARs. As required by the SEARs, the process of environmental risk analysis continued during the course of preparing the EIS. Emphasis was placed on using the detailed information gathered during the EIS process to review the environmental aspects of the project. More specifically, the analysis:

- Identified environmental issues, including key issues in the SEARs, and any other issues
- Examined potential impacts and proposed mitigation measures in relation to the identified issues
- Identified the nature and extent of impacts likely to remain after mitigation measures are applied.

Based on this analysis, an environmental risk category was assigned to each potential impact (refer to **section 28.4** and **Table 28.3**. This enabled the identification of any matters that might be considered as additional key issues, and provided a basis for an appropriately detailed assessment of these additional key issues in this environmental assessment. The environmental risk categories are described in **Table 28.2**.

Table 28.2 Environmental risk categories

Risk category	Description
Key issue	High or moderate impact (actual and perceived) requiring further investigation to identify specific management and mitigation measures
Other issue	Moderate or low impact that can be managed effectively with standard and best practice management and mitigation measures

28.2 Preliminary environmental assessment

A preliminary environmental risk assessment (WDA, 2013) was undertaken prior to the preparation of the EIS to inform the State Significant Infrastructure (SSI) application for the project. The outcomes of this preliminary assessment identified the following key issues for the project:

- Traffic and transport
- Noise and vibration
- Air quality
- Urban revitalisation, land use and property
- Socio-economic impacts
- Urban design and visual impact
- Non-Aboriginal heritage
- Energy efficiency
- Resource use and waste management.

The outcomes of the preliminary environmental assessment were documented in the SSI application report, which was lodged with the Director-General of the then NSW Department of Planning & Infrastructure.

28.3 Assessment of key issues identified in the Secretary's environmental assessment requirements

On 7 January 2014, the Director-General notified Roads and Maritime of the environmental assessment requirements for preparation of an EIS. This included the following key issues:

- Traffic and transport
- Air quality
- Socio-economic impacts
- Soil and water
- Urban design and visual amenity
- Noise and vibration
- Heritage
- Biodiversity.

On 16 June 2015, modified environmental assessment requirements were provided to Roads and Maritime. The modified requirements reflect changes to the project since the application was lodged, in particular the inclusion of work in the Auburn local government area (LGA), and are also consistent with the SEARs for the New M5.

The key issues identified in the SEARs are consistent with and add to the key issues identified within the SSI application report. The SEARs identified the following as the key issues to be addressed in the EIS:

- Traffic and transport
- Air quality
- Human health
- Social and economic
- Soil and water
- Urban design and visual amenity

- Noise and vibration
- Heritage
- Biodiversity.

These identified issues have been assessed in detail and the results have been presented in **chapters 8** to **20** of this EIS.

28.4 Risk analysis summary

A summary of the environmental risk analysis is provided in **Table 28.3**.

Two additional environmental issues that were not specified as key issues in the SEARs were identified through the environmental risk analysis:

- Greenhouse gas
- Hazard and risk.

These issues have been addressed in this EIS.

Table 28.3 Environment risk analysis

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
Traffic and transport	**Yes**			**Key issue**	**Chapter 8**
		Construction impact: Potential for safety impacts for road users, pedestrians, cyclists and construction workers, due to temporary road arrangements or the proximity of construction activities to general traffic. *Mitigation:* Implement measures to address safety risks as part of the traffic management and safety plan.	Safety measures will address safety risks for construction workers and motorists. With mitigation, residual safety impacts are considered to be low.		**Section 8.3.5** **Section 8.6.3**
		Construction impact: Temporary disruptions and delays to traffic due to modification of traffic signals, speed restrictions, heavy vehicle movements and temporary road closures. *Mitigation:* Implement measures to address construction related delays as part of the traffic management and safety plan.	Moderate residual impacts are likely to remain with periodic delays associated with temporary road closures, lane occupancy and heavy vehicle movements.		**Section 8.3.2** **Section 8.6.3**
		Construction impact: Impacts on pedestrians and cyclists which result in delays and longer journeys. *Mitigation*: Pedestrian and cyclist access to be maintained where possible throughout construction. Where not feasible, alternative routes are to be provided and communicated to the community	Low residual impacts are likely to remain with minor delays expected for pedestrians and cyclists and potentially longer journeys (eg cyclists requiring to use the alternate cycle route instead of the M4 shoulder).		**Section 8.3.7** **Section 8.6.3**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Construction impact: Impacts on the local bus network as a result of changes to bus stop locations and increase travel times due to slower travel speeds and increased delays at intersections. *Mitigation*: Changes in bus stops would be undertaken in consultation with Transport for NSW and bus operators, with the community to be informed of any potential changes in advance.	Moderate residual impact due to increase in bus service travel times as a result of slower travel speeds and increased intersection delays.		**Section 8.3.6** **Section 8.6.3**
		Construction impact: Potential changes or disruption to property access in the vicinity of the project. *Mitigation*: Access to roads/streets and properties will be maintained. If local roads/streets need to be closed (short or long term), arrangements would be made to provide access to properties of affected residents and their visitors. These impacts and mitigation measures would also be discussed with Roads and Maritime and the relevant local council.	Moderate residual impacts considered likely with respect to access changes.		**Section 8.3.4** **Section 8.6.3**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Construction impact: Damage to existing road surfaces. *Mitigation*: A road dilapidation report would be prepared and would include identification of the existing conditions of local roads and mechanisms to repair any damage caused by the project. Repair damage caused by the project.	Low residual impacts to roads as a result of the project following completion of any necessary repairs.		**Section 8.3.1** **Section 8.6.3**
		Construction impact: Delay of emergency service vehicles travelling through the project construction areas. *Mitigation*: Communication systems and a traffic management and safety plan would be developed in consultation with local emergency services and procedures would be implemented to maintain priority access and a safe environment for emergency vehicles to travel through construction areas.	Appropriate implementation of the communications system and traffic management and safety plan is considered to result in low residual impacts to the operation of the emergency services.		**Section 8.6.3**
		Operation impact: impacts to network infrastructure. *Mitigation*: A review of existing Sydney Co-ordinated Adaptive Traffic System (SCATS) infrastructure at key intersections in the study area, including detectors, would be undertaken and upgrades would be implemented where appropriate to mitigate any impacts resulting from the project.	Residual impacts to the network infrastructure, as a result of the operation of the project, are considered to be moderate to high in 2021.		**Section 8.6.2** **Section 8.6.3**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
Air quality	**Yes**			**Key issue**	**Chapter 9**
		Construction impact: Fugitive dust emissions from construction activities including emissions from construction plant and equipment. *Mitigation*: A dust management plan would be produced and implemented to cover all construction phases of the project. This plan would contain details of site-specific mitigation measures to be applied, including ensuring that all construction vehicles comply with their relevant emission standards.	Even with a rigorous dust management plan being implemented, it is not possible to guarantee that the dust mitigation measures would be effective all the time. Any effects would be temporary and relatively short-lived, and would only arise during dry weather with the wind blowing towards a receptor. With mitigation the effects would be low and not significant.		**Section 9.6** **Section 9.9.1**
		Operational impact: In-tunnel air quality exceeds limits. *Mitigation*: In-tunnel air quality would be managed through appropriate tunnel design, ventilation design and control, air treatment systems; and emission controls (including continuous in tunnel monitoring).	Model simulations of traffic scenarios have demonstrated that in-tunnel pollution concentrations could be maintained at levels below the required limits, under all conditions with mitigation measures implemented. Residual impacts are therefore considered to be low and not significant.		**Section 9.7** **Section 9.10**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Operational impact: Ambient air quality exceeds limits. *Mitigation*: Ventilation outlets have been designed and sized to ensure compliance with criteria.	There would be a general improvement in air quality along Parramatta Road as a result of the project. This is due to a reduction in traffic volumes along Parramatta Road and the improved dispersion of emissions from diverted traffic through tunnel ventilation outlets. Residual impacts to the majority of receptors are therefore expected to moderately beneficial. However there would be minor residual adverse impacts on a small number of receptors.		**Section 9.7**
Human health	**Yes**			**Key issue**	**Chapter 10**
		Pre-construction impact: Property acquisition causing a negative short-term impact through stress on the health of individuals. *Mitigation:* Provision of access for affected households to a counselling service, WestConnex Assist. This would support affected households in negotiating the land acquisition process and relocation.	Even with the application of mitigation, short term adverse residual impacts are expected to remain.		**Section 10.9**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
Land use and property	**Yes**			**Key issue**	**Chapter 12**
		Pre-construction impact: Impacts on residents and businesses as a result of the total or partial acquisition and relocation of private properties. *Mitigation:* Early and on-going consultation with impacted individuals and businesses. Undertake acquisition consistent with the requirements of the *Land Acquisition (Just Terms Compensation) Act 1991* (NSW).	Even with the application of mitigation, adverse residual impacts are expected to be high.		**Section 12.3** **Section 12.5**
		Pre-construction impact: Temporary lease or acquisition of property required for the project. *Mitigation:* Consultation would occur with the relevant property owners in relation to temporary land leases and acquisition of properties required for construction. Where acquisition is identified as the preferred option, this would be undertaken in accordance with the *Roads and Maritime Services land acquisition information guide* (Roads and Maritime 2014) and the *Land Acquisition (Just Terms Compensation) Act 1991* (NSW).	Even with the application of mitigation, adverse residual impacts are expected to be high.		**Section 12.3** **Section 12.5**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Construction impact: Changes and disruption of access to properties located adjacent to the project. *Mitigation:* Where property access is to be impact (either long or short term), consultation with the landowners or occupiers would be undertaken to determine their requirements and to discuss alternative access to be provided.	When combined with the mitigation measures outlined in **Chapter 8** (Traffic and transport), residual impacts resulting from increased traffic and restricted access to private properties are considered to be low.		**Section 12.3** **Section 12.5**
Social and economic	**Yes**			**Key issue**	**Chapter 14**
		Construction impact: Acquisition of businesses *Mitigation:* Acquisitions would be under the terms of the *Land Acquisition (Just Terms Compensation) Act 1991* (NSW). A business management plan would also be developed to effectively communicate with businesses during the construction of the project	Residual impacts to businesses after the application of mitigation are considered to be low.		**Section 14.3** **Section 14.6**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Operational impact: reduced community cohesion and connectedness due to new infrastructure which alters access around the community. *Mitigation:* Opportunities for providing increased pedestrian and cyclist connectivity, especially in the vicinity of Wentworth Street, Underwood Road and Allen Street, Homebush, Concord Road Interchange and specifically to bus stops, will be explored	Residual impacts following mitigation are considered to be low. Even with the implementation of mitigation, there may still be a feeling of reduced community cohesion and connectedness.		**Section 14.4** **Section 14.6**
Soils and water quality	**Yes**			**Key issue**	**Chapter 15**
		Construction impact: Construction works resulting in erosion, scour and sedimentation. *Mitigation*: Erosion, stockpile, scour and pollution controls would be implemented as part of a soil and water quality management plan in consultation with the NSW Environment Protection Agency (EPA) and NSW Office of Water (NOW) and in accordance with: Blue Book requirements NSW Road Transport Authority*Code of Practice for Water Management* (RTA 1999).	It is considered that with mitigation in place, residual impacts are likely to be low.		**Section 15.3** **Section 15.5**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Construction impact: Pollution impacts to water quality. A major spill has the potential to pollute the downstream waterways via the stormwater and therefore cause detrimental effects for the riparian and Parramatta River estuary receiving environments. *Mitigation*: In consultation with the EPA and NOW measures would be implemented to minimise the risk of spills. To include • Spill containment equipment. • Appropriately bunded areas for storage of hazardous materials. • Adequate controls around stockpile areas and excavation works. • Maintenance of containment/spill infrastructure.	With mitigation, residual impacts are expected to be low.		**Section 15.3** **Section 15.5**
		Operational impact: Impacts on water quality. *Mitigation*: Measures to prevent runoff, stormwater or spillage being directed onto other roadways outside of the project footprint would be implemented	With mitigation, residual impacts are expected to be low.		**Section 15.4** **Section 15.5**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
Contamination	**Yes**			**Other issue**	**Chapter 16**
		Construction impact: Disturbance of contaminated land potentially resulting in environmental pollution *Mitigation:* Procedures to manage unexpected contamination finds and hazardous materials identified during site preparation and/or construction works would be prepared. Potentially contaminated areas directly affected by the project would be investigated and managed in accordance with the requirements of the *Contaminated Land Management Act 1997* (NSW) and *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites* (Office of Environment and Heritage, 2011).	Adherence to the nominated mitigation measures would result in limited exposure of contaminated land. Residual impacts are therefore expected to low.		**Section 16.4.1** **Section 16.6**
		Construction impact: Disturbance and exposure of acid sulfate soils resulting in impacts on built structures and the environment. *Mitigation:* If acid sulfate soils are encountered, they would be managed in accordance with the *Acid Sulfate Soil Manual* (Acid Sulfate Soil Management Advisory Committee, 1998).	With mitigation in place, residual impacts are considered to be low.		**Section 16.4.2** **Section 16.6**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Construction impact: Management of demolition waste including asbestos containing material. *Mitigation:* Demolition works would be undertaken in accordance with Australian and NSW WorkCover Standards. Stockpiling and management of potentially contaminated material would be undertaken at building demolition sites to prevent movement of material into receiving waters. Asbestos management (handling, stockpiling, transport and disposal) would be undertaken in accordance with an asbestos management plan and relevant State legislation, government policies and Australian Standards.	Residual impacts are expected to be low and not significant as a result of the controls that would be established during demolition.		**Section 16.4.1** **Section 16.6**
Flooding and drainage	**Yes**			**Key issue**	**Chapter 17**
		Construction impact: Flood risk to the project. Local catchment runoff entering project excavations and impacting the construction ancillary facilities. *Mitigation*: A flood and stormwater management plan would be prepared to manage flooding and stormwater related issues.	With mitigation, residual impacts are expected to be low.		**Section 17.3** **Section 17.5**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Construction impact: Construction activities affecting flooding behaviour and exacerbating flooding conditions in adjacent properties. *Mitigation*: A flood level survey would be carried out at all properties at risk to confirm whether construction activities would increase flood levels. Where flooding potential is confirmed, management measures for construction works and operational design would be incorporated.	With mitigation, residual impacts are expected to be low.		**Section 17.3** **Section 17.5**
		Operational impact: Flooding during operation of the project. *Mitigation:* The project design includes measures to prevent and mitigate flooding during operation that would achieve the hydrologic standard requirements for key components of the project	With mitigation, residual impacts are expected to be low.		**Section 17.4** **Section 17.5**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
Groundwater	**Yes**			**Key issue**	**Chapter 18**
		Construction impact: Impacts to groundwater flow and quality. *Mitigation*: A construction groundwater monitoring plan would be developed in consultation with the Department of Primary Industries and the EPA. Pre-construction surface and groundwater monitoring would continue on a monthly basis to establish baseline conditions and treatment programmes.	With mitigation, residual impacts are expected to be low.		**Section 18.3** **Section 18.5**
		Construction impact: Ground movement and settlement. *Mitigation*: Existing condition surveys and further assessment would be undertaken for structures at risk from ground movement impacts and mitigation measures identified and implemented as required, including make good provisions.	Residual impacts would be determined following the existing condition surveys. However it is considered likely that with suitable mitigation applied, residual impacts would be low.		**Section 18.3** **Section 18.5**
		Construction and operation impact: Licensed bore drawdown and impacts to groundwater users. *Mitigation*: Management of licensed bores identified as being at risk of drawdown would include monitoring and, where appropriate, modifications, compensation, redrilling or provision of an alternative water supply.	With mitigation, provision of water supply would be maintained to all licensees, although specific bores may no longer be available. In consultation with licensees, compensation may be provided as an alternative. Residual impacts to licensees are considered to be low.		**Section 18.4** **Section 18.5**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Operational impact: Pollution, of groundwater. *Mitigation:* A tunnel drainage system and water treatment facility located at Cintra Park would be provided to collect and treat tunnel groundwater and manage saline intrusion.	With mitigation, residual impacts are expected to be low.		
		Operational impact: Quantity and availability of groundwater. *Mitigation:* Tunnel lining would be installed progressively following tunnel excavation to minimise groundwater inflows and drawdown.	With mitigation, residual impacts are expected to be low.		**Section 18.4** **Section 18.5**
Urban design, landscape character and visual amenity	**Yes**			**Key issue**	**Chapter 13**
		Construction impact: Visual changes due to motorway, tunnel and bridge construction. Visual impacts associated with construction site compounds. *Mitigation:* Site compounds and work areas would be screened, organised and managed to minimise visual impacts.	Construction activities would still be visible from some locations. However, construction impacts are temporary and therefore the residual impacts are considered to be low.		**Section 13.3** **Section 13.5**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Construction impact: Impact of construction lighting as a result of night works, including 24 hour tunnelling activities. *Mitigation:* Use of cut-off and direction lighting to ensure glare and light spill is minimised. Lighting should only be used when sites are in use.	Construction lighting impacts would be temporary during construction and with mitigation residual impacts are considered to be low.		**Section 13.3.3**
		Construction impact: Impact of built structures and vegetation removal on sensitive receivers. *Mitigation:* Vegetation clearance would be minimised where possible. Built structures would be designed to minimise impacts and to integrate into the surrounding area. Landscaping of the project footprint in line with the urban design and landscape management plan to minimise impacts.	Residual impacts would vary depending on the location of the sensitive receiver. However, residual impacts on sensitive receivers would be low to moderate.		**Section 13.4.3** **Section 13.5.3**
		Operational impact: Impact on the community due to new lighting associated with operational features of the project such as roads and operational facilities. *Mitigation*: Lighting design to minimise light spill on to adjacent properties.	Operational lighting impacts would occur in areas generally already subject to lighting impacts due to existing roads and buildings. With careful design the residual impacts are considered to be low.		

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
Noise and vibration	**Yes**			**Key issue**	**Chapter 11**
		Construction impact: Noise and vibration from road construction activities within the corridor and from the operation of construction site compounds. *Mitigation:* A construction noise and vibration management plan would be prepared and implemented in accordance with the *Interim Construction Noise Guideline* (DECC 2009)	Mitigation would reduce impacts, but intrusive construction noise and vibration is still likely to occur at some locations. Residual impacts are considered to be moderate with the application of a construction noise and vibration management plan.		**Section 11.4** **Section 11.7**
		Operational impact: Increase in road traffic noise. There would be an increase in noise impacts around the proposed interchanges as a result of the roads moving closer to properties, increased traffic numbers and the removal of structures which previously provided screening. *Mitigation:* Noise barriers and low noise pavement would be considered during detailed design to maximise the number of receivers which receive a reduction in exceedances of noise criteria. At-property acoustic treatments would be considered for sensitive receivers where low noise road surfaces and noise barriers do not reduce noise impacts. Active noise monitoring would also be undertaken to determine whether additional mitigation is required.	Residual impacts following the implementation of mitigation are expected to reduce the number of impacted receivers. Residual impacts are therefore considered to be moderate.		**Section 11.5.1** **Section 11.7**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Operational impact: Noise from operational ancillary facilities *Mitigation:* Operational ancillary facilities would be designed to meet project specific noise criteria derived in accordance with the *NSW Industrial Noise Policy*.	Adherence to operational noise criteria would result in low residual noise impacts to nearby sensitive receivers.		**Section 11.5.2** **Section 11.7**
Non-Aboriginal heritage	**Yes**			**Key issue**	**Chapter 19**
		Construction impact: Visual impacts on setting of heritage conservation areas (HCA) and heritage items. *Mitigation*: Heritage specialist input into detailed design would be provided to guide location and design of new structures. New structures would be of high-quality design and materials. Where feasible and reasonable, vegetated buffers would be retained and new planting strategies implemented. Photographic archival recording would be undertaken.	Residual impacts would vary, and would be minor to moderate, and would not be effectively mitigated at all locations.		**Section 19.3** **Section 19.4**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Construction impact: 22 locally listed heritage items and nine potential heritage items would be demolished. *Mitigation*: Photographic archival recording would be undertaken of heritage items and potential items. Heritage fabric will be salvaged from properties to be demolished, and stored for future conservation works by owners of heritage properties in the Canada Bay and Ashfield LGAs.	Residual impacts would be high, and would not be effectively mitigated.		**Section 19.3** **Section 19.4**
		Construction impact: Two HCA (Powell's Estate and Haberfield) would be partially demolished. *Mitigation*: Photographic archival recording would be undertaken of contributory items. Heritage fabric would be salvaged, and stored for future conservation works in the Canada Bay and Ashfield LGAs.	Residual impacts would be high, and would not be effectively mitigated.		**Section 19.3** **Section 19.4**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Construction impact: Impact on potential historical archaeological resource. *Mitigation*: Monitoring and salvage would be undertaken as stipulated by the NSW Office of Environment and Heritage, Canada Bay Council and Ashfield Council. The *Standard Management Procedure – Unexpected Heritage Items* (Roads and Maritime, 2015) would be applied in the event any unanticipated archaeological artefacts are discovered.	Assessment found that the majority of potential historical archaeological resource would be of local significance. With mitigation, residual impacts are therefore expected to be low.		**Section 19.3** **Section 19.4**
		Construction impact: Partial demolition of heritage items (including gardens and street trees) *Mitigation*: Boundary structures would be replaced with appropriate materials, the maximum number of street trees would be retained and protected during construction, and landscape buffers and replacement trees would be provided where appropriate (with suitable/sympathetic species). Structures to be retained would be protected during construction.	Residual impacts would be minor to moderate, and could not be effectively mitigated for all heritage items.		**Section 19.3** **Section 19.4**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Operational impact: Impacts on the setting of heritage items or Powell's Estate/Haberfield HCA, from future development of residual land. *Mitigation*: Future development of residual land within a HCA would comply with the provisions of the relevant development control plan and would respect the scale, form and pattern of neighbouring heritage features.	With mitigation, residual adverse impacts are expected to be low and beneficial impacts could be achieved through appropriate development and landscaping.		**Section 19.3** **Section 19.4**
Aboriginal heritage	**Yes**			**Other issue**	**Chapter 22**
		Construction impact: Disturbance or destruction of previously unidentified Aboriginal heritage artefacts or discovery of human remains in the project footprint. *Mitigation:* Procedures for unexpected finds would be developed and implemented in accordance with the standard management procedure, *Unexpected Archaeological Finds* (Roads and Maritime 2015a),	No surface expressions of Aboriginal objects or material were identified within the project footprint. The terrain within the study area is grossly disturbed and is unlikely to contain unidentified Aboriginal archaeological materials in either a surface or subsurface context. With mitigation, residual impacts are expected to be low.		**Section 22.3** **Section 22.5**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
Biodiversity	**Yes**			**Other issue**	**Chapter 20**
		Construction impact: The project would remove 12.9 hectares of planted vegetation that is foraging habitat for the threatened grey-headed flying-fox and for common species such as birds and possums. *Mitigation*: A flora and fauna management plan would be developed for the construction phase. Landscaping would include planting of native trees and shrubs at a number of locations, including along the M4 on- and off- ramps, the Concord Road interchange, and the Parramatta Road interchange.	The project would result in some low residual adverse impacts, namely the removal of planted native trees and the possible mortality of some common native fauna species during clearing and construction. Impacts to the Grey-headed Flying-fox are considered to be minimal during clearing works due to the infrequency of this species using the area.		**Section 20.3** **Section 20.5**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
Resource use and waste minimisation	**No**			**Other issue**	**Chapter 23**
		Construction impact: Use of resources and the generation of waste. *Mitigation*: A waste management plan would be prepared for the construction phase of the project, detailing appropriate procedures for waste management and pre-construction surveys (ie asbestos). Residual waste would be classified, handled, stored on site and disposed of, in accordance with the *Waste Classification Guidelines: Part 1 Classifying Waste* (DECCW 2009b), State legislation and government policies. The project would aim to reuse or recycle at least 95 per cent of spoil and 90 per cent of construction and demolition waste.	With mitigation, residual impacts are expected to be low.		**Section 23.3** **Section 23.5**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Construction impact: Excess spoil. *Mitigation*: A spoil management plan would be developed in accordance with the spoil management strategy prior to the commencement of tunnelling works. The plan would identify spoil disposal site(s) and describe the management of spoil on site and during off-site transport. The project is aiming to reuse 95 per cent of spoil (i.e. only five per cent being sent to land fill)	With mitigation, residual impacts are expected to be low.		**Section 23.3** **Section 23.5**
Greenhouse gas	**No**			**Other issue**	**Chapter 21**
		Construction impact: Increase in greenhouse gas emissions from construction fuel use and energy embodied in construction materials. *Mitigation:* Reuse and recycling would be maximised throughout the construction period. Energy efficiency measures would be implemented and materials would be sourced locally where possible to reduce transport emissions. The project aims to source six per cent of energy from renewable energy sources.	With mitigation, there would still be greenhouse gas emissions associated with the construction of the project. It is estimated that the project would generate about 382,200 t CO_{2}-e.		**Section 21.3** **Section 21.6**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Operational impact: Increased emission of greenhouse gases from the operation of road infrastructure. *Mitigation:* Low carbon energy generation options would be investigated as part of the design process in order to reduce the demand on mains electricity and generate renewable energy onsite, where feasible. The project aims to source six per cent of power from renewable sources.	Results indicate that the project would reduce annual greenhouse emissions due to fuel and operational efficiency resulting in a beneficial decrease in emissions.		**Section 21.5** **Section 21.6**
Hazard and risk	**No**			**Other issue**	**Chapter 25**
		Construction impact: Potential hazards resulting from accidental releases or improper handling and storage of dangerous goods and hazardous substances within construction sites *Mitigation:* Dangerous goods and hazardous materials would be stored in accordance with applicable legislation, Australian standards and guidelines. For liquids, a minimum bund volume requirement of 110 per cent of the volume of the largest single stored volume within the bund would be provided.	With the appropriate controls in place, the storage and use of dangerous goods and hazardous materials on the project construction sites would not pose a significant risk of harm within or beyond the construction site boundary. Residual impacts are therefore considered to be low.		**Section 25.1** **Section 25.3**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Construction impact: Releases of hazardous substances from vehicles transporting dangerous goods and hazardous substances to and from the construction sites in the event of an accident. *Mitigation:* Transport of dangerous goods and hazardous substances would be conducted in accordance with relevant legislation and codes, including the *Dangerous Goods (Road and Rail Transport) Act* 2008, *Dangerous Goods (Road and Rail Transport) Regulation* 2014 and the *Australian Code for the Transport of Dangerous Goods by Road and Rail* (National Transport Commission 2008).	The transportation of dangerous goods and hazardous materials to project construction sites would be well below the applicable thresholds. This indicates that residual risks associated with transport of dangerous goods and hazardous materials are low and unlikely to be significant.		**Section 25.1.2** **Section 25.3**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Operational impact: Crashes and incidents within the mainline tunnels, on- and off-ramps, and surface roads. *Mitigation:* The project would be designed to provide efficient, free flowing traffic with physical capacity to accommodate predicted traffic volumes. An incident response plan would also be developed and implemented in the event of an accident or incident. The design of the project includes a motorway control centre and emergency response. Emergency access is provided via cross passages and longitudinal passages to allow egress from the tunnels during an emergency.	Due to the anticipated reduction in vehicles on Parramatta Road as a result of the project, travelling conditions on Parramatta Road and the surrounding network would improve and therefore the risk of crashes would be reduced. The residual impacts on potential crashes and incidents are therefore considered to be high and beneficial.		**Section 25.2.3** **Section 25.2.4** **Section 25.3**
Cumulative interactions	**No**			**Other issue**	**Chapter 26**
		Construction impact: Construction of the project would occur simultaneously with the M4 Widening and therefore there is potential for cumulative construction impacts such as traffic and noise. *Mitigation:* Project Managers of other WestConnex projects would be consulted during the preparation of the construction traffic management plan and other environmental management documentation.	Cumulative impacts during construction would potentially occur, however the level of impacts is considered to be low.		**Section 26.4**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Construction impact: The project is unlikely to overlap with the M4–M5 Link construction period, however, cumulative impacts from both projects could be consecutive. *Mitigation*: Surface works for the M4–M5 Link in the vicinity of Haberfield and Ashfield would be constructed as part of the M4 East project. M4-M5 Link Project Manager would be consulted during the preparation of the construction traffic management plan and other environmental management documentation.	If consecutive cumulative impacts result from the consecutive construction periods, impacts would be considered low.		**Section 26.4**
		Operational impact: Cumulative impacts resulting from the operation of all WestConnex projects would include traffic, noise and air quality impacts. These have been modelled as part of these assessments. *Mitigation:* Measures proposed as part of the traffic, noise and air quality assessment would be implemented to minimise any operational cumulative impacts.	Cumulative impacts during operation would potentially occur. Beneficial impacts to traffic including freight, and businesses along the alignment of WestConnex.		**Section 26.4**

Issue	SEAR key issue?	Potential impacts and proposed mitigation	Potential residual impacts	Risk category of residual impacts	Where discussed in EIS
		Construction impact: Additional impacts arising from interaction with other projects during the construction period (primarily construction traffic). *Mitigation:* Proponents of other projects would be consulted during the preparation of the construction traffic management plan and other environmental management documentation.	With mitigation, residual cumulative impacts resulting from other known projects are expected to be low.		**Section 26.4**

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29 Summary of environmental management measures

This chapter collates the environmental management measures for the project that were identified through the impact assessment process in **Chapter 8** through to **Chapter 29**. All measures identified would be incorporated into management plans and the operational framework for the project. A framework for managing the potential impacts is provided with reference to environmental management plans.

29.1 Environmental management plans (or systems)

A number of safeguards and management measures have been identified in order to minimise adverse environmental impacts, including social impacts, which could potentially arise as a result of the project. These management measures would be incorporated into the detailed design and applied during the construction and operation of the project.

A contractor's construction environmental management plan (CEMP) would be prepared to describe safeguards and management measures identified. The plan would provide a framework for establishing how these measures would be implemented and who would be responsible for their implementation.

The plan would be prepared prior to construction of the proposal and must be reviewed and certified by the WDA, prior to the commencement of any on-site works. The CEMP would be a working document, subject to ongoing change and updated as necessary to respond to specific requirements.

29.2 Summary of safeguards and management measures

Environmental safeguards outlined in **Chapter 8** through to **Chapter 29** of this EIS would be incorporated into the detailed design phase of the project and during construction and operation. These safeguards would minimise any potential adverse impacts arising from the proposed works on the surrounding environment. All safeguards described in this EIS would be incorporated into the contractor's CEMP. Safeguards and management measures applicable to the project are summarised in **Table 29.1**

Table 29.1 Summary of safeguards and management measures

Impact	Ref #	Environmental management measure	Responsibility	Timing
Traffic and Transport				
General	TT1	A Traffic Management and Safety Plan (TMSP) will be prepared as part of the construction environmental management plan (CEMP), in consultation with the relevant road authority, local councils, emergency services, road user groups and pedestrian and bicycle groups. The TMSP will include the guidelines, general requirements and principles of traffic management to be implemented during construction. It will be prepared in accordance with Austroads *Guide to Road Design* (with appropriate Roads and Maritime supplements), the RTA *Traffic Control at Work Sites* manual and AS1742.3: *Manual of uniform traffic control devices – Part 3:Traffic control for works on roads*, and any other relevant standard, guide or manual. It will seek to minimise delays and disruptions, and identify and respond to any changes in road safety as a result of highway construction works.	Construction Contractor	Pre-construction and construction
	TT2	The TMSP will include: • A traffic route and haulage management plan • Site traffic and access management plans • An incident response plan • A detailed travel management plan for construction staff at the various worksites, in consultation with local councils and stakeholders associated with the sporting facilities adjacent to the project site. This will include the promotion of public transport and car-pooling to reduce work site-related vehicle movements, and also investigate feasible options for the provision of off-site car parking to reduce parking on local roads	Construction Contractor	Construction
Impacts to road network performance (delays) and safety	TT3	Construction and temporary works will be staged to avoid conflicts with the existing road network and maximise spatial separation between work areas and travel lanes.	Construction Contractor	Construction
	TT4	Analyse traffic volume data to identify capacity requirements, assess the potential impact of lane occupancies on traffic flows, plan lane occupancies to minimise the work area, and identify the best time to minimise inconvenience to road users. Restrictions and obstructions will be limited, road capacities maximised and peak traffic periods avoided where possible.	Construction Contractor	Construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	TT5	Temporary closed-circuit television (CCTV) and variable message signs (VMS) will be provided to link with the existing TMC network to facilitate monitoring and management of impacts	Construction Contractor	Construction
	TT6	Throughout construction, consultation with the Transport Management Centre will be undertaken to ensure impacts to traffic flows are minimised.	Construction Contractor	Construction
	TT7	Road occupancy licences will be obtained for work that impacts traffic on existing roads in accordance with the requirements of council or Roads and Maritime.	Construction Contractor/ Roads and Maritime	Construction
Impacts on pedestrians and cyclists	TT8	Pedestrian and cyclist access will be maintained where possible throughout construction. Where not feasible, alternate routes will be provided and communicated to the community.	Construction Contractor	Prior to construction commencing
Impacts to public transport	TT9	Changes in bus stops will be undertaken in consultation with Transport for NSW and bus operators, with the community informed of any potential changes in advance.	Construction Contractor	Construction
Impacts to access	TT10	Local road closures will be managed and adequate property access will be maintained. Where road closures are required, reasonable and practical alternate traffic routes will be provided and communicated to the community. This will be undertaken in consultation with Roads and Maritime, local councils and property owners likely to be affected.	Construction Contractor	Construction
Impacts on existing road surfaces	TT11	A Road Dilapidation Report will be prepared and will include identification of the existing conditions of local roads and mechanisms to repair any damage caused by the project.	Construction Contractor	Post-construction
Impacts to emergency services	TT12	The TMSP will be developed in consultation with local emergency services and procedures will be implemented to maintain priority access and a safe environment will be maintained for emergency vehicles to travel through construction areas.	Construction Contractor	Construction
	TT13	Local emergency services will be frequently updated on the staging and progress of construction works.	Construction Contractor	Construction
Confirmation of assessed impacts	OpTT1	An operational traffic review will be undertaken 12 months after the opening of the project to confirm the operational impacts of the project on surrounding arterial roads and major intersections. This review will be undertaken by a suitably qualified traffic consultant that is independent of the design and studies undertaken as part of the EIS.	Roads and Maritime	12 months from start of operation

Impact	Ref #	Environmental management measure	Responsibility	Timing
Network and corridor optimisation	OpTT2	A network and corridor optimisation approach will be adopted to manage delay and queuing impacts with optimisation works occurring at the following locations: • Parramatta Road/George Street intersection in Homebush/North Strathfield • Concord Road corridor between Patterson Street and Parramatta Road in Concord • Parramatta Road/Shaftesbury Road intersection in Burwood/Concord (post M4-M5 Link opening) • Dobroyd Parade/Timbrell Drive intersection in Haberfield • Parramatta Road/Great North Road intersection in Croydon/Five Dock (post M4–M5 Link opening) • Parramatta Road/Wattle Street intersection in Ashfield/Haberfield (post M4–M5 Link opening) • Parramatta Road (east of Bland Street) • Parramatta Road/Crystal Street/Balmain Road in Leichhardt/Petersham • Sydney Olympic Park access. Further detail of the proposed optimisation is outlined in Section 10.2.3 of the Traffic and Transport Assessment in **Appendix G**.	Roads and Maritime	Operation
Maintenance of existing network	OpTT3	A review of existing SCATS infrastructure at key intersections in the study area, including detectors, will be undertaken and upgrades will be implemented where appropriate to improve any impacts resulting from the project.	Roads and Maritime	Operation

Impact	Ref #	Environmental management measure	Responsibility	Timing
Network upgrades	OpTT4	The following network upgrades will be investigated in consultation with relevant local councils, Roads and Maritime and affected communities: • Conversion of Mortley Avenue to entry only (except buses) at the Timbrell Drive / Dobroyd Parade intersection, with an additional entry lane to facilitate amended lane utilisation on the Timbrell Drive approach. Layout amendments could be required on Mortley Avenue which will need to consider impacts on existing parking provision, the location of the bus stop and some existing mature trees • Extension of left turn bay from Dobroyd Parade to Timbrell Avenue providing additional capacity for traffic reassigned from Mortley Avenue via Waratah Avenue and Dobroyd Parade • Provision of additional short lane on the Timbrell Drive approach to Dobroyd Parade potentially facilitated by using the old footpath area which is currently being replaced by the construction of a footbridge (subject to bridge assessment). The additional capacity will allow a greater share of green time for Dobroyd Parade movements • Provision of a new signalised left turn slip lane from Parramatta Road to Wattle Street to accommodate the high number of movements to the M4-M5 tunnel in the PM peak • Increase in parking restrictions on the southbound side of Great North Road to provide increased capacity. Further detail of the identified network upgrades is outlined in Section 10.2.3 of the Traffic and Transport Assessment in **Appendix G**.	Roads and Maritime	Operation

Impact	Ref #	Environmental management measure	Responsibility	Timing
	OpTT5	The following network upgrades will be investigated in consultation with relevant local councils, Roads and Maritime and affected communities, and implemented as and when required based on traffic growth and changing traffic patterns: • Enabling right turn movements from the kerbside lane from George Street southbound to Parramatta Road • Extension of parking restrictions on the southern (westbound) side of Ramsay Street between Wattle Street and Walker Avenue • Reassignment of the second right turn lane on the Wattle Street westbound approach to Parramatta Road post opening of the M4–M5 Link, to provide an additional right turn bay for traffic exiting the M4–M5 Link and leaving a single right turn lane from Wattle Street • Creation of a double right turn on the Wattle Street westbound approach to Ramsay Street post opening of the M4–M5 Link. This could be achieved by reallocating the right hand through lane, leaving a single through/left lane.	Roads and Maritime	Operation
Smart motorways	OpTT6	Smart motorway management will be considered for implementation within the project tunnel and associated ramps and approaches.	Roads and Maritime/Motorway operator	Operation
Air quality				
General	AQ1	Develop and implement a Construction Air Quality Management Plan which requires consultation with NSW EPA. Any measures that are required will differ depending on the activities occurring, and so will need to be tailored for each individual site.	Construction contractor	Pre-construction
	AQ2	Carry out regular site inspections to monitor compliance with the Construction Air Quality Management Plan, record inspection results.	Construction contractor	Construction
	AQ3	Develop and implement a stakeholder communications plan that includes community engagement before work commences on site.	Construction contractor	Pre-construction
	AQ4	Display the name and contact details of person(s) accountable for air quality and dust issues at the boundaries of each construction area. This may be the environment manager/engineer or the site manager. Display the head or regional office contact information	Construction contractor	Construction
Dust Management	AQ5	Plan site layout so that machinery and dust causing activities are located away from receptors, as far as is possible.	Construction contractor	Construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	AQ6	Erect solid screens or barriers around dusty activities or the site boundary that are at least as high as any stockpiles on site.	Construction contractor	Construction
	AQ7	Ensure where reasonable and feasible appropriate control methods are implemented to minimise dust emissions from the project site.	Construction contractor	Construction
	AQ8	Remove materials that have a potential to produce dust from site as soon as possible, unless being re-used on site. If they are being re-used on-site, cover as soon as practicable.	Construction contractor	Construction
	AQ9	Impose and signpost a maximum-speed-limit of 20 km/h on surfaced and unsurfaced haul roads and in work areas.	Construction contractor	Construction
	AQ10	Where practicable, only use cutting, grinding or sawing equipment fitted or in conjunction with suitable dust suppression techniques such as water sprays or local extraction, (e.g. suitable local exhaust ventilation systems).	Construction contractor	Construction
	AQ11	Ensure an adequate water supply on the site for effective dust/particulate matter suppression/mitigation, using non-potable water where possible and appropriate.	Construction contractor	Construction
	AQ12	Where possible, use enclosed chutes and conveyors and covered skips.	Construction contractor	Construction
	AQ13	Minimise drop heights from conveyors, loading shovels, hoppers and other loading or handling equipment and use fine water sprays on such equipment wherever appropriate.	Construction contractor	Construction
	AQ14	Ensure equipment is readily available on site to clean any dry spillages, and clean up spillages as soon as reasonably practicable after the event using appropriate cleaning methods.	Construction contractor	Construction
	AQ15	Avoid scabbling (roughening of concrete surfaces) if possible.	Construction contractor	Construction
Stockpile Management	AQ16	Stockpiles would be located outside overland flowpaths, and where left exposed and undisturbed for longer than 28 days, would be finished and contoured to minimise loss of material in flood or rainfall events. Materials which require stockpiling for longer than 28 days would be stabilised by compaction, covering with anchored fabrics, or seeded with sterile grass where appropriate.	Construction contractor	Construction
	AQ17	Where a stockpile, eg sand or fine aggregate, has the potential to generate dust, control measures would be implemented. These would include wetting the stockpile, covering the stockpile or contouring the stockpile.	Construction contractor	Construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	AQ18	Ensure bulk cement and other fine powder materials are delivered in enclosed tankers and stored in silos with suitable emission control systems to prevent escape of material and overfilling during delivery.	Construction contractor	Construction
	AQ19	For smaller supplies of fine powder materials ensure bags are sealed after use and stored appropriately to prevent dust.	Construction contractor	Construction
Tracking of material on roads	AQ20	Use water-assisted dust sweeper(s) on the access and local roads, to remove, as necessary, any material tracked out of the site.	Construction contractor	Construction
	AQ21	Avoid dry sweeping of large areas.	Construction contractor	Construction
	AQ22	Ensure vehicles entering and leaving sites are covered to prevent escape of materials during transport.	Construction contractor	Construction
	AQ23	Inspect on-site haul routes for integrity and instigate necessary repairs to the surface as soon as reasonably practicable.	Construction contractor	Construction
	AQ24	Record all inspections of haul routes and any subsequent action in a site log book.	Construction contractor	Construction
	AQ25	Where reasonable and feasible, haul roads will be maintained with water carts and graders, and the condition of the roads will be monitored.	Construction contractor	Construction
	AQ26	Implement site exit controls (e.g. wheel washing system and rumble grids) to dislodge accumulated dust and mud prior to leaving the site where reasonably practicable.	Construction contractor	Construction
	AQ27	Ensure there is an adequate area of hard surfaced road between the wheel wash facility and the site exit, wherever site size and layout permits.	Construction contractor	Construction
	AQ28	Access gates to be located at least 10 metres from receptors where possible.	Construction contractor	Construction
Emissions management	AQ29	Ensure all construction vehicles comply with their relevant emission standards.	Construction contractor	Construction
	AQ30	Ensure that, where practicable engines idling is minimised when stationary.	Construction contractor	Construction
	AQ31	Avoid the use of diesel or petrol powered generators and use mains electricity or battery powered equipment where practicable.	Construction contractor	Construction
	AQ32	Promote and encourage sustainable travel (public transport, cycling, walking, and car-sharing).	Construction contractor	Construction
	AQ33	No bonfires and burning of waste materials	Construction contractor	Construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
Demolition	AQ34	Soft strip inside buildings before demolition (retaining walls and windows in the rest of the building where possible, to provide a screen against dust).	Construction contractor	Construction
	AQ35	Ensure effective water suppression is used during demolition operations. Hand held sprays are more effective than hoses attached to equipment as the water can be directed to where it is needed. In addition high volume water suppression systems, manually controlled, can produce fine water droplets that effectively bring the dust particles to the ground and may be more useful for covering larger areas.	Construction contractor	Construction
	AQ36	Minimise explosive blasting where possible during demolition, using appropriate manual or mechanical alternatives.	Construction contractor	Construction
	AQ37	Bag and remove any biological debris or other hazardous materials such as asbestos, damp down such material before demolition.	Construction contractor	Construction
Earthworks	AQ38	Re-vegetate earthworks and exposed areas/soil stockpiles to stabilise surfaces as soon as practicable.	Construction contractor	Construction
	AQ39	Use hessian, mulches or tackifiers where it is not possible to re-vegetate or cover with topsoil, as soon as practicable.	Construction contractor	Construction
	AQ40	Where possible, only remove any cover for exposed areas in small areas during work and not all at once.	Construction contractor	Construction
Cumulative impacts	AQ41	Regular communication with other high risk construction ancillary facilities within 500 metres of the site boundary, to ensure plans are co-ordinated and dust and particulate matter emissions are minimised. It is important to understand the interactions of the off-site transport/deliveries which might be using the same strategic road network routes.	Construction contractor	Construction
	AQ42	Undertake regular on-site and off-site inspection, where receptors are nearby, to monitor dust, record inspection results	Construction contractor	Construction
Complaints management	AQ43	Record all dust and air quality complaints, identify cause(s), take appropriate measures to reduce emissions in a timely manner, and record the measures taken.	Construction contractor	Construction
	AQ44	Make complaints available to the Secretary upon request.	Construction contractor	Construction
	AQ45	Record any exceptional incidents that cause dust and/or air emissions, either on- or offsite, and the action taken to resolve the situation in the log book.	Construction contractor	Construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
Monitoring	AQ46	Ambient air quality will be monitored continuously for at least twelve months prior to project opening, during construction and for at least two years after project opening. Monitoring results will be made publicly available and will be subject to an independent audit.	Construction contractor and motorway operator	Pre-construction, construction and operation
	OpAQ1	Sampling points with safe access will be installed at the ventilation outlets during construction. The sampling points will be designed and located in accordance with the Approved Methods for the Sampling and Analysis of Air Pollutants in New South Wales (EPA 2007, or as updated), or an equivalent methodology approved by the Secretary in consultation with the EPA.	Construction contractor	Operation
	OpAQ2	Ventilation will be automatically controlled using real-time traffic data and feedback from air quality sensors in the tunnel, to ensure in-tunnel conditions are managed effectively in accordance with the agreed criteria	Motorway operator	Operation
	OpAQ3	Specific ventilation modes and procedures will be developed to manage breakdown, congested and emergency situations.	Motorway operator	Operation
Human Health				
Moving house due to property acquisition	HH1	Provision of access for affected households to a counselling service, WestConnex Assist, to support them in negotiating the land acquisition process and relocation.	WDA	Pre-construction
Noise and vibration				
General	NV1	A Construction Noise and Vibration Management Plan will be prepared and implemented consistent with the requirements of the *Interim Construction Noise Guideline* (DECC 2009), and will include the following: • Identification of nearby residences and other sensitive land uses • Description of approved hours of work • Description and identification of all construction activities, including work areas, equipment and duration • Description of what work practices (generic and specific) will be applied to minimise noise and vibration • A complaints handling process • Noise and vibration monitoring procedures • Overview of community consultation required for identified high impact works.	Construction contractor	Pre-construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
Construction noise	NV2	Induction and training will be provided to relevant staff and subcontractors outlining their responsibilities with regard to noise.	Construction contractor	Construction
	NV3	Work will be undertaken during standard construction hours as far as feasible and reasonable.	Construction contractor	Construction
	NV4	Where feasible and reasonable, particularly noisy activities such as the use of impact piling rigs, road and concrete saws and rockbreakers, will be scheduled around times of high background noise to provide masking.	Construction contractor	Construction
	NV5	Noisy activities that cannot be undertaken during standard construction hours will be scheduled as early as possible during the evening and/or night-time periods.	Construction contractor	Construction
	NV6	Particularly noisy activities will be scheduled during the less sensitive times of 9.00 am to 12.00 pm or 2.00 pm to 5.00 pm where appropriate.	Construction contractor	Construction
	NV7	Permanent noise barriers will be scheduled for completion as early as possible in order to minimise construction noise.	Construction contractor	Construction
	NV8	Property treatments identified for the operational phase of the project will be considered for installation before construction where they would improve noise levels.	Construction contractor	Construction
	NV9	Acoustic sheds to be erected at the Underwood Road tunnel site (C3), Concord Road tunnel site (C5), Cintra Park tunnel site (C6) and Northcote Street tunnel site (C7) will be reviewed during construction planning to determine the attenuation level required.	Construction contractor	Pre-construction
	NV10	Temporary acoustic barriers (walls or hoarding) will be considered at all construction ancillary facility and work areas where feasible and reasonable. Recommended heights and locations of these barriers are provided in Table 42 of the noise and vibration assessment in **Appendix J**.	Construction contractor	Pre-construction
	NV11	Night works will be programmed to minimise the number of consecutive nights that work affects the same receivers.	Construction contractor	Construction
	NV12	When working adjacent to schools, particularly noisy activities will be scheduled outside normal school hours, where practicable.	Construction contractor	Construction
	NV13	Works will be scheduled to avoid the coincidence of noisy plant working simultaneously close together and adjacent to sensitive receivers.	Construction contractor	Construction
	NV14	Equipment that is used intermittently will be shut down when not in use.	Construction contractor	Construction
	NV15	Where feasible and reasonable, heavy vehicle movements will be limited to daytime hours.	Construction contractor	Construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	NV16	Where feasible and reasonable, the offset distance between noisy plant items and nearby noise sensitive receivers will be as large as possible.	Construction contractor	Construction
	NV17	Where feasible and reasonable, equipment with directional noise emissions will be oriented away from sensitive receivers.	Construction contractor	Construction
	NV18	Regular compliance checks on the noise emissions of all plant and machinery will be conducted.	Construction contractor	Construction
	NV19	Ongoing noise monitoring will be undertaken during construction at sensitive receivers during critical periods to identify and assist in managing high risk noise events.	Construction contractor	Construction
	NV20	Reversing of equipment will be minimised to prevent nuisance caused by reversing alarms. Use of non-tonal reversing alarms ('quackers') will be implemented to further reduce the nuisance caused by reversing alarms.	Construction contractor	Construction
	NV21	Loading and unloading will be carried out away from sensitive receivers, where practicable.	Construction contractor	Construction
	NV22	Deliveries will be carried out during standard construction hours where feasible and reasonable.	Construction contractor	Construction
	NV23	Alternative works methods, such as use of hydraulic or electric controlled units in place of diesel units, will be considered and implemented where feasible and reasonable.	Construction contractor	Construction
	NV24	Respite periods (eg one hour respite for every three hours of continuous construction activity) will be scheduled for high noise impact works where appropriate.	Construction contractor	Construction
	NV25	Truck drivers will be advised of designated vehicle routes, parking and queuing locations, acceptable delivery hours and other relevant practices (ie minimising the use of engine brakes, and no extended periods of engine idling).	Construction contractor	Construction
Construction traffic noise	NV26	Deliveries and spoil removal will be planned to avoid queuing of trucks around construction ancillary facilities.	Construction contractor	Construction
	NV27	As far as practicable, construction vehicle movements along local roads at night will be restricted to light vehicles only, subject to further investigation of potential night-time maximum noise levels during detailed design.	Construction contractor	Construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	NV28	As far as practicable, heavy vehicle movements outside standard construction hours associated with tunnel support works (spoil removal, concrete delivery and other heavy vehicle movements) will be limited to access and egress directly to and from the arterial road network.	Construction contractor	Construction
	NV29	Spoil removal will be undertaken during the day as far as practicable.	Construction contractor	Construction
Construction vibration	NV30	Before the start of tunnelling or other vibration intensive works at each site, condition surveys will be undertaken on properties and structures within the preferred project corridor (the zone on the surface equal to 50 metres from the outer edge of the tunnels) and within 50 metres of surface works.	Construction contractor	Construction
	NV31	The safe working distances will be complied with where feasible and reasonable. This will include the consideration of smaller equipment when working close to existing structures.	Construction contractor	Construction
	NV32	If vibration intensive works are required within the safe working distances, vibration monitoring or attended vibration trials will be undertaken at the outset of these works to ensure that levels are within relevant criteria.	Construction contractor	Construction
	NV33	Investigate the feasibility of rescheduling the hours of operation of major vibration generating plant and equipment to less sensitive times such as 9.00 am to 12.00 pm or 2.00 pm to 5.00 pm, if agreed by the community affected.	Construction contractor	Construction
	NV34	Investigations will be undertaken into all heritage items located within the safe working boundary to determine if these structures are structurally unsound, to assist with determining the applicable criteria for each item.	Construction contractor	Construction
	NV35	Building condition surveys of potentially affected structures will be completed both before and after the works to identify existing damage and any damage due to the works.	Construction contractor	Construction
Ground borne noise	NV36	Vibration intensive construction works will be confined to the less sensitive daytime period (9.00 am to 12.00 pm or 2.00 pm to 5.00 pm) as far as reasonably practicable.	Construction contractor	Construction
	NV37	A detailed ground-borne vibration assessment will be undertaken following further geotechnical investigations. This will include developing the vibration site law for the project.	Construction contractor	Pre-construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
Blasting	NV38	Noise and vibration mitigation methods specific to blasting will be incorporated into the CNVMPs where required.	Construction contractor	Pre-construction and post construction
	NV39	Blasting will be restricted to standard daytime hours (except where approved by the relevant authority).	Construction contractor	Construction
	NV40	Site investigations will be conducted prior to production blasting to define suitable blast sizes to comply with project blasting noise and vibration criteria.	Construction contractor	Construction
	NV41	Dilapidation studies of nearby receiver buildings will be undertaken where the potential for exceedances of the blasting criteria is identified.	Construction contractor	Construction
	NV42	Where the predicted levels exceed the noise or vibration criteria for blasting, alternative construction methods, such as penetrating cone fracture, will be utilised.	Construction contractor	Pre-construction
	NV43	Noise and vibration mitigation methods specific to blasting will be incorporated into the CNVMPs where required.	Construction contractor	Construction
Operational ventilation facility	NV44	Once plant items within the ventilation building are confirmed during detailed design, impacts will be assessed with consideration of the INP modifying factors. Where modifying factors are found to be applicable they will be added to the assessment, and compliance with the INP criteria checked at all receivers.	Construction contractor	Pre-construction
Consultation with impacted receivers	NV45	Community consultation protocols for sensitive receivers likely to be impacted by construction activities such as blasting, vibration and noise will be prepared and implemented.	Construction contractor	Pre-construction and construction
Road noise impact	OpNV1	At locations where residual impacts remain after all feasible and reasonable approaches have been exhausted, noise mitigation in the form of acoustic treatment of existing individual dwellings will be considered.	Roads and Maritime	Operation
	OpNV2	Noise barriers will be refined during detailed design to maximise the number of receivers that receive a reduction in exceedances of noise criteria.	Construction contractor	Pre-construction
	OpNV3	Operational traffic noise will be monitored at sensitive receivers for between six months and one year after opening. If the traffic noise levels are above the predicted levels, consideration of additional feasible and reasonable mitigation measures will be undertaken.	Construction contractor	Operation

Impact	Ref #	Environmental management measure	Responsibility	Timing
Operational ancillary facilities	OpNV4	Operational ancillary facilities will be designed to meet project specific noise criteria derived in accordance with the NSW Industrial Noise Policy.	Construction contractor	Pre-construction
Property and land use				
Acquisition of property required for the project	PL1	Land acquisition for the project will be undertaken in accordance with the *Roads and Maritime Services land acquisition information guide* (Roads and Maritime 2014b) and the *Land Acquisition (Just Terms Compensation) Act 1991* (NSW).	Roads and Maritime	Pre-construction
Temporary lease or acquisition of property required for the project	PL2	Consultation will occur with the relevant property owners in relation to temporary land leases and acquisition of properties required for construction. Where acquisition is identified as the preferred option, this will be undertaken in accordance with the *Roads and Maritime Services land acquisition information guide* (Roads and Maritime 2014) and the *Land Acquisition (Just Terms Compensation) Act 1991* (NSW).	Roads and Maritime	Pre-construction
Loss of land use and property access	PL3	Property accesses that are affected as a result of the project will be reinstated in consultation with the affected landowners.	Construction contractor	Pre- construction
Property access	PL4	Affected property owners will be consulted where temporary property access will be required.	Construction contractor	Pre-construction and construction
	PL5	Affected property owners will be provided with advanced notification of relevant project schedules, construction works and changes to access arrangements.	Construction contractor	Pre-construction and Construction
	PL6	Community updates will be provided on changes to the local road network within the project area during construction.	Construction contractor	Construction
Overshadowing	PL7	A Solar Access and Overshadowing report will be developed during detailed design to assess the impacts of overshadowing as a result of the final design.	Construction contractor	Pre-construction
Urban design and visual amenity				
General	V1	The urban design and landscape objectives would continue to be considered during development.	Contractor	Pre-construction
	V2	Explore opportunities to rationalise the project footprint during pre-construction.	Contractor	Pre-construction
	V3	Engineer slopes with gradients no steeper than 3H:1V where possible.	Contractor	Pre-construction
	V4	Explore ways to integrate the project into existing streetscapes, to improve connectivity, amenity and community value.	Contractor	Pre-construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	V5	Optimise the integration of noise barriers and other features to improve amenity.	Contractor	Pre-construction
	V6	Consider a standard design for retaining walls and major structures across the project, to present a coordinated 'suite of elements'.	Contractor	Pre-construction
	V7	Consider use of LED lighting, which saves energy, costs less to maintain and provides better, safer light quality for roads.	Contractor	Pre-construction
	V8	Consider ways to maximise opportunities for tree planting, while also satisfying road design requirements.	Contractor	Pre-construction
	V9	Consider the inclusion of an arts strategy across the project.	Contractor	Pre-construction
	V10	Where practicable, areas of residual land should be made good with appropriately sized street planting, especially those areas where mature street trees have been removed.	Contractor	Construction
	V11	Provide guidance about the future development of residual land, including ways to promote project integration and activation.	Roads and Maritime	Pre-construction/ construction
	V12	Consider having the detailed design regularly reviewed by an independent design and sustainability review panel to ensure design quality throughout each stage of works, in accordance with the WUDF Principle 6.6.	Contractor	Pre-construction
General visual amenity	V13	Retain existing vegetation around the perimeter of construction sites where feasible and reasonable.	Contractor	Construction
	V14	Early implementation of noise barriers and landscape planting around ancillary facilities to provide visual screening and minimise noise impacts during construction.	Contractor	Construction
	V15	Locate equipment on construction sites to minimise visual impacts as far as feasible and reasonable.	Contractor	Construction
	V16	Acoustic shed design would aim to blend into the background where feasible and reasonable.	Contractor	Pre-construction/ construction
	V17	Design of site hoardings would consider the use of artwork or project information.	Contractor	Pre-construction/ construction
	V18	Maintain site hoardings and perimeter areas including the prompt removal of graffiti.	Contractor	Construction
	V19	Revegetation and landscaping would be undertaken progressively.	Contractor	Construction
Construction lighting	V20	Cut-off and directed lighting would be used to ensure glare and light spill are minimised.	Contractor	Construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	V21	Lighting within ancillary facilities will be turned off or reduced to a level which maintains site safety, whenever the facility is not in use.	Contractor	Construction
Signage	V22	Develop a signage strategy during pre-construction. Potentially affected receivers would be consulted on the final signage in relation to its location and associated impacts.	Contractor	Pre-construction/ construction
Tree planting on structures	V23	Consider engaging an appropriately qualified and experienced arborist and/or soil scientist to assess the feasibility of proposed tree planting (such as above the cut-and-cover sections) on structures.	Contractor	Pre-construction
	V24	Consider the use of water sensitive urban design (WSUD) measures eg water harvesting off roads, incorporation of bio-retention planting areas/planted swale treatment for stormwater polishing.	Contractor	Pre-construction
Tunnel interiors	V25	Consider the 'integration of lighting and art to enhance the travel experience,' subject to detailed design, and user and safety audits.	Contractor	Pre-construction
	V26	During pre-construction, consider the gradation of light on approach to tunnel portals, subject to detailed design, and user and safety audits.	Contractor	Pre-construction
	V27	Consider 3D animation testing of the tunnel interior designs from the driver's perspective.	Contractor	Pre-construction
Ventilation and substation facilities	V28	During pre-construction, refinements to the ventilation facilities' designs should be considered to further moderate their visual impact.	Contractor	Pre-construction
	V29	Refine substation designs during pre-construction to be integrated as far as possible within each landscape and urban context.	Contractor	Pre-construction
	V30	During pre-construction (if feasible), consider how the eastern ventilation facility addresses Walker Avenue. Explore whether the exterior of the ventilation facility can be oriented to mirror the Bunnings 'street-wall', with street trees providing scale mitigation and shade amenity.	Contractor	Pre-construction
Bridges	V31	Further develop the interface between the project pedestrian bridge and the existing shared paths and retaining walls.	Contractor	Pre-construction
	V32	Further develop the bridge lighting, in particular pedestrian bridges and connecting shared path systems, during pre-construction.	Contractor	Pre-construction
	V33	Design the highly visible bridge parts, such as piers, girders and parapets, to ensure a controlled, integrated and high quality finish taking into account the Roads and Maritime *Bridge Aesthetics: Design guidelines to improve the appearance of bridges in NSW*.	Contractor	Pre-construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	V34	Refine composite sub-structures − such as Super-T girders, headstocks and piers − having regard to the bridge aesthetics guidelines.	Contractor	Pre-construction
	V35	Develop the lighting of bridges and undercrofts to enhance safety and add character to these spaces.	Contractor	Pre-construction
	V36	Explore opportunities to enhance accessible public areas under viaduct and bridge structures to create inviting, safe and interesting environments with good solar access.	Contractor	Pre-construction
	V37	Develop the design of the Powells Creek on-ramp to consider access, amenity and safety.	Contractor	Pre-construction
	V38	Develop the integral abutment connection with the proposed cantilevered Concord Bridge deck.	Contractor	Pre-construction
	V39	Create links between the project elements and realigned pedestrian access, and the existing footpaths.	Contractor	Pre-construction
	V40	Develop fascia wall panels and/or reinforced earth wall details for the proposed soil nail walls and reinforced earth walls.	Contractor	Pre-construction
Landscaping	V41	Refine the size, numbers and densities of proposed trees, to foster robust, rapid growth and canopy closure for shade and screening.	Contractor	Pre-construction
	V42	Undertake appropriate soil analysis and adopt a soil management strategy.	Contractor	Pre-construction
	V43	Engage an ecologist to select appropriate species for mass plantings at project boundaries, and for sedimentation basin planting.	Contractor	Pre-construction
	V44	Minimise the earthworks and embankment modifications required to support the proposed cycleway on-ramp at Queens Street, in order to minimise tree loss.	Contractor	Pre-construction
Parramatta Road Transformation Program	V45	Maintain and enhance pedestrian and cycle connectivity across the Parramatta Road corridor.	Roads and Maritime	Operation
	V46	Residual land redevelopment typology, land use and design controls would be developed to provide certainty about future street amenity and activation	Roads and Maritime	Operation
	V47	Maintain and enhance public transport connectivity across the Parramatta Road corridor and to adjacent suburbs, through appropriate location of bus stops, provision of shelters and attendant furniture	Roads and Maritime	Operation

Impact	Ref #	Environmental management measure	Responsibility	Timing
	V48	Consider opportunities to improve pedestrian and shared path amenity, for example by: • Introducing shade trees of appropriate scale • Separating users from busy traffic lanes behind a landscape amenity strip • Providing appropriate lighting for pedestrian functions.	Roads and Maritime	Operation
LCZ 1 – M4	V49	Maximise opportunities for tree planting within the road corridor, where this is feasible and appropriate.	Construction contractor	Pre-construction
	V50	Provide a visually compelling, beautiful urban design overlay for the corridor that includes vegetation as one component.	Construction contractor	Pre-construction
	V51	Minimise tall tree planting between Powells Creek and the Northern Line to maintain district views from the M4.	Construction contractor	Pre-construction
	V52	Consider at-receiver planting to reduce visual and lighting impacts on residential receivers.	Construction contractor	Pre-construction
LCZ 2 –Homebush commercial	V53	Where practicable, incorporate substantial avenue planting along the northern edge of the motorway operations complex access road.	Construction contractor	Pre-construction
	V54	Where possible, provide trees within the carpark within the motorway operations complex to provide shade and visually break up the hard landscape.	Construction contractor	Pre-construction
	V55	Consider the incorporation of WSUD measures to provide passive irrigation of trees, particularly within carparks and other areas where stormwater run-on is limited.	Construction contractor	Pre-construction
LCZ 3 – Parramatta Road (west)	V56	Explore opportunities with Strathfield Council to provide landscape screening and tree planting between the project corridor and the Park Road/Powell Street precinct.	Construction contractor	Pre-construction
	V57	Investigate with Strathfield Council the feasibility of providing a pedestrian/cycleway link along the northern edge of Powell Street where it joins the M4, to link directly to the Powells Creek Corridor between the M4 and the property on the eastern corner of Powell Street and Parramatta Road.	Construction contractor	Pre-construction
LCZ 4 – Underwood Road	V58	During pre-construction, consider a formal park design that incorporates measures (eg mounding/deeper soils areas) to facilitate a successful large tree planting program between Underwood Road and Ismay Avenue.	Construction contractor	Pre-construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	V59	Explore opportunities with local councils to provide avenue planting down both sides of the street, and a linking canopy across the road.	Construction contractor	Pre-construction
	V60	Consider the use of a planting mix for the proposed park on the corner of Short Street East and Underwood Road that draws upon the suburban setting of cultural plantings, and which may include elements such as park seating, other park furniture, paving, signage and lighting.	Construction contractor	Pre-construction
	V61	Consider at-receiver planting for residences at 65−71 and 73 Underwood Road and at the end of Short Street East.	Construction contractor	Pre-construction
	V62	Consider the use of street trees along both sides of Short Street East.	Construction contractor	Pre-construction
LCZ 5 – Powells Creek	V63	During pre-construction of the M4 on-ramp at Powells Creek, consider incorporating design features that maximise the height of the opening, and facilitate views and pedestrian/cycle access under the structure to the northern end of the park.	Construction contractor	Pre-construction
	V64	Consider the provision of active recreation facilities within the park area, e.g. basketball or skateboarding, which are compatible with traffic noise, relatively high background light levels at night and adjacent development.	Construction contractor	Pre-construction
	V65	Consider ways to increase the level of screening between the apartment block at the eastern end of Powell Street and the project.	Construction contractor	Pre-construction
LCZ 6 – Concord Road	V66	Design the two large ‘island’ parks within the ramps to meet Crime Prevention Through Environmental Design (CPTED) requirements including, where feasible, spaces that would actively encourage a significant level of park use, eg active recreational facilities such as basketball courts or a skateboard facility.	Construction contractor	Pre-construction
	V67	Where residual land is used for housing, provide an architectural outcome that is responsive to the adjoining/adjacent Powell's Estate HCA.	Construction contractor	Pre-construction
	V68	For the replacement boundary wall on Concord Road fronting the Sydney Cheil Church, consider matching the design and materials of the existing wall, which is in keeping with the design of the church.	Construction contractor	Pre-construction
LCZ 7 – Edward Street	V69	Refine the design of the end of Edward Street to minimise the visual prominence of the on-ramp wall and noise barrier. Facilitate a planting edge between the on-ramp wall and the footpath, and between the footpath and the Edward Street turning head, that reflects the Federation-era character of the streetscape.	Construction contractor	Pre-construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	V70	Minimise the landscaping required between the carriageway and noise barrier (between Parramatta Road and the pedestrian bridge over the tunnel on- and off-ramps), which could be difficult to maintain. Instead, retain sufficient room to provide screen planting along the edge of the M4.	Construction contractor	Pre-construction
	V71	Consider ways to better integrate the existing disused land between the end of Alexandra Street and Parramatta Road eg a pocket park responding to the Federation era residential setting of the Edward Street area.	Construction contractor	Pre-construction
LCZ 8 – Concord Oval	V72	Configure the construction and operational layout of the Cintra Park site so as to retain the mature line of trees running along the boundary and screening to adjoining receivers.	Construction contractor	Pre-construction
	V73	Investigate opportunities during pre-construction to minimise the removal of established trees at Cintra Park.	Construction contractor	Pre-construction
LCZ 9 – Dobroyd Parade	V74	Consider the provision of a landscape design response to Reg Coady Reserve that re-integrates the new road edge with the landscape character of the park.	Construction contractor	Pre-construction
	V75	Consider a landscape response along the edge of Reg Coady Reserve edge which more closely reflects the existing, generally informal planting character of the reserve.	Construction contractor	Pre-construction
	V76	Where feasible, consider moving the footpath away from the busy road edge on both sides of Dobroyd Parade.	Construction contractor	Pre-construction
	V77	Consider augmentation of the existing screen planting to the area between Waratah Street and Crane Avenue on the residential side to maximise screening of the noise barrier on the southern edge of Dobroyd Parade.	Construction contractor	Pre-construction
	V78	Consider setting the noise barrier far enough back from Dobroyd Parade to provide an avenue of tall planting continuing up to Martin Street, as currently proposed north of Martin Street.	Construction contractor	Pre-construction
LCZ 10 – Wattle Street	V79	Consider an opportunity to extend the street tree planting along the western side of Wattle Street and Dobroyd Parade.	Construction contractor	Pre-construction
	V80	Investigate opportunities to locate the footpath away from the busy kerb and provide tall tree planting between the kerb and the footpath, to match that proposed between Ramsey Street and Martin Street.	Construction contractor	Pre-construction
	V81	Consider an integrated artwork approach to the noise barriers along Wattle Street and Dobroyd Parade.	Construction contractor	Pre-construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	V82	Consider ways to provide pedestrian and streetscape amenity between the noise barriers and the street, and to integrate the area between the back fences of the Walker Street residences and the curving noise barrier.	Construction contractor	Pre-construction
LCZ 11 – Parramatta Road (east)	V83	Consider increasing the extent of street tree planting along the frontage between Chandos Street and Rogers Avenue.	Construction contractor	Pre-construction
	V84	Consider refining the verge design to the southern edge of Parramatta Road to create a planted verge and avenue tree planting.	Construction contractor	Pre-construction
	V85	Consider providing a planted verge and avenue tree planting between the footpath and the carriageway to the Parramatta Road frontage to the residual land on the corner of Bland Street.	Construction contractor	Pre-construction
LCZ 12 – Haberfield	V86	Investigate opportunities to increase the proposed street tree planting to Walker Avenue, and seek to reinstate the original brush box street tree avenue character. This would reduce the view of the infrastructure for pedestrians and residential receivers.	Construction contractor	Pre-construction
	V87	Consider whether the proposed development of residual land on Walker Avenue visually complements the remaining row of low density housing on the other side/end of the street, and whether it reinforces the Federation-era landscape/heritage qualities and character of the street.	Construction contractor	Pre-construction
LCZ 13 – Yasmar Juvenile Training Facility	V88	Ensure that no street trees are removed from in front of, and immediately adjoining, Yasmar Estate.	Construction contractor	Pre-construction
LCZ 14 – Ashfield medium density	V89	Consider the provision for street tree planting within the parking lanes along Loftus Street to provide an increased level of street amenity and to mitigate the landscape character impact of the Parramatta Road edge effect on the street.	Construction contractor	Pre-construction
LCZ 15 – Ashfield Park	V90	Consider establishing a stand of brush box trees to the northern corner of Orpington Street and Parramatta Road to tie in with the brush box tree planting in the opposite northern corner of Ashfield Park.	Construction contractor	Pre-construction
Collaboration with councils	OpV1	In consultation with the relevant council, provide pre-construction for park/residual area landscape treatments that reflect the cultural setting of the adjoining residential precincts.	Contractor	Operation
	OpV2	Undertake the design, development and implementation of proposed ‘pocket park’ spaces adjacent to residential areas.	Contractor	Operation
	OpV3	Undertake screen planting in consultation with the relevant council to council verge areas.	Contractor	Operation

Impact	Ref #	Environmental management measure	Responsibility	Timing
Socio-economic				
Property acquisition	SE1	All acquisitions will be under the terms of the *Land Acquisition (Just Terms Compensation) Act 1991* (NSW) and in accordance with the *Land Acquisition Information Guide* (Roads and Maritime 2014d).	Roads and Maritime	Pre-construction
Relocation	SE2	Home owners will be supported to acquire alternative independent property valuations, with a commitment from Roads and Maritime to ensure property owners will not be left out of pocket (ie property valuation fees to be paid at the time the invoice is due, if this is before settlement). Relocation support teams will be provided to assist households that must relocate (both renters and owners) and land owners. These services could include: • Assistance with identifying alternate properties • Social support for households relocating within the area and to other areas, providing contacts and information in regard to social services, facilities and logistical matters (eg the logistics of moving including required administrative tasks) • Access to financial advice for affected households. • Advertising of the WestConnex Assist counselling program will continue as well as providing first language support for households with English as a second language.	WDA	Pre-construction
Access and connectivity	SE3	A community communication strategy (or equivalent plan) will be implemented to provide timely, regular and transparent information about changes to access and traffic conditions, details of future work programs and general construction progress throughout the construction phase of the project. Information will be provided in a variety of ways including letter box drops, media releases, website, signage and 24 hour project information line.	WDA/Construction contractor	Pre-construction and construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	SE4	The following specific measures will be undertaken to minimise traffic-related impacts on the community: • Consultation (with Haberfield Public School and Ashfield Council) to determine if traffic management is required at egress points at the Parramatta Road civil site exit at Bland Street • Consultation with key local infrastructure providers will be undertaken when developing the construction traffic and safety management plan (or equivalent plan), including notification to local emergency services about changes to local road networks, particularly road closures • Relocating Orpington Street bus stop in consultation with the Willows Private Nursing Home to minimise walking distance between the relocated bus stop and the nursing home where possible • Bus stop, pedestrian and cycle way changes will be advertised locally, including to local social infrastructure providers • Appropriate signage will be applied to ensure motorists understand how to access local businesses adjacent to construction works.	Construction contractor	Pre-construction and construction
Amenity - visual	SE5	Support will be given to local beautification of construction ancillary infrastructure sites through temporary plantings, decorated hoardings, or similar, to assist in reducing visual impacts. Consultation will be undertaken with the community in planning and implementing these approaches to contribute to sustaining community cohesion and identity throughout the construction period.	WDA/Construction contractor	Construction
	SE6	Local communities will be consulted in the development of options and plans for the reuse of residual land for open public spaces, or as part of the public domain to increase community connectedness and sense of belonging through landscaped areas with public art.	WDA and Roads and Maritime	
Business impacts	SE7	Providing support for local community development activities, such as community events, to assist with restoring and increasing community cohesion during construction.	WDA	Construction
	SE8	A business management plan will be developed to effectively communicate with affected businesses during the construction of the project. The plan will address the key issues raised by businesses, including access arrangements, traffic conditions, parking and local supplier opportunities.	WDA	Construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
Social infrastructure	SE9	A 24 hour project information line and website will be maintained to enable business owners and operators to receive prompt responses to their concerns, access information and view assistance measures in place during construction related work.	WDA and construction contractor	Pre-construction and construction
	SE10	Consultation will continue with all key social infrastructure providers to assist them and their clients in planning for and adapting to the changes expected during the construction period.	Construction contractor	Pre-construction and construction
	SE11	Notification of any traffic and access changes during construction periods will be provided to emergency services well in advance of the changes occurring.	Construction contractor	Pre-construction and construction
	SE12	Route changes will be notified to emergency services and social infrastructure providers to ensure they can continue to operate effectively.	Roads and Maritime and WDA	Pre-construction
	SE13	Opportunities will be explored to provide alternative land for the Cheil Church to accommodate open space, a children's playground and parking in consultation with the property owners and the congregation of users.	Roads and Maritime and WDA	Pre-construction
	SE14	Strathfield Council and Strathfield Girl Guides will be assisted to identify and access temporary premises.	Roads and Maritime and WDA	Pre-construction
	SE15	Continued support will be provided to the Zongde Temple in planning for relocation in the short and long term.	Roads and Maritime and WDA	Pre-construction
	SE16	Restoration of Bill Boyce and Reg Coady reserves to at least their pre-construction condition in consultation with the relevant councils and local communities.	Construction contractor	Pre-construction
	SE17	Consultation will be undertaken with social infrastructure providers (specifically aged care and child care facilities) in regard to any respite periods (where reasonable and feasible) for the most intrusive construction activities undertaken during the day.	Construction contractor	Pre-construction
Access and connectivity	OpSE1	Opportunities for providing increased pedestrian and cyclist connectivity, especially in the vicinity of Wentworth Street, Underwood Road and Allen Street, Homebush, will be explored.	WDA	Operation
	OpSE2	Consult with Transport for NSW in regard to improving pedestrian access in the vicinity of the Concord Road Interchange and specifically to bus stops.		

Impact	Ref #	Environmental management measure	Responsibility	Timing
Amenity – noise and vibration	OpSE3	Long-term amenity impacts (eg changes to local noise) can affect individual wellbeing and also the cohesion and connectedness of communities. Support for local community development activities (eg grants provided through councils or local community organisations) will assist with restoring and increasing community cohesion following construction, through activities such as community events.	WDA	Operation
Amenity - Visual	OpSE4	Support will be given to local beautification of operational facilities and spaces through public art and landscaping to assist in reducing visual impacts associated with these facilities. Consultation will be undertaken with the community in planning and implementing these approaches to contribute to sustaining community cohesion and identity following the construction period. Support will be provided for local community development activities such as community events to assist with restoring and increasing community cohesion post construction. Consideration will be given to the creation of legacy projects that deliver social benefit, such as developing residual land as open space areas. Legacy projects will be identified and developed in consultation with local councils. Tree planting will be maximised in those areas within the project corridor where this is feasible and appropriate within an overall design framework.	WDA	Operation
Soil and water				
Managing soil and water in general	SW1	A soil and water quality management plan will be prepared in consultation with the New South Wales Environment Protection Agency and NSW Office of Water and in accordance with: • Blue Book requirements • RTA Code of Practice for Water Management (RTA 1999).	Construction contractor	Pre-construction
	SW2	Work method statements will be prepared for waterway works with particular emphasis on the early implementation of erosion and scour protection requirements.	Construction contractor	Pre-construction
	SW3	A qualified soil conservationist will develop the initial project erosion and sediment control plans and advise on appropriate controls, implementation and monitoring and management processes.	Construction contractor	Pre-construction and construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	SW4	Tool box talks or similar inductions will be carried out to inform employees of erosion and sedimentation control plans.	Construction contractor	Pre-construction and construction
	SW5	A surface water quality monitoring program for the pre-construction, construction and operation will be undertaken in accordance with the ANZECC Guidelines and RTA Guideline. The program will be periodically reviewed so that it provides appropriate information relevant to the project implementation phase.	Construction contractor	Pre-construction and construction
Erosion risk	SW6	Measures will be implemented to minimise the risk of erosion and sedimentation. These measures may include: • Disturbed areas will be minimised and revegetated or stabilised as soon as practical. • Erosion control measures such as sediment fences, check dams, temporary ground stabilising, diversion berm or site regrading will be installed as appropriate. • Where practical, clean water will be diverted away from works or disturbed areas. • Measures will be employed to control ground stability and limit run-off lengths and velocities within the construction ancillary facilities. • Wheel wash or rumble grid systems will be installed, where practical, at compound heavy vehicle exit points to minimise the transfer of soil from construction areas to roadways. • Erosion and sedimentation controls will be regularly inspected to maintain performance to the design criteria and design specifications. Controls are to be upgraded or altered if these objectives are found to not be satisfied.	Construction contractor	Pre-construction and construction
Scour protection	SW7	Measures will be implemented to minimise the risk of scour of waterways. These measures may include: • Permanent scour protection measures required for the operational phase will be installed early, where practical. • Work platforms or access tracks required in the vicinity of waterways will be constructed of large clean rock material wrapped or underlain with geofabric.	Construction contractor	Construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
Stockpile management	SW8	Measures will be implemented to manage stockpiles. These measures may include: • Stockpiles will to be located outside of overland flowpaths, riparian corridors and finished and contoured so as to minimise loss of material in flood or rainfall events. • Stockpiles left exposed and undisturbed for longer than 28 days will be stabilised by compaction then either: – Sprayed with suitable tackifier – Covering with anchored fabrics – Seeded with sterile grass.	Construction contractor	Construction
Pollution control	SW9	Measures will be implemented to minimise the risk of spills. These measures may include: • Spill containment will be included at locations where there is direct discharge of stormwater to receiving waterways. • Appropriately bunded areas will be provided for storage of hazardous materials such as oils, chemicals and fuels. • Adequate controls around stockpile areas and excavation works will be installed to minimise the risk of contaminants being washed into waterways or stormwater systems. • Maintenance of containment/spill infrastructure and clean-up procedures for on-site spills will be undertaken. • Spilt materials and/or any contaminated materials will be disposed of appropriately.	Construction contractor	Construction
Rehabilitation of disturbed and riparian zones	SW10	Disturbed areas, including riparian environments, will be rehabilitated as soon as practical. Measures will include revegetation (using native species from the relevant local vegetation communities) and stabilisation.	Construction contractor	Construction
Operational water quality	OpSW1	Measures to prevent runoff, stormwater or spillage being directed onto other roadways outside of the project footprint will be implemented.	Construction contractor	Operation
	OpSW2	Water quality monitoring will continue from SW5 for at least 12 months post-construction or until any affected waterways are certified by an independent expert as being rehabilitated to an acceptable condition as required by any condition of approval.	Construction contractor	Operation

Impact	Ref #	Environmental management measure	Responsibility	Timing
Contamination				
Confirmation of contamination	C1	Further intrusive investigation will be undertaken within the Powells Creek construction ancillary facility (at Arnotts Reserve) to obtain a statistically complete dataset. The investigation will include sampling of soils likely to be disturbed during construction, analysed for benzo(a)pyrene, lead and asbestos.	Construction contractor	Pre-construction
	C2	Further site investigations will be undertaken in the vicinity of BH1344 to confirm the presence and determine the nature of contaminant of potential concern in this area.	Construction contractor	Pre-construction
	C3	Hazardous materials assessments will be undertaken for buildings proposed for demolition to manage potential risk of exposure to site workers during these works. Management strategies will be developed from these assessments and will be included Safe Work Method Statements and/or Waste Management Plan.	Construction contractor	Pre-construction
	C4	Further site investigations will be undertaken to assess the level and extent of asbestos in publicly accessible areas beside the M4 in Section 1 of the project footprint.	Construction contractor	Pre-construction
	C5	Targeted site investigations will be undertaken at the former laundry/dry cleaners at 225-227 Parramatta Road, Ashfield and the former service station located at 186 Parramatta Road, to confirm the presence of any latent contamination.	Construction contractor	Pre-construction
Management of contamination	C6	Procedures to manage unexpected contamination finds and hazardous materials identified during site preparation and/or construction works will be prepared. The procedures will include details for the management of the following identified contaminants: • PAHs and benzo(a)pyrene TEQ • Latent contamination.	Construction contractor	Construction
	C7	Potentially contaminated areas directly affected by the project will be investigated and managed in accordance with the requirements of the *Contaminated Land Management Act 1997* (NSW) and *Contaminated Sites: Guidelines for Consultants Reporting on Contaminated Sites* (OEH 2011).	Construction contractor	Construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
Contaminated groundwater	C8	Where passive dewatering of the aquifer system is required, additional contamination sampling (of groundwater and seepage quality) would be completed to assess the potential management and disposal options. A baseline groundwater monitoring plan would be implemented to gather water quality data to inform management and disposal options of groundwater seepage during construction.		
Management of potentially contaminated waste	C9	Any excavated soil contaminated with benzo(a)pyrene will be managed to prevent spreading potentially contaminated soil on final ground surfaces where the general public could be exposed post construction.	Construction contractor	Construction
Waste classification	C10	Further waste classification will be undertaken during construction to allow appropriate soil management and disposal, in particular for areas that were not accessible during this assessment (including private properties). Details of sampling and analysis protocols will be included in the Spoil Management Plan (refer to **Chapter 23** (Resource Use and Waste)).	Construction contractor	Construction
Asbestos	C11	Asbestos handling and management will be undertaken in accordance with an Asbestos Management Plan and relevant State legislation, government policies and Australian Standards. The plan will include • Protocols and procedures for entering and safe working in areas with surface asbestos (eg Sections 1 and 3) with respect to asbestos containing materials (fibrous and cement-bound) • Appropriate remediation/ management strategies.	Construction contractor	Pre-construction
Acid sulfate soils	C13	Confirmatory testing of areas identified as disturbed terrain (eg such as near, to Bedford Road and Verley Drive (Section 1), Concord Oval (Section 5), and Wattle Street (Section 6)) and stockpiled spoil during construction will be carried out in areas where potential acid sulfate soils have been mapped, to confirm their presence or absence, and to obtain a specific liming rate for stockpiles (if required).	Construction contractor	Construction
	C14	If acid sulfate soils are encountered, they will be managed in accordance with the *Acid Sulfate Soil Manual* (Acid Sulfate Soil Management Advisory Committee, 1998).	Construction contractor	Construction
Demolition	C15	Demolition works will be undertaken in accordance with Australian and NSW WorkCover Standards.	Construction contractor	Construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	C16	Appropriate mitigation measures including stockpiling and management of potentially contaminated material will be undertaken at building demolition sites to prevent movement of material into receiving waters.	Construction contractor	Construction
Contamination during operation	OpC1	Procedures to address spills, leaks and tunnel washing will be developed and implemented during operation of the project.	Construction contractor	Operation
Flooding and drainage				
Management of flood and stormwater − General	FD01	A flood management strategy (FMS) will be prepared to manage flooding and stormwater related issues and will include: • The layout of construction ancillary facilities • Location of amenities buildings and equipment outside high flood hazard areas • Controlled diversion of overland flow either through or around work areas • Staging construction to limit the extent and duration of temporary works on the floodplain • Monitoring weather conditions • Ensuring construction equipment and materials are removed from floodplain areas at the completion of each work activity, or upon issuing of a weather warning of impending flood producing rain • Provision of temporary flood protection for properties identified as being at risk of adverse flood impacts during any stage of construction of the project • Development of flood emergency response procedures to remove temporary works during periods of heavy rainfall and staff evacuation plans. • For site facilities located within the floodplain, the FMS will identify how risks to personal safety and damage to construction facilities will be managed.	Construction contractor	Pre-construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
Flooding impacts on adjacent development	FD02	Adverse flood impacts on existing development will be managed through the FSM. This will include: • A detailed hydrologic and hydraulic assessment into flooding behaviour and mitigation measures required during detailed design • Design of works within the floodplain to minimise adverse impacts on surrounding development for flooding up to the 100 year ARI event. Assessment will also be made of impacts during flooding in excess of the 100 year ARI event up to the PMF, in the context of impacts on critical infrastructure and flood hazards • Floor level survey will be carried out at all properties at risk (where there is a potential increase in flood levels) to confirm whether construction activities will increase flood damages. Where flooding potential is confirmed, management measures for construction works and operational design will be incorporated.	Construction contractor	Pre-construction
Management of stormwater	FD03	Appropriate local stormwater measures will be provided, where required.	Construction contractor	Pre-construction and construction
Impacts of future climate change on flooding behaviour	FD04	The project will be designed to manage the potential impacts due to climate change in accordance with the *Practical Considerations of Climate Change – Floodplain Risk Management Guideline* (DECC 2007).	Construction contractor	Pre-construction
Homebush Bay Drive interchange	FD05	Refinement of XD02 realignment and reshaping of the overbank area will partially divert overland flow away from the affected properties.	Construction contractor	Pre-construction and construction
Homebush Bay Drive interchange − bridge over Saleyards Creek	FD06	The detailed design will exceed minimum clearance requirements. The longer spans of the new bridges will offset the increased hydraulic losses associated with their larger footprint and multiple bridges, when compared to the existing arrangement. Continuous walls will be provided between the abutments of the new bridges to provide a uniform waterway section. The eastbound cycleway bridge will be managed through provision of a waterway area consistent with that of the M4.	Construction contractor	Pre-construction and construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
Homebush Bay Drive interchange − Underwood Road distribution substation and western ventilation facility	FD07	Openings to the buildings will be located to prevent the ingress of floodwaters in a PMF event, providing a freeboard allowance greater than 0.5 metres freeboard to the 100 year ARI flood level.	Construction contractor	Pre-construction and construction
Powells Creek on-ramp − bridge over Powells Creek	FD08	The bridge over Powells Creek will be designed to provide a minimum 0.5 m clearance between the underside of the bridge and the 100 year ARI flood level. The bridge abutment at Parramatta Road will be located to minimise impacts during a 100 year ARI event.	Construction contractor	Pre-construction and construction
Concord Road interchange − tunnel dive structure	FD09	A barrier wall and overland flow path will be provided along the eastern side of the on- and off-ramps to direct overland flow around the tunnel entry during a PMF event. The top of the barrier wall will be located a minimum 0.5 metres above the 100 year ARI flood level.	Construction contractor	Pre-construction and construction
Concord Road interchange − realignment of existing stormwater drainage line XD04	FD10	A grassed channel will be provided to divert overland flow from stormwater drainage line XD04 around the surface road works. The grassed channel will be sized to contain 100 year ARI flows within the project footprint and thus prevent an increase in the extent of inundation within residential properties in Sydney Street.	Construction contractor	Pre-construction and construction
Cintra Park facilities	FD11	Openings to the facility will be located at a minimum elevation of 6.2 metres AHD, to prevent the ingress of floodwater in a PMF event and to provide a freeboard greater than 0.5 metres to the 100 year ARI flood level.	Construction contractor	Pre-construction and construction
Cintra Park facilities	FD12	The size and layout of the overland flow path will be integrated with the layout of the water treatment facility.	Construction contractor	Pre-construction and construction
Parramatta Road interchange − tunnel dive structure	FD13	A barrier wall will be provided along the eastern side of the tunnel dive structure to direct overland flow around the tunnel entry during a PMF event. The top of the barrier wall will be located a minimum 0.5 m above the 100 year ARI flood level.	Construction contractor	Pre-construction and construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
Parramatta Road interchange − realignment of stormwater drainage line XD09c	FD14	The diversion of stormwater drainage line XD09c and the overland flow path at Chandos Street will be designed to contain flows within the project footprint, preventing an increase in the extent of inundation within the adjacent commercial property. Refinement of the pit and pipe drainage system design will be undertaken to prevent an increases in flows and flood levels along Parramatta Road and Bland Street.	Construction contractor	Pre-construction and construction
Wattle Street interchange − dive structure	FD15	Road level and barriers at the entry to the tunnel portals will prevent ingress of floodwaters during a PMF event, providing a freeboard allowance greater than 0.5 metres freeboard to the peak 100 year ARI flood level. A drainage path will be provided to drain local catchment runoff from Allum Street around the tunnel dive structure during a PMF event.	Construction contractor	Pre-construction and construction
Changes to flooding behaviour – bridge construction	FD16	Temporary bridge works and access roads will be staged and removed as soon as practical after serving their primary purpose.	Construction contractor	Construction
Scour prevention	FD17	Measures will be implemented and maintained to intercept concentrated flow and divert it in a controlled manner to prevent scour of disturbed surfaces and transportation of sediment and construction materials.	Construction contractor	Construction
M4 Motorway - Homebush Bay Drive to Pomeroy Street and Homebush Bay Drive Civil Site (C1)	FD18	The resulting increase in peak flood levels will be managed by providing a setback (up to about 8.0 m) between the edge of the existing concrete channel and the construction site.	Construction contractor	Construction
Homebush Bay Drive interchange and Underwood Road civil site (C3a)	FD19	The width of the flow path where it crosses the cut-and-cover section of tunnel will be increased and ground levels lowered on the eastern side of Underwood Street. The overland flow path will be maintained so as not to increase depths of inundation in adjacent residential development.	Construction contractor	Construction
Powells Creek civil site (C4) Incorporating Powells Creek on ramp	FD20	The location and dimensions of the temporary access crossings across the Powells Creek channel will be managed. Temporary flood protection measures at the allotment level will be implemented as required.	Construction contractor	Construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
Concord Road interchange, M4 Motorway – Sydney Street to Parramatta Road and Concord Road civil and tunnel site (C5)	FD21	The impacts on depths of overland flow in existing residential development are localised and will be addressed by providing an overland flow path through the site or around its perimeter to control flows that exceed the capacity of stormwater drainage line XD04.	Construction contractor	Construction
Cintra Park tunnel site (C6) Incorporating Cintra Park fresh air supply and water treatment facility	FD22	An overland flow path through the site will be provided.	Construction contractor	Construction
Wattle Street (City West Link) interchange and Wattle Street and Walker Avenue civil site (C9)	FD23	Bunding will be provided to direct overland flow along the haul road and around the Sydney Water pump station.	Construction contractor	Construction
Parramatta Road interchange and Parramatta Road civil site (C10)	FD24	An overland flow path will be provided along Parramatta Road between Chandos Street and Bland Street to control flows that exceed the capacity of stormwater drainage line XD09c. Subject to land access, the detention tank at Bland Street and upgrades to the drainage line along Parramatta Road and Bland Street will be built as part of enabling works or temporary storage on site C10 will be considered as an alternative measure. Temporary flood protection measures will be implemented at the allotment level, as required, to address residual flood impacts.	Construction contractor	Construction
All tunnel structures	FD25	The flood standard adopted at each tunnel entry during construction will take account of the duration of construction, the magnitude of inflows and the potential risks to personal safety and the project works.	Construction contractor	Construction
Groundwater				
Managing groundwater general	GW1	Pre-construction surface and groundwater monitoring will continue on a monthly basis to establish baseline conditions.	Roads and Maritime	Pre-construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	GW2	Prior to construction, a groundwater monitoring plan for the construction and operational phases of the project will be developed in consultation with the Department of Primary Industries – Water and the NSW Environment Protection Authority. This will include: • Tunnel inflow rates and chemistry compared with the predicted inflows • Mineral precipitation relating to blockage of inflow collection, reticulation and treatment systems.	Construction contractor	Pre-construction,
Precipitation of iron and manganese	GW3	Following further groundwater monitoring, the potential for clogging of groundwater drainage and collection systems will be considered during detailed design. Where ferrous (soluble) iron concentrations remain high, consideration will be given to treating captured groundwater prior to discharge for: • Aeration to reduce dissolved iron and manganese • Settlement to remove precipitated iron and sediments.	Construction contractor	Pre-construction
Groundwater discharge to surface waters	GW4	The location of the groundwater discharge to St Lukes Park Canal will be confirmed following further surface water monitoring. Untreated saline groundwater will be discharged to a location that is influenced by existing saline conditions. If a suitable discharge location is unable to be identified, saline groundwater will be treated prior to discharge.	Construction contractor	Pre-construction
Licensed bore drawdown	GW5	Management of licensed bores identified as being at risk of drawdown will include: • Inspect and confirm existing status of the licensed bores prior to tunnel excavation and, if active, confirm their current purpose • Monitoring water chemistry and water levels pre-construction, construction and during operation • Appropriate make good trigger levels and make good requirements for impacted bores • Where appropriate, provide compensatory measures for adverse impacts.	Construction contractor	Pre-construction, construction and operation
Ground movement and settlement	GW6	Further assessments will be undertaken during detailed design to determine the level of potential impact on structures and to identify feasible and reasonable mitigation and management measures required to minimise potential ground movement impacts and make good identified impacts.	Construction contractor	Pre-construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	GW7	Prior to the commencement of tunnelling works, existing condition surveys will be undertaken on properties and structures within the project corridor (the zone on the surface equal to 50 m from the outer edge of the tunnels) and within 50 m of surface works.	Construction contractor	Pre-construction and construction
Non-Aboriginal heritage				
Detailed design	NAH1	Where practical, heritage specialists (built and landscape heritage and historical archaeology) and urban designers will provide input into the detailed design and documentation phase to assist in identifying opportunities to enhance the conservation options for heritage items and archaeological sites and ensure adverse impacts are avoided or minimised. This will include, but not be limited to, the alignment and design of noise barriers to avoid or minimise impacts on heritage items. (moderately effective).	Construction contractor	Pre-construction
	NAH2	New structures will be of a high quality, sympathetic design to minimise visual impacts on the setting of heritage buildings and landscapes taking into account a range of design considerations. (somewhat effective).	Construction contractor	Pre-construction
	NAH3	As part of the construction heritage management plan, an overarching historical archaeological research design will be prepared prior to commencement of construction. It will describe clear significance thresholds to possible archaeological items that may be uncovered during works and designate when monitoring, testing and/or salvage and excavation should occur in relation to the project works and timing. Post-excavation reporting, including artefact analysis and additional historical research (where necessary), would be required for any historical archaeological investigations undertaken. (moderately effective).	Construction contractor	Pre-construction
General	NAH4	A construction heritage management plan would be prepared prior to construction detailing how construction impacts on heritage will be minimised and managed including training and induction processes for construction personnel. Inductions are to cover built heritage, landscape and historical archaeological sites and their management, and provide heritage guidance on how to avoid/manage impacts. The induction would be prepared in consultation with a suitably qualified heritage specialist and historical archaeologist (highly effective).	Construction contractor	Pre-construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	NAH5	Impacts to built heritage, heritage landscapes and historical archaeological sites, will to the greatest extent practicable, be avoided and minimised. Where impacts are unavoidable, works shall be undertaken in accordance with the strategy outlined in the construction heritage management plan. (moderately effective).	Construction contractor	Pre-construction and construction
	NAH6	The Roads and Maritime *Standard Management Procedure—Unexpected Heritage Items* (2015) will be applied in the event any unanticipated archaeological remains are discovered during the project. The procedure covers identification of heritage items and archaeological sites; recording and reporting on items including guidelines for photography; key environmental contacts; and procedural information for example on uncovering human remains. (moderately effective) If human remains were discovered during any phase of works associated with the project, works will cease immediately in the surrounding area. The findings will be reported immediately to the NSW Coroner's Office and/or the NSW Police. (moderately effective).	Construction contractor	Construction
Impacts on heritage items – general	NAH7	An Interpretation Plan will be developed and implemented for the project, in accordance with the NSW Heritage Division guidelines. The Interpretation Plan will focus on the Powells Estate heritage conservation area, Thornleigh House gates and driveway, Longbottom Stockade (Concord Oval) and the Haberfield Conservation Area, and will include interpretive initiatives in new public reserves and walkways. Artefacts and archaeological remains will be considered for their interpretative value when identified or recovered by excavation. (somewhat effective).	Construction contractor	Pre-construction
	NAH8	Photographic recording would be undertaken of heritage items, contributory items, groups/streetscapes comprising combinations of heritage items and contributory items, and potential heritage items that would be directly impacted by the project. The recording methodology would be generally in accordance with the NSW Heritage Office guidelines *Photographic Recording of Heritage Items Using Film or Digital Capture* (2006b), but the detail of the recording required would be determined by the significance of the items/groups/streetscapes (least effective).	Construction contractor	Pre-construction and construction
	NAH9	During demolition, where practical, recycle elements of heritage fabric from items of heritage significance using recycling agents. (least effective).	Construction contractor	Construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
Impacts on archaeology - general	NAH10	Where required by the historical archaeological research design and prior to the commencement of pre-construction and/or construction activities that will impact historical archaeological sites identified in the EIS, an archaeological excavation program in accordance with the *Heritage Council of NSW Archaeological Assessment Guidelines* (1996). This work will be undertaken by an appropriately qualified archaeological consultant (moderately effective).	Construction contractor	Pre-construction and construction
	NAH11	Mitigation methodologies for the management of impacts on known and potential significant historical archaeological resources will be further developed at the detailed design stage, once key ground disturbance impacts have been finalised (in terms of exact depth, width, extent and type of impact). This would ensure that the archaeological mitigation strategies are streamlined and reduced in scope to target the key areas of unavoidable impact on significant archaeological resources (moderately effective).	Construction contractor	Pre-construction
	NAH 12	All archaeological mitigation measures including archaeological monitoring, testing and/or salvage excavation, as required, would be undertaken in accordance with standards and processes stipulated by the NSW Heritage Division, Office of Environment and Heritage with respect to the archaeological resource (moderately effective).	Construction contractor	Pre-construction and construction
	NAH13	The construction heritage management plan would include detailed procedures/ strategies for the conservation and curation of any historical artefacts recovered during works (moderately effective).	Construction contractor	Pre-construction and construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
State-significant archaeology	NAH14	In the event that historical archaeological relics of State significance are identified (eg HAMU 8), they will be managed in accordance with the following measures: • An excavation director who meets the NSW Heritage Branch requirements for directing State significant archaeological investigations must monitor the works • In situ retention of the archaeological resource may be required, unless it is highly disturbed and/or of a fragmentary nature—or if the impacts are assessed by the excavation director to be minor in nature • A work method statement or historical archaeological research design will be prepared by a qualified historical archaeologist in accordance with Heritage Division requirements, prior to the commencement of works. This will outline a methodology for the investigation, salvage and/or conservation of archaeological resources • Where required, an archaeological excavation program will be implemented in accordance with the *Heritage Council of NSW Archaeological Assessments Guideline* (1996). This work will be undertaken by an appropriately qualified archaeological consultant • The NSW Heritage Division and Roads and Maritime must be notified when intact State significant relics are discovered • Public engagement such as media releases, public open days during the works program, and/or post-works heritage interpretation may be warranted • If relics are found, post-excavation reporting, artefact analysis and conservation of relics. (moderately effective). In the event that State significant historical archaeology remains are identified within Cintra Park (HAMU 8) rearrangement of elements within the site compound will be considered and other conservation measures applied as necessary. Ground works in the existing carpark north of Concord Oval would be avoided (highly effective).	Construction contractor	Construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
Locally significant archaeology	NAH15	In the event that historical archaeological relics of local significance are identified, they will be managed in accordance with the following measures: • A work method statement or heritage archaeological research design will be prepared by a qualified historical archaeologist in accordance with Heritage Division requirements, prior to the commencement of works. The Work Method Statement or Archaeological Research Design will outline a methodology for the investigation, monitoring and/or salvage of archaeological resources • Archaeological monitoring will be led by a suitably qualified Excavation Director for the works. Monitoring will be followed by open-area excavation as required. This will depend on the nature, extent and integrity of the archaeological resource to be impacted, and the level of impact proposed • Where required, an archaeological excavation program will be implemented in accordance with the *Heritage Council of NSW Archaeological Assessments Guideline* (1996). This work will be undertaken by an appropriately qualified archaeological consultant • If unexpected State significant relics were to be discovered, such relics may need to be managed in accordance with State significant requirements as listed above. The Excavation Director should determine if the unexpected relics are likely to be reassessed as State significant, and then determine appropriate mitigation • The NSW Heritage Division and Roads and Maritime are to be notified if intact State significant relics are discovered • Public engagement, such as heritage interpretation and/or public open days may be warranted, depending on the nature and significance of the archaeological resource • If relics are found, post-excavation reporting, artefact analysis and conservation (moderately effective).	Construction contractor	Construction
Welfare Street Conservation Area	NAH16	Where feasible and reasonable, a vegetated buffer will be retained between the conservation area and the widened M4 off-ramps to Homebush Bay Drive (highly effective).	Construction contractor	Pre-construction and construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
Powells Estate Conservation Area, North Strathfield	NAH17	Where feasible, the size and form of the proposed distribution substation to be located near the corner of Sydney Street and Concord Road will be designed to be as recessive as possible and incorporate sensitive landscaping treatment to reduce permanent visual impacts on the remaining portion of Powells Estate Conservation Area (somewhat effective).	Construction contractor	Pre-construction and construction
House, 99 Concord Road, Concord	NAH18	The front garden and fence will be re-established on completion of construction works (highly effective).	Construction contractor	Construction
House and garden, 10 Thornleigh Road, Concord	NAH19	A landscape buffer will be established between the house and the widened Concord Road (highly effective).	Construction contractor	Pre-construction and construction
Wesley Uniting Church and hall, Concord	NAH20	Subject to agreement with the landowner, the church grounds, entrance gates and boundary fence will be re-established along the new Concord Road boundary (moderately effective).	Construction contractor	Pre-construction and construction
	NAH21	A photographic archival recording of the entrance gates with measured drawings will be undertaken before construction, to assist with their relocation. The sandstone cobble driveway will be included in the recording (moderately effective).	Construction contractor	Pre-construction and construction
	NAH22	The condition of the church and tower and its vulnerability to construction vibration will be confirmed prior to works commencing, and appropriate strategies will be implemented to avoid or minimise impacts if required. This will include, as a minimum, vibration monitoring (highly effective).	Construction contractor	Pre-construction and construction
Street trees: Sydney Street, Concord and Edward Street, Concord	NAH23	Where feasible and reasonable, the detailed design and construction stages will seek to maximise the number of trees retained (highly effective).	Construction contractor	Pre-construction
	NAH24	Significant trees in the vicinity of the project along Sydney Street and Edward Street will be protected during construction works, on the advice of a suitably qualified and experienced arborist (highly effective).	Construction contractor	Construction
	NAH25	New trees planted at the western end of Sydney Street will be brush box or a similar, sympathetic species (highly effective).	Construction contractor	Construction
St Luke's Park gateway/entrance − gates and trees only, Concord	NAH26	If feasible, the Moreton Bay fig trees along the Loftus Street boundary of Concord Oval, within the car park, will be retained and protected during construction works, in accordance with the advice of a suitably qualified and experienced arborist (highly effective).	Construction contractor	Pre-construction and construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
Haberfield Heritage Conservation Area	NAH27	The vents and motorway facilities would be sited as close as possible to Parramatta Road to minimise their intrusion into the conservation area. An orientation that is more consistent with the Haberfield built form and subdivision would also be investigated. Where feasible, the proposed ventilation outlet and motorway facilities will be as recessive as feasible and reasonable to reduce permanent visual impacts on the Haberfield Conservation Area. They will be of high-quality design and materials (somewhat effective).	Construction contractor	Pre-construction
	NAH28	The urban design and landscape plan will include planting strategies for the impacted area of the Haberfield Heritage Conservation Area to guide the landscaping along the project, around the ventilation facility and motorway facilities and along streets. The planting strategies would be developed with a view to complementing the existing historic streetscape plantings where relevant, with particular focus on Martin Street, Walker Avenue and Northcote Streets (moderately effective).	Construction contractor	Pre-construction and construction
	NAH29	The photographic archival recording of the affected areas of the Haberfield Conservation Area will include the streetscapes affected by the demolition of individual buildings (least effective).	Construction contractor	Pre-construction and construction
Yasmar, Parramatta Road, Haberfield	NAH30	The urban design and landscape plan would ensure views to the front gates and landmark Moreton Bay figs within Yasmar's mature garden are not obscured (highly effective).	Construction contractor	Pre-construction and construction
	NAH31	If required, the front entrance gates and mature trees along Yasmar's front (Parramatta Road) boundary will be protected during construction works (highly effective).	Construction contractor	Pre-construction and construction
	NAH32	If impacted by construction works, the access way from Parramatta Road into Yasmar would be re-instated (highly effective).	Construction contractor	Pre-construction and construction
	NAH33	Significant trees in the vicinity of the project will be protected during construction works (highly effective).	Construction contractor	Pre-construction and construction
Dobroyd Stormwater Channel No. 53, Haberfield	NAH34	The fabric of the channel would be protected during construction works on the advice of a suitably qualified civil engineer (highly effective).	Construction contractor	Pre-construction and construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
Biodiversity				
General	B1	A Construction Flora and Fauna Management Plan will be developed for the construction phase of the project to confirm potential impacts and provide details of biodiversity management measures and procedures to be undertaken during construction to minimise and manage impacts on biodiversity.	Construction contractor	Pre-construction
Impact on adjacent vegetation	B2	The project footprint will be clearly delineated to minimise impacts on adjacent vegetation.	Construction contractor	Construction
Impact on adjacent vegetation	B3	Investigate opportunities to retain perimeter plantings where feasible at construction ancillary facilities at Cintra Park and Powells Creek.	Construction contractor	Pre-construction
Impact on fauna	B4	A pre-clearing survey will be carried out to identify any habitat trees or other features that require the presence of an appropriately qualified fauna handler during clearing.	Construction contractor	Construction
Impact on threatened microbats	B5	An appropriately qualified fauna handler will be present during removal of habitat trees identified during pre-clearing surveys to guide clearing activities and undertake rescue and relocation of fauna.	Construction contractor	Construction
Impacts on Grey-headed Flying-fox	B6	Landscaping should incorporate planting of Grey-headed Flying-fox feed trees where feasible.	Construction contractor	Construction
Spread of weeds and pathogens	B7	Weed and pathogen management and control will be undertaken in accordance with the *Biodiversity Guidelines* (Roads and Traffic Authority (RTA) 2011).	Construction contractor	Construction
Saleyards Creek	B8	The water quality basin at Saleyards Creek will be designed to minimise impacts on the creek corridor and the setback area along this boundary should be appropriately landscaped.	Construction contractor	Pre- construction and construction
Rehabilitation	B9	At the completion of construction, complementary landscaping using locally endemic species will be undertaken in areas of construction ancillary facilities abutting creeks, canals and open space areas, where feasible.	Construction contractor	Post-construction
General	OpB1	Weed management and control will be undertaken in accordance with the *Biodiversity Guidelines* (RTA 2011).	Motorway operator and Roads and Maritime	Operation
Greenhouse gas				
Greenhouse gas	GHG1	Prepare an Energy Efficiency and GHG Emissions Strategy for the project.	Construction contractor	Detailed design

Impact	Ref #	Environmental management measure	Responsibility	Timing
	GHG2	Undertake an updated GHG assessment (Scope 1 and Scope 2) based on detailed design.	Construction contractor	Detailed design
	GHG3	The emissions intensity of significant construction materials specified in the design of the project would be assessed and, where feasible and in compliance with technical specifications, purchasing power would be used to drive the procurement and use of low emission construction materials.	Construction contractor	Detailed design
	GHG4	Where feasible, recycled content road construction materials such as recycled aggregates in road pavement and surfacing, or similar, would be used.	Construction contractor	Detailed design
	GHG5	The fuel efficiency of construction plant and equipment would be assessed before selection and, where feasible and reasonable, equipment with the highest fuel efficiency or equipment that uses lower GHG intensive fuel such as biofuels (eg biodiesel, ethanol) would be used.	Construction contractor	Detailed design
	GHG6	Project planning would be undertaken to ensure that the site vehicle movements and construction activities are efficient, to avoid double handling of materials and unnecessary fuel use where possible.	Construction contractor	Detailed design
	GHG7	Locally produced goods and services would be procured where feasible and cost effective to reduce transport fuel emissions.	Construction contractor	Detailed design and construction
	GHG8	A minimum of six per cent of the project's estimated electricity consumption would be sourced from a renewable energy source or GreenPower, where reasonable and feasible.	Construction contractor	Detailed design and construction
	GHG9	Waste would be diverted from landfill, including diversion of spoil, construction and demolition waste, and commercial and industrial waste, where reasonable and feasible.	Construction contractor	Detailed design and construction
	GHG10	The tunnel would be designed to minimise fuel consumed by vehicles using the road, for example through the provision of a vertical alignment that allows consistent vehicle speeds to be maintained.	Construction contractor	Detailed design
	GHG11	A life cycle assessment would be undertaken as part of the detailed design in order to select mechanical and electrical systems with increased energy efficiencies, where reasonable and feasible, such as the tunnel ventilation system, tunnel lighting, water treatment systems and electronic toll and surveillance systems.	Construction contractor	Detailed design
	GHG12	Low carbon energy generation options would be investigated as part of the design process in order to reduce the demand on mains electricity and generate renewable energy onsite, where feasible.	Construction contractor	Detailed design

Impact	Ref #	Environmental management measure	Responsibility	Timing
	GHG13	A portion of the project's estimated electricity consumption would be sourced from a renewable energy source or GreenPower, where reasonable and feasible.	Motorway operator	Detailed design/ operation
Aboriginal heritage				
Unexpected finds	AH1	If an Aboriginal object(s) is discovered during construction it will be managed in accordance with the standard management procedure, Unexpected Archaeological Finds (Roads and Maritime 2015a), which includes the following provisions: • Relevant works in the vicinity of the object(s), with the potential to directly or indirectly impact on the object(s), will cease • The construction Environmental Representative, OEH and the Metropolitan Local Aboriginal Land Council will be notified of the discovery • A qualified archaeologist will be engaged to determine the nature, extent and scientific significance of the object(s) • Management recommendations will be developed in consultation with the qualified archaeologist, OEH and the Metropolitan Local Aboriginal Land Council	Construction contractor	Construction
Unexpected finds	AH2	If human remains are discovered during construction, the find will be managed in accordance with the standard management procedure, Unexpected Archaeological Finds (Roads and Maritime 2015a), which includes the following provisions: • Relevant works in the vicinity of the remains, with the potential to directly or indirectly impact on the remains, will cease • The construction Environmental Representative, OEH and NSW Police will be notified of the discovery • Directions from the NSW Police and/or OEH, as relevant, will be followed, depending on the nature of the remains and the outcome of forensic investigations.	Construction contractor	Construction
Resource use and waste minimisation				
Resource consumption	RW1	Wherever feasible and reasonable, construction material will be sourced from within the Sydney region.	Construction contractor	Pre-construction/ Construction
	RW2	Unnecessary resource consumption will be avoided by making realistic predictions on the required quantities of resources, such as construction materials.	Construction contractor	Pre-construction/ Construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
Management of waste	RW3	Wastes will be managed and disposed of in accordance with relevant State legislation and government policies.	Construction contractor	Construction
	RW4	A Waste Management Plan will be prepared for the construction phase of the project, detailing appropriate procedures for waste management.	Construction contractor	Construction
	RW5	Wastes will be managed using the waste hierarchy principles of: • Avoidance of unnecessary resource consumption to reduce the quantity of waste being generated. • Recover of resources for reuse on site or off site for the same or similar use, without reprocessing • Recover of resources through recycling and reprocessing so that waste can be processed into a similar non-waste product and reused • Disposal of residual waste.	Construction contractor	Construction
	RW6	Residual waste will be classified, handled and stored on site in accordance with the *Waste Classification Guidelines: Part 1 Classifying Waste* (EPA 2014) until collection by a contractor for disposal.	Construction contractor	Construction
	RW7	Off-site reuse of waste will comply with relevant EPA resource recovery exemptions and requirements.	Construction contractor	Construction
Management of asbestos	RW8	An asbestos survey will be undertaken of buildings to be demolished as part of the project. The survey will be conducted by a suitably qualified person.	Construction contractor	Construction
	RW9	Asbestos handling and management will be undertaken in accordance with an Asbestos Management Plan and relevant State legislation, government policies and Australian Standards	Construction contractor	Construction
Excess spoil	RW10	A spoil management plan will be developed in accordance with the spoil management strategy prior to the commencement of tunnelling works. The plan will identify spoil disposal site/s and describe the management of spoil on site and during off-site transport.	Construction contractor	Pre-construction
Management of waste	OpRW1	Wastes will be manage and disposed of in accordance with relevant State legislation and government policies.	Motorway operator	Operation
Operational water requirements	OpRW2	Opportunities for reuse of wastewater will be considered including irrigation of landscaped areas within the project or local parks in preference to discharge to the local stormwater system.	Motorway operator	Operation

Impact	Ref #	Environmental management measure	Responsibility	Timing
	OpRW3	In order to reduce demand on local water supplies, options will be investigated to provide water for the deluge system from wastewater produced through the tunnel drainage system where it meets appropriate quality parameters.	Motorway operator	Operation
Climate change				
Climate change impacts	OpCC1	The risks of future climate change will be further considered during detailed design.	Construction contractor	Pre-construction
Climate change impacts	OpCC2	Implement adaptation measures to address high and extreme rated risks identified in the subsequent detailed climate change risk assessment.	Construction contractor	Pre-construction
Climate change impacts	OpCC3	Where extreme, high or medium risks have been identified in this assessment or subsequent climate change risk assessments, a review of the existing design policies, specifications or practices will be undertaken to consider the impacts of climate change.	Construction contractor	Pre-construction
Hazard and risk				
General	HR1	Site-specific hazard and risk management measures will be included within the CEMP, which will include items such as: • Details of the hazards and risk associated with construction activities for both surface and subsurface works • Procedures to comply with legislative and industry standard requirements • Training for relevant personnel (including subcontractors) and site inductions, including the recognition and awareness of site hazards and locations of relevant equipment.	Construction contractor	Pre-construction/ construction
Storage of dangerous goods and hazardous substances	HR2	Dangerous goods and hazardous materials will be stored in accordance with: • *Work Health and Safety Act 2011* (NSW) • Storage and Handling of Dangerous Goods Code of Practice (WorkCover NSW 2005) • Supplier's instructions • Relevant Australian Standards • The *Environment Protection Manual for Authorised Officers: Bunding and Spill Management*, technical bulletin (Environment Protection Authority 1997). For liquids, a minimum bund volume requirement of 110 per cent of the volume of the largest single stored volume within the bund will be provided.	Construction contractor	Construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	HR3	Material Safety Data Sheets for dangerous goods and hazardous substances will be obtained before these materials arrive on site.	Construction contractor	Construction
Transport of dangerous goods and hazardous substances	HR4	Transport of dangerous goods and hazardous substances will be conducted in accordance with relevant legislation and codes, including the *Dangerous Goods (Road and Rail Transport) Act 2008* (NSW), *Dangerous Goods (Road and Rail Transport) Regulation 2014* (NSW) and the Australian Code for the Transport of Dangerous Goods by Road and Rail (National Transport Commission 2008).	Construction contractor	Construction
Storage of dangerous goods and substances	HRop1	Dangerous goods and hazardous materials will be stored in accordance with: • *Work Health and Safety Act 2011* (NSW) • Storage and Handling of Dangerous Goods Code of Practice (WorkCover NSW 2005) • Supplier's instructions • Relevant Australian Standards • The *Environment Protection Manual for Authorised Officers: Bunding and Spill Management*, technical bulletin (Environment Protection Authority 1997). For liquids, a minimum bund volume requirement of 110 per cent of the volume of the largest single stored volume within the bund will be provided.	Motorway operator	Operation
	HRop2	Material Safety Data Sheets for dangerous goods and hazardous substances will be obtained before these materials arrive on site.	Motorway operator	Operation
Transportation of dangerous goods and hazardous substances	HRop3	Transport of dangerous goods and hazardous substances will be conducted in accordance with relevant legislation and codes, including the *Dangerous Goods (Road and Rail Transport) Act 2008* (NSW), *Dangerous Goods (Road and Rail Transport) Regulation 2014* (NSW) and the Australian Code for the Transport of Dangerous Goods by Road and Rail (National Transport Commission 2008).	Motorway operator	Operation
Incident response	HRop4	An Incident Response Plan will be developed and implemented in the event of an accident or incident.	Motorway operator	Operation
Cumulative impacts				
Cumulative impacts	CI1	Consultation will be undertaken with local communities potentially affected by the impacts of multiple projects in addition to the project.	WDA/Construction Contractor	Construction

Impact	Ref #	Environmental management measure	Responsibility	Timing
	CI2	Where relevant, consultation will be undertaken with proponents of other nearby developments to increase the overall awareness of project timeframes and impacts.	WDA/Construction Contractor	Construction
Sustainability				
Sustainability	S1	The construction contractor would develop and implement a Sustainability Management Plan during detailed design. The Sustainability Management Plan would establish governance structures, processes and systems that ensure integration of all sustainability considerations (vision, commitments, principles, objectives and targets), initiatives, monitoring and reporting during the detailed design and construction phases of the project.	Construction contractor	Pre-construction

30 Project justification and conclusion

This chapter presents a justification for the project and a conclusion to the environmental impact statement. The justification is based on the strategic need for the project and in particular, how it would fulfil the project objectives outlined in **Chapter 3** (Strategic context and project need) **section 3.3**. **Table 30.1** sets out the Director-General's requirements, as they relate to the justification of the project and where these have been addressed in the environmental impact statement.

Table 30.1 Secretary's Environmental Assessment Requirements (SEAR's) – project justification and conclusion

SEAR's	
Requirement	**Where addressed in the EIS**
an analysis of feasible alternatives to the carrying out of the project and project justification, including: • an analysis of alternatives/options considered having regard to the project objectives (including an assessment of the environmental costs and benefits of the project relative to alternatives and the consequences of not carrying out the project), and the provision of a clear discussion of the route development and selection process, the suitability of the chosen alignment taking into account environmental impacts, consideration of tunnel construction methods and whether or not the project is in the public interest, and • justification for the preferred project taking into consideration the objects of the Environmental Planning and Assessment Act 1979.	Analysis of alternatives and options considered for the project are described in **Chapter 4**. The project justification is provided in **Chapter 3** (Strategic context and project need) and **section 30.1.1**. A description of the project objectives and how they are achieved are addressed in **Chapter 3** (Strategic context and project need) and **section 30.1.2**. The objects of the Environmental Planning and Assessment Act 1979 are considered in **section 30.2**

30.1 Justification

30.1.1 Summary of strategic need and justification

Parramatta Road is Sydney's main east-west route and the only continuous route between Parramatta and the Sydney CBD. Sections of Parramatta Road carry more than 90,000 vehicles each day which results in Parramatta Road (an urban arterial road) rating on par with the M4 and M5, which are Sydney's busiest motorways. Congestion caused by these high traffic volumes has led to long travel times along the corridor and also impacts on public transport services which run along the corridor.

The project would include the construction of a tunnel between Homebush and Haberfield which would allow traffic, predominantly through traffic to use the tunnel thus reducing traffic numbers on Parramatta Road. A reduction of traffic along Parramatta Road would allow for improvements on the network to allow for greater north-south movements across the corridor and also improved movements for local traffic. The reduction in traffic along the Parramatta Road corridor would also be the driver for redevelopment of the corridor as part of the Parramatta Road Urban Transformation Program.

A reduction in traffic would improve road safety as congestion is considered to be one of the main causes of crashes along Parramatta Road. The reduction in traffic and congestion along sections of Parramatta Road would also make the corridor more attractive for pedestrians and cyclists due largely to improved safety.

The project forms part of WestConnex which, when complete, would have significant benefits for Sydney and NSW. When considered as part of WestConnex, the project would support NSW's key economic generators and provide a strategic response to the currently inadequate, and highly

congested, transport routes. Critically, this includes providing the missing link in the motorway network. Improvements to the transport network, including this project, support the global economic corridor by enabling domestic and international trade and therefore underpin a sustainable NSW economy and Sydney's role as a global city.

Integrated land use and transport planning initiatives are key factors in developing a future where Sydney's growing population can reliably access jobs and services. The project would complement a number of other transport and freight based infrastructure initiatives identified in the NSW Long Term Transport Master Plan (Transport for NSW 2012a). Ultimately, it is the combination of these initiatives that will best address global Sydney's needs.

Sydney's freight, service and business task requires distribution of goods and services across the Sydney region, which relies on more diverse and dispersed point-to-point transport connections. The project would support this task by improving access to, and reliability of, the motorway network. The project would also provide a high quality road connection between the key centres in the global economic corridor, such as the Parramatta and Sydney CBDs.

30.1.2 Achieving project objectives

As discussed in **Chapter 3** (Strategic context and project need) section 3.3, 10 key objectives have been developed for the project to respond to key issues that underlie the strategic need for the project. The project objectives are consistent with strategic objectives of national and NSW planning and policy documents. **Table 30.2** provides a summary of how the project would meet these objectives.

Table 30.2 Assessment of the project against the project objectives

Project objectives	Assessment of project against objectives
Support Sydney's long-term economic growth through improved motorway access and connections linking Sydney's international gateways (Sydney Airport and Port Botany), Western Sydney and places of business across the city	*A Plan For Growing Sydney* (NSW Government 2014a) identifies the project as essential to support major planning renewal and growth areas, including precincts in the Parramatta Road corridor. Here it would allow for significant improvements to local amenity by reducing through traffic on surface roads, and allowing for enhanced north−south local connectivity. The project would result in a reduction in travel times along the M4 and Parramatta Road corridor, reduced congestion, improved access to the major international gateways of Sydney Airport and Port Botany (and future Western Sydney Airport), and improved industrial and business efficiency. The project would also provide opportunities for urban renewal along Parramatta Road, where a reduction in travel times and improved local connectivity would reduce costs and help to increase the competitiveness of doing business, in NSW.

Project objectives	Assessment of project against objectives
Relieve road congestion so as to improve the speed, reliability and safety of travel in the M4 corridor, including parallel arterial roads	The project would result in a reduction in traffic along sections of Parramatta Road particularly between the end of the M4 and Wattle Street, due to vehicles using the M4 East tunnels in this section. There are however some areas where traffic numbers would increase such as Parramatta Road east of the project. This increase in traffic in these areas is considered to only be an issue until further stages of WestConnex are built. Once operational WestConnex would remove around 45 per cent of the existing traffic from Parramatta Road by 2031. The project would be a key link in the transport network to support Sydney's growth. The project is designed to reduce travel times along the Parramatta Road corridor by removing through traffic from the surface network into tunnels. The reduction in congestion along parts of Parramatta Road would result in improved road safety because lower vehicle numbers would result in fewer potential conflicts between vehicles. A reduction in the number of vehicles would also potentially result in increased safety for pedestrians and cyclists, making these modes more desirable along the Parramatta Road corridor.
Cater for the diverse travel demands along these corridors that are best met by road infrastructure	WestConnex is intended to be delivered as an integrated package of transport improvements across Sydney, with complementary enhancements to the existing road network (including associated surface street changes, bus priority measures, heavy vehicle access improvements), redesign of bus services and facilities, improved access to rail stations and upgrades to cyclist and pedestrian facilities. The project (as part of WestConnex) is considered to be a key driver for the introduction of a rapid transport solution (ie buses or light rail). The introduction of a rapid transit solution would result in more frequent and reliable public transport which would encourage higher patronage of public transport along the Parramatta Road corridor.
Create opportunities for urban revitalisation, improved liveability, and public and active transport improvements along and around Parramatta Road	The project would enable the use of some road space for other purposes such as bus lanes. This provision of space for public transport will enable the growth in local trips from urban renewal and general development in the corridor to be met. The project would therefore serve as a catalyst for urban renewal and transport improvement in the Parramatta Road corridor. The planned reduction in trucks and cars travelling longer distances on Parramatta Road (refer to **Chapter 8** (Traffic and transport)) would facilitate urban renewal along the corridor through improved urban amenity and liveability characteristics, supported by improved public transport, active transport such as walking and cycling, and local vehicle travel. The project would enhance the connections between key housing and employment areas.

Project objectives	Assessment of project against objectives
Enhance the productivity of commercial and freight generating land uses strategically located near transport infrastructure	Sydney's freight, service and businesses require distribution of goods and services across the Sydney region, which relies on more diverse and dispersed point-to-point transport connections. The project supports this task by improving access to, and reliability of, the motorway network.
Enhance movements across the Parramatta Road corridor which are currently restricted	The project would provide a high quality road connection between the key centres in the global economic corridor, such as the Parramatta and Sydney CBDs, where it would allow for significant improvements to local amenity by reducing through traffic on surface roads, and allowing for enhanced north−south local connectivity.
Fit within the financial capacity of the State and Federal Governments, in partnership with the private sector	The project would play a key role in supporting the financial delivery of proposed future stages by using toll revenue to raise private sector investment. Investment in the project and subsequent stages of WestConnex would facilitate a step change in network performance, enabling delivery of major city shaping improvements and delivering economic growth.
Optimise user pays contributions to support funding in a way that is affordable and equitable	Funding of WestConnex as proposed, assumes a distance based toll would be implemented on operation of the M4 Widening and the project. This would optimise private contributions in an equitable and affordable way.
Integrate with the preceding and proposed future stages of WestConnex, without creating significant impacts on the surrounding environment or duplicating any potential issues across the construction periods	The project is a component of WestConnex, which is a proposal to provide a 33 kilometre motorway linking Sydney's west and south-west with Sydney Airport and the Port Botany precinct. Separate planning applications will be lodged for each individual component project. Each project will be assessed separately, but the impacts of each project will also be considered in the context of the wider WestConnex.
Protect natural and cultural resources and enhance the environment	Potential impacts on the environment have been assessed and a range of safeguards and management measures are proposed.

30.2 Objectives of the Environmental Planning and Assessment Act (1979)

The objects of the Environmental Planning and Assessment Act 1979 provide a framework within which the justification of the project has been considered. A summary of this assessment is provided in **Table 30.3**.

Table 30.3 Objects of the Environmental Planning and Assessment Act 1979

Environmental Planning and Assessment Act 1979 objects	Comment
To encourage the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, waters, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment.	Where possible the project has been designed to conserve natural and artificial resources. Where reasonable and feasible, the project has been designed to avoid impacts on the surrounding natural environment and to minimise the need for land acquisition, impacts on existing development and local communities. The improved efficiency of the road network and the predicted travel time savings would result in a reduction in fuel use in the future. Additionally, the project would result in a long term reduction in greenhouse gas emissions (refer **Chapter 24** (Climate change risk and adaptation)). The project would provide improved traffic conditions, safety and efficiency on Parramatta Road and would result in improvements to local amenity in terms of noise and vibration, air quality and traffic. Measures would be implemented to ensure that impacts of the project on the natural and built environment are minimised.
To encourage the promotion and coordination of the orderly and economic use and development of land.	The project has been designed to minimise impacts to the surrounding natural and built environments, and to minimise disruption to existing development patterns. Provision of a mostly underground motorway is an orderly and economic approach to support major planning renewal and growth areas, including precincts in the Parramatta Road corridor.
To encourage the protection, provision and co-ordination of communication and utility services.	The project has been designed to minimise impacts on communications and utility services, where possible. Utility services would be relocated, adjusted or protected where affected by the construction of the project (subject to separate approval). Communication and utility service providers would be consulted during design and implementation of relevant works to ensure coordination and delivery of new and / or modified communications and utility infrastructure.
To encourage the provision and coordination of community services and facilities.	The mainline tunnels and the location of construction ancillary facilities have been designed and located to minimise direct impacts to community facilities and areas of public open space (refer **Chapter 14** (Social and economic)). The planned reduction in trucks and cars travelling longer distances on Parramatta Road would facilitate urban renewal along the corridor through improved urban amenity and liveability characteristics, supported by improved public transport, active transport such as walking and cycling, and local vehicle travel. The project would enhance the connections between key housing and employment areas.

Environmental Planning and Assessment Act 1979 objects	Comment
To encourage the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats.	The project is located in a highly modified urban area and would not result in the clearing of native vegetation. Construction would not result in the clearing of native vegetation; however areas of planted vegetation would be removed. Where impacts are unavoidable, mitigation measures have been proposed to minimise the potential for indirect impacts. No threatened flora or fauna is likely to be significantly affected by the project. Biodiversity is considered further in **Chapter 20** (Biodiversity)
To encourage ecologically sustainable development	The project is consistent with the four principles of ecologically sustainable development: • The precautionary principle • Inter-generational equity • Conservation of biological diversity and ecological integrity • Improved valuation and pricing and incentive mechanisms. Ecologically sustainable development is further considered in **Chapter 27** (Sustainability).
To encourage the provision and maintenance of affordable housing.	Not directly applicable.
To promote the sharing of the responsibility for environmental planning between different levels of government in the State.	Consultation has been undertaken with the relevant local councils and government agencies throughout the development of the project and the preparation of this environmental impact statement. All levels of government have been encouraged to be actively involved in and to contribute to the evolution of the project and this environmental impact statement through historical and continuing consultation activities.
To provide increased opportunity for public involvement and participation in environmental planning and assessment.	Community consultation has been carried out through all stages of the project development, commencing in November 2013 with the preliminary concept design to the display of the preferred design in June 2015. Community feedback has been considered at each stage of the project development to inform the selection of the preferred corridor alignment and subsequent design development and refinements. Community consultation would continue through the detailed design, construction and operational stages should the project be approved. Details of community involvement are provided in **Chapter 7** (Consultation).

30.3 Conclusion

This EIS addresses the key issues identified in the Secretary's environmental assessment requirements issued under Part 5.1 of the EP&A Act and the relevant provisions of Schedule 2 of the EP&A Regulation. A checklist showing where the Secretary's environmental assessment requirements are addressed in this EIS is provided in **Appendix A**.

The project is a component of WestConnex, which is a proposal to provide a 33 kilometre motorway linking Sydney's west and south-west with Sydney Airport and the Port Botany precinct. The project would be a vital link in this transport network designed to support Sydney's growth and would play a key role in supporting the financial delivery of proposed future stages by using toll revenue to raise private sector investment. Investment in the project and subsequent stages of WestConnex would facilitate a step change in network performance, enabling delivery of major city shaping improvements and delivering economic growth.

WestConnex is intended to be delivered as an integrated package of transport improvements across Sydney, with complementary enhancements to the existing road network (including associated surface street changes, bus priority measures, heavy vehicle access improvements), redesign of bus services and facilities, improved access to rail stations and upgrades to cyclist and pedestrian facilities.

Parramatta Road currently experiences heavy traffic congestion, particularly during peak travel times. This results in slow speeds and unreliable travel times for motorists, buses, commercial and freight vehicles, as well as poor amenity for residents and businesses located along Parramatta Road. The project would reduce travel times along the Parramatta Road corridor by removing through traffic from the surface network into tunnels. Due to the existing traffic numbers along Parramatta Road, east−west movements are given priority, limiting other movements from Parramatta Road to streets north or south of the corridor, including pedestrian movements.

The project would contribute to the following long-term benefits:

- Provide a motorway standard link between Concord and Haberfield which would provide reliability and savings in travel time for through traffic
- Provide improved access and travel along and across Parramatta Road for local vehicle trips and for active transport
- Enable improvements to public transport on Parramatta Road, including provision of kerbside bus lanes between Burwood Road at Burwood/Concord and Chandos Street at Ashfield/Haberfield at project opening (establishment of these lanes does not form part of the project), and the possible future provision of rapid public transport services along Parramatta Road (bus rapid transit or light rail transit)
- Facilitate urban renewal in precincts along Parramatta Road by improving local amenity with less traffic noise and vehicle emissions from congested traffic.

The project incorporates appropriate operational surface water management and drainage design measures in order to adequately manage potential ongoing operational impacts to surrounding watercourses, water quality and flood risk.

Potential adverse impacts associated with the project have been fully assessed and strategies to avoid, minimise and mitigate those impacts have been an integral part of the project development process. Construction of the project would result in short-term impacts on noise, vibration, air quality, traffic and access. These impacts would be minimised through the development and implementation of construction environmental management plans and planning of the construction schedule and methodologies. Construction would not result in the clearing of native vegetation; however areas of planted vegetation would be removed. No threatened biota is likely to be significantly affected by the project.

The project would involve full acquisition of 167 properties and partial acquisition of 15 properties: a total of 182 properties comprising private property and land owned by councils, public authorities or the State of NSW. Ten road reserves would also be acquired and 98 properties owned by Roads and Maritime would be affected by the project. One additional property would be leased during construction, which would be rehabilitated and returned to its owner following construction. In addition to the 291 properties affected by surface works, land (or interests in land such as easements) below the surface of the ground would be acquired (subsurface acquisition). About 700 properties would be affected by subsurface acquisition. All property acquisition requirements would be confirmed during detailed design.

Of the buildings to be demolished 22 are locally listed heritage items and a further nine are potential heritage items, in addition two heritage conservation areas would be partially demolished. The impact of the project on the heritage significance of the Haberfield heritage conservation area, Powells Creek heritage conservation area and individual heritage items would be significant.

Operational impacts of the project such as noise and flooding would be further investigated during detailed design to confirm the need for appropriate mitigation measures or, where relevant, design refinements.

WestConnex would result in both positive and adverse cumulative impacts in relation to noise and traffic in particular. One key cumulative benefit of WestConnex would be the improved movement of freight around Sydney. The construction of WestConnex progressively would also result in prolonged impacts on some areas which are located in close proximity to multiple stages. Cumulative impacts from other projects are not considered to be significant.

This EIS includes a suite of management measures that aim to ensure the best possible environmental outcomes are achieved during its construction and operation.

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