9. Environmental impact assessment – other issues

9.1 Visual amenity

9.1.1 Construction impacts

Stage 1 of the Project would take approximately 24 months to construct. Stage 2 would be built as a later stage of the Project and is likely to also take approximately 24 months; however, this would be determined as part of Stage 2 construction planning at a later date. For the Project as a whole, a number of major work sites would be required: at the new Schofields (Stage 1) and Vineyard (Stage 2) stations, Westminster Street overbridge (Stage 1) and Riverstone Station (Stage 2, refer Figure 6-1). Site compounds would also be established during Stage 1 at Quakers Hill and Schofields, and during Stage 2 at Riverstone and Vineyard (refer Figure 6-1). Visual amenity impacts associated with the proposed construction compounds are discussed further in Chapter 10.

Construction of the Project may cause temporary visual amenity impacts for surrounding residents, rail commuters and occupants of vehicles using nearby roads when the above-mentioned major work sites are in use. Visual changes would include security fencing, temporary storage of material, heavy machinery and new structures (as they are constructed). In particular, the reconstruction of Westminster Street overbridge would be a highly visible construction activity due to the height of the bridge and the topography of the surrounding land.

9.1.2 Operational impacts

Assessment approach

Given that the Project passes through the North West Growth Centre (NWGC), the receiving environment in which the Project is located would be subject to significant modification as a result of future urban growth. For this reason, an assessment of visual impacts has been undertaken in relation to the existing environment (this Section) and the future environment following urbanisation of the NWGC (Section 9.1.3). The extent to which the NWGC has developed is not likely to be significant for Stage 1; however, for Stage 2, depending on when this is undertaken, the NWGC may be significantly more developed. Notwithstanding, the following assessment considers the operational impact of the Project as a whole and is primarily focused on the impacts on existing sensitive visual receptors. In the event that Stage 2 of the Project is significantly delayed, consideration would be given to reassessment of impacts prior to construction.

The Project currently comprises three options for noise mitigation as described in Sections 6.2.6 and 8.4.6, each of which would have different impacts on visual amenity. As such, this visual assessment considers the impact of these three options.

As outlined above, this Section describes the main potential visual changes and impacts on each landscape unit (existing environment; refer Figure 3-24) as a result of the Project (refer Figures 6-2 to 6-10). For each of the landscape units, the viewshed (the area from which the Project would be visible) is identified and the visual change has been summarised.

The sensitivity of the location and magnitude of change has been considered — these two aspects (sensitivity and magnitude of impact) are combined to give an overall indication of the potential visual impact as either low, moderate or high.

Management and mitigation measures to reduce the potential visual impacts of the Project are discussed in Section 9.1.4.

Visual impacts from the Project during operation would be primarily associated with:

- the new stations and associated transport infrastructure at Schofields and Vineyard
- new pedestrian overbridges at Quakers Hill, Schofields and Riverstone
- the built form of the disused (existing) stations at Schofields and Vineyard
- rail corridor impacts, including loss of vegetation as a result of corridor widening, overhead wiring and any retaining walls, noise walls (or other structural mitigation measures), embankments and rail tracks.

Unit 1 — Town centre

Quakers Hill

The effect of the Project on the visual amenity of the Quakers Hill town centre following construction would be low as the new visual landscape would be in keeping with the existing landscape character. The viewshed for the proposed works includes Pearce Road, Railway Road and Quakers Hill Parkway, and any vehicle traffic, pedestrians or occupied buildings along these roads. The main change to the existing visual environment would be the footbridge with ramps that would replace the existing pedestrian level crossing (described in detail in Section 6.2.4). A perspective showing the proposed footbridge is provided in Figure 9-1. The proposed design of the footbridge comprises contemporary steel and concrete structures incorporating mesh balustrades, which are easily maintained and vandal-proof.

Other visible changes would include:

- additional track visible from Quakers Hill Station and from Quakers Hill Parkway
- additional overhead wiring visible from properties adjacent to the rail corridor (i.e. along Pearce Road and Railway Road).

The visual sensitivity of this landscape unit is considered low due to the visual intrusion of existing transport structures such as Quakers Hill Station and Quakers Hill Parkway. While the footbridge would be visible from commercial and residential premises on both sides of the rail corridor, the magnitude of change is considered low due to the low sensitivity of the existing visual landscape. The potential visual impact is, therefore, considered to be low.

Note: Indicative only, subject to detailed design

Figure 9-1 Perspective of the Quakers Hill footbridge (facing north)

Riverstone

The majority of the rail line within the Riverstone town centre is already duplicated. A total of 18 houses along Richards Avenue face the rail corridor, of which approximately six have a view toward a single track. The change to the views from these houses following duplication of the track is expected to be minimal, comprising one new track and overhead wiring, which would be in keeping with the existing visual environment.

The upgrade to Riverstone Station would be the main visual impact of the Project within this area. The current station is single storey and only visible from vehicles and shops using/fronting Railway Terrace or Garfield Road. The proposed new footbridge, stairs and lifts would be approximately 12 metres higher than the rail track and, consequently, would be visible from the town centre, and the approaches to the town along Railway Terrace and Riverstone Parade.

The existing Riverstone Station complex comprises a number of station and service buildings (referred to as the Riverstone Station precinct). Although the site has been added to over time, it retains the form of an early station complex and is a surviving example of a late 19th century station building and part of an important phase in the development of railway transport throughout NSW. This is reflective of its listing on the State Heritage Register (refer Section 3.5.2). Impacts of the proposed pedestrian footbridge on the heritage significance of the Project have been discussed in Section 8.5.2. As such, this Section focuses on visual impacts to human receivers.

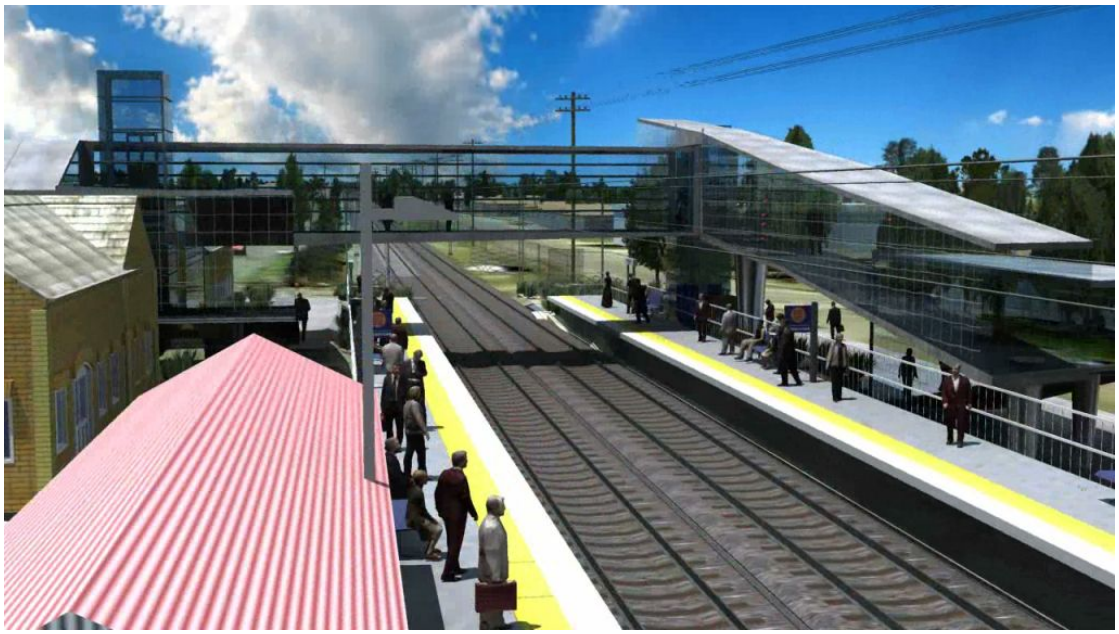
When viewed as part of the overall streetscape, the Project would not have a significant impact on the Riverstone Station precinct, as the design of the footbridge is compact and set back behind the existing building line. The addition of a forecourt to Riverstone Parade would reduce the apparent bulk and overshadowing associated with the new structure. The concept design has been developed to retain several mature trees along Riverstone Parade, which would assist in screening the structure from the street and creating a positive gateway to the station precinct. Figure 9-2 provides an aerial perspective (facing the south-

west) of the proposed additions to Riverstone Station, showing the key features as the footbridge, stairs and lifts. Figure 9-3 presents an artist's impression of the station upgrade facing west from Riverstone Parade, showing the key features as the station forecourt, the stairs, lifts and the footbridge. One of the heritage-listed station buildings is shown on the left-hand side of the figure. The perspective in Figure 9-4 shows a view of the upgraded station facing north along the rail corridor.

The urban and landscape character of Riverstone town centre would be further modified by the NSW Roads and Traffic Authority's (RTA's) proposed replacement of the Garfield Road level crossing. The final design for the replacement of the crossing is yet to be determined; therefore, the impacts are difficult to identify and, importantly, do not form part of this Project.

Without considering the heritage values of Riverstone Station, the visual sensitivity of this location is considered low, due to the influence of existing transport infrastructure such as the level crossing, congestion on Garfield Road and the commercial nature of the town. However, when considering the heritage values of the station (refer Section 8.5), the visual sensitivity of this location as a whole is moderate.

Although the footbridge and lifts would alter the appearance of the station, the changes associated with the Project would remain in keeping with the existing landscape character. Therefore, the visual impact of the Project on the Riverstone town centre is considered moderate.

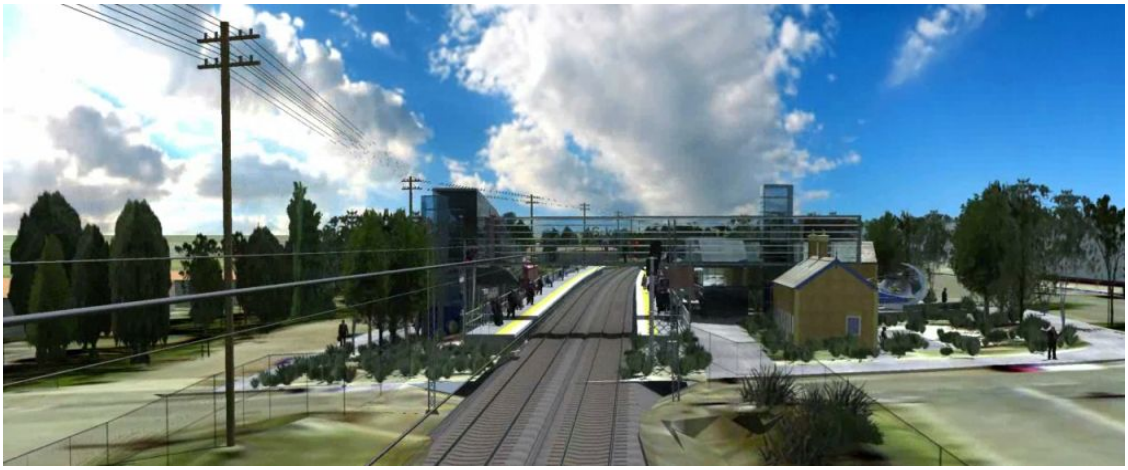


Note: Indicative only, subject to detailed design

Figure 9-2 Perspective of the Riverstone Station upgrade (facing south-west)

Note: Indicative only, subject to detailed design

Figure 9-3 Artist's impression of the Riverstone Station upgrade (facing west from Riverstone Parade)



Note: Indicative only, subject to detailed design

Figure 9-4 Perspective of the Riverstone Station upgrade (facing north)

Unit 2 — Suburban residential

Quakers Hill

Changes to the landscape character of the Quakers Hill suburban residential landscape unit as a result of the construction of the new track would be minimal and in keeping with existing views. The viewshed for the additional track and overhead wiring would include Oppy Reserve, and some properties adjacent to the rail corridor along Manorhouse Boulevard, Reycroft Avenue and Seldon Street.

The construction of the new track on the western side of the existing track (and associated widening of the rail corridor) would result in the removal of a number of the trees that currently line the western boundary of the rail corridor, opposite Manorhouse Boulevard. These trees provide a pleasant backdrop for houses facing the rail corridor along Manorhouse Boulevard; their removal would have a moderate impact on existing views as the rail track and overhead wiring would become more prominent features in the landscape. The removal of these trees would also reduce the quality of views across the rail corridor towards rural land and bushland.

The construction of mitigation measures (such as noise barriers) adjacent to the rail corridor along Manorhouse Boulevard and within the vicinity of the Quakers Hill Pre-school could also have a visual impact on adjacent residential properties. As discussed in sections 6.2.5 and 8.4.6, three types of noise mitigation measures would be explored in consultation with landowners.

The first preference for noise mitigation would be to provide at-source measures, such as rail dampers. This measure would not result in additional visual impacts at adjacent residential properties as this measure would form part of the final track work.

The second preference for noise mitigation would be to provide at-corridor measures (i.e. noise barriers). If selected, this option would involve the construction of noise barriers along the eastern side of the rail corridor boundary at Manorhouse Boulevard and within the vicinity of the Quakers Hill Pre-school. While these noise barriers would be designed and landscaped to reduce their visual impact, it would not be possible to mitigate all impacts associated with their construction. Visual impacts associated with noise barriers may include:

- shielding of existing views — the pleasant backdrop of native trees lining the western side of the rail corridor at Manorhouse Boulevard would no longer be visible following installation of noise barriers
- shadowing — reducing a property's access to natural sunlight
- providing a surface for graffiti, hence further reducing visual amenity.

Based on the balance between the density of residential development and the quality of views across the rail corridor towards rural land and bushland, the visual sensitivity of this location is considered moderate. The magnitude of change is considered low if noise barriers are not required, but high if they are required. Notwithstanding this, the perceived impact of the noise barriers is subjective, as some residents may prefer the noise barriers as a mechanism for screening views of the rail corridor. This option would be developed further during the detailed design of the Project, in consultation with land owners.

The third preference for noise mitigation would be to provide at-receiver measures (i.e. architectural treatment of buildings). As discussed in Section 6.2.5, this measure would involve sealing off wall vents, upgrading windows, installing glazing and solid core doors on noise exposed façades, and/or providing fresh air ventilation systems (in accordance with the Building Code of Australia requirements for fresh air). This form of noise mitigation would be unlikely to have an additional visual impact for residential properties.

Schofields

The addition of a new track is unlikely to result in considerable visual change to the landscape character of the Schofields suburban residential landscape unit, as it would be in keeping with existing views. The new track would be constructed on the eastern side of the existing track and is unlikely to require extensive removal of vegetation.

As discussed above, there is potential that noise barriers may be required to mitigate noise impacts associated with the operation of the Project. If selected as the most suitable option, noise barriers may be constructed along the western rail corridor boundary to shield properties on Bridge Street and Tain Place. In these locations, the rail line is built up on an embankment approximately 2–3 metres above the ground level of the adjacent properties. Some of the properties on Tain Place are screened from the rail corridor by vegetation. If noise barriers were constructed on the eastern side of the vegetation, they would be unlikely to cause significant visual impacts as they would be partially screened from the residential properties. If the vegetation is removed to allow for the construction of the noise barriers, the visual impacts would be more pronounced. Where the properties are not already screened from the rail corridor by vegetation, it is likely that if noise barriers were constructed on the embankment, they would reduce access to natural sunlight, in particular morning sun from the east.

The removal of Schofields Station is likely to have a considerable visual impact as it is currently the focal point of the suburb. Detailed planning would be required for the reuse of the site to ensure that the removal of the station is substituted by vibrant and attractive surroundings that complement the revitalisation of the suburb. The future of the area of the former Schofields stock feed and fertiliser store located adjacent to the station would also need to be considered as part of any planning for the future of the site, however it is likely these structures will be removed. Again, detailed planning for the future of the Railway Terrace streetscape would be required given the visual impacts of the Project in Schofields are likely to be considerable and could include an empty lot where the station is demolished, providing unattractive views for occupants of buildings facing the rail corridor, and the potential for graffiti and vandalism.

While the removal of Schofields Station could have considerable visual impacts on surrounding land uses in the short-term (if not appropriately planned), in the long-term these impacts would be addressed through appropriate revitalisation measures. The GCC has identified that Schofields village would be subject to revitalisation plans (refer Section 8.3.4) as part of the Riverstone precinct, which would reduce the overall visual impacts resulting from the removal of the existing Schofields Station in the future.

In addition to the removal of the station, the replacement of the pedestrian level crossing with a footbridge and ramps would represent another considerable visual change to the suburb. Figure 9-5 shows a perspective of the new footbridge facing north. The footbridge would be constructed at a height of up to approximately 12 metres above the rail track (to the top of the roof) and would be clearly visible from both sides of the rail corridor.

Once constructed, the new Westminster Street overbridge would be unlikely to have a substantial impact on the existing visual environment, as it would replace an existing structure and would be built to similar dimensions and style.

Note: Indicative only, subject to detailed design

Figure 9-5 Perspective of the Schofields footbridge (facing north)

The visual sensitivity of the Schofields town centre is considered moderate as it comprises only a few key facilities, including the station, shops and surrounding residential properties. The magnitude of visual change resulting from the construction of the Schofields footbridge is considered to be high, as the new footbridge would be substantially higher than any development in the surrounding area. This impact would be managed through the detailed planning of the adjacent vacant site, created by the removal of Schofields Station, to ensure that the footbridge is surrounded by a vibrant and attractive area that blends the Schofields footbridge into the surrounded town centre and minimises the apparent height of the structure relative to the surrounding development.

The magnitude of visual change due to construction of noise barriers in this location (if selected as part of the final detailed design) is also considered high, due to the potential shadowing effect on adjacent properties. The design of noise barriers, if required, would be developed during the detailed design, in consultation with residents from the Schofields town centre.

Riverstone

Visual changes to the Riverstone suburban residential landscape character would be minimal and in keeping with existing views. Visible changes would include:

- additional track visible to vehicles travelling along Railway Terrace and West Parade and from some one and two-storey residences facing the rail corridor
- additional overhead wiring visible from properties adjacent to the rail corridor.

The visual sensitivity of the location is considered to be moderate, characterised by residential properties. As the magnitude of change is low, the potential visual impact on this landscape would also be low.

Unit 3 — Rural residential

Schofields

The viewshed for the new track would include Railway Terrace and the few properties facing the rail corridor. As the new track is in keeping with the existing views of the rail corridor, the visual affect on the landscape character of the Schofields rural residential landscape unit are expected to be minimal.

The new Schofields Station would be located within this landscape unit and would substantially alter views in the area. The area is largely undeveloped, so the station would be highly visible and in contrast to the existing landscape character. The following viewpoints and impacts have been identified, and are illustrated on Figure 9-6:

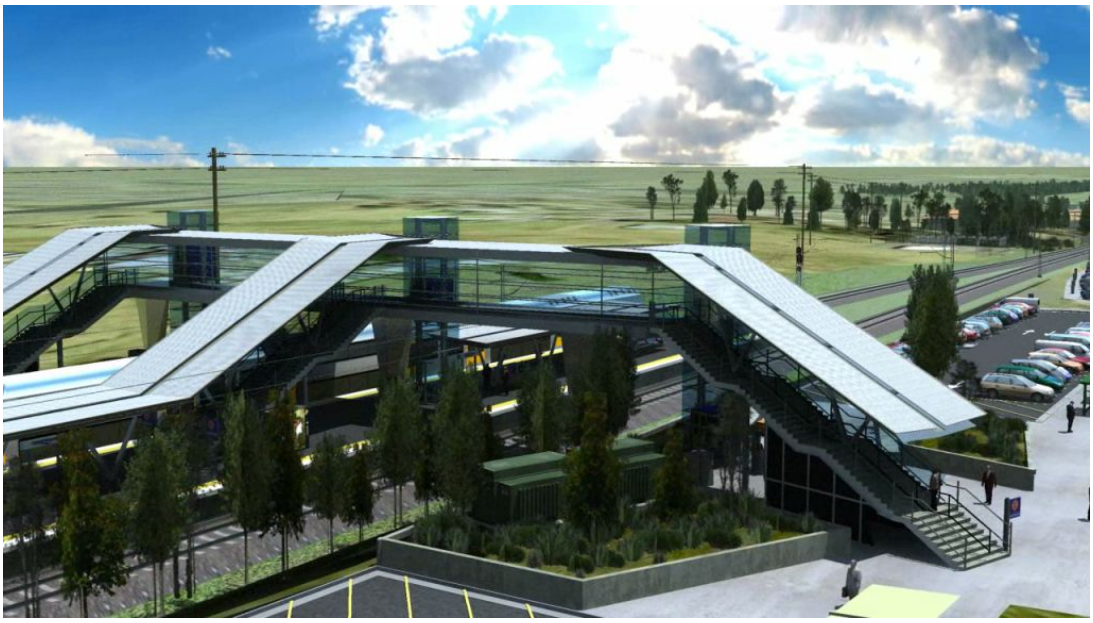
- Railway Terrace — the new station would be highly visible to vehicles travelling along Railway Terrace. Due to the height of the footbridge, stairs and lifts, the new station is likely to be visible from just south of Pelican Road to Schofields Road.
- Properties along Railway Terrace — the new station would be highly visible from three properties located along Railway Terrace, and one property on the corner of Railway Terrace and Pelican Road. There are currently no trees to provide visual screening of the site. It is expected that the station would reduce the scenic quality of views from these houses by interrupting existing rural views.
- Properties along Bridge Street — the new station would be visible from the two properties at the southern end of Bridge Street. The other houses along Bridge Street tend to face away from the site of the proposed station site and would, therefore, have limited (if any) views of the new station.
- Property along the western side of Railway Terrace — the new station would be located on this property approximately between Pelican Road and Schofields Road. This property currently consists of unoccupied, dilapidated sheds and buildings. As the property is unoccupied, changes to visual amenity affecting the existing land use are not considered to be substantial; however, impacts on potential future development of this land need to be considered (refer Section 3.14).

Figure 9-6 Sensitive visual receivers impacted by the new Schofields Station

The visual aspects of the station are shown in the following perspectives, and would include a footbridge with stairs and lifts, car parking on both the eastern and western sides of the station, bus interchange and island platform with station buildings. Figure 9-7 shows a perspective taken facing north-west towards the new station. The key features shown are the station forecourt and car park on Railway Parade, the stairs and the footbridge (note that the car park on the western side of the rail corridor is not shown). Figure 9-8 shows an artist's impression of the new station as would be seen from Railway Parade. This impression shows the stairs and lifts, covered waiting areas and seating, taxi and kiss-and-ride area (far right of impression) and the footbridge across the platforms.

Due to the low density of existing development and the high availability of sweeping, rural views, the visual sensitivity of this landscape unit is considered high. The magnitude of change associated with the construction of the new station on existing land uses is considered high and, therefore, the potential visual impact is also considered high in the short to medium term. However, in the long term, the visual impacts associated with

construction of the new Schofields Station are expected to be minimal as a result of the overall redevelopment of the area. It is expected that future land uses would integrate with the new Schofields Station to create a vibrant and attractive town centre that is focused around the train station. Furthermore, the principles of transit-oriented development would be applied to the design of the immediate environment around the station. The opportunity for future land uses to integrate with the station would be maximised by ensuring that the new Schofields Station is completed prior to the redevelopment of the area.



Note: Indicative only, subject to detailed design. The car park on the western side of the rail corridor is not shown.

Figure 9-7 Perspective of the new Schofields Station (facing north-west)

Note: Indicative only, subject to detailed design

Figure 9-8 Artist's impression of the new Schofields Station

Vineyard

The new track would be built on the western side of the existing track. For this reason, and as a result of the trees lining the eastern side of the rail corridor, the new track is unlikely to be highly visible from Riverstone Parade. The new track would be visible from the western side of the rail corridor; however, as there are no residential properties located in viewing distance of the rail line on this side of the rail corridor, and as the new track would be in keeping with the existing views of the rail corridor, the changes to the landscape character of the Vineyard rural residential landscape unit are expected to be minimal.

The new Vineyard Station would be located within this landscape unit and would significantly alter the visual context of the area. Figure 9-9 shows a perspective facing north towards the new station, and showing the key features as the two platforms, the footbridge, the stairs and the lifts. The new station and its associated facilities (car park, bus interchange etc) would require some vegetation clearing. For this reason, and due to the height of the footbridge, the station would be highly visible to the occupants of vehicles travelling along Riverstone Parade. It is expected that the station would reduce the scenic quality of views from the road by interrupting the existing rural/bushland views. Due to the height and density of the existing vegetation, the view shed is likely to be short range and the station is unlikely to be visible from any existing residential properties.

The construction of the new car park on the eastern side of Riverstone Parade between Ashford Road and Camberwell Road would reduce the quality of views from a residence on the southern side of Ashford Road, which faces the proposed car park site. The quality of views would also be affected for occupants of vehicles travelling along Riverstone Parade. Figure 9-10 shows a perspective facing south towards the new station, showing the two platforms in the foreground, and the footbridge and the car park in the background. At present, this site is covered in relatively dense native vegetation. The construction of the car park would require the removal of this vegetation and would, therefore, considerably alter the appearance of the site.

Figure 9-11 shows an artist's impression of the new station as would be seen from Riverstone Parade. This impression shows the stairs and lifts, covered waiting areas and seating, bus interchange (far left of photo), taxi and kiss-and-ride area (far right of impression) and the footbridge across the platforms.

As discussed above, there are no residential properties located on the western side of the rail corridor and within the viewshed of the rail line. The visual changes to the existing landscape are not considered to be substantial; however, impacts to visual changes with respect to potential future development must also be considered (refer Section 9.1.3).

As the existing Vineyard Station comprises only a single platform with no station buildings, car park or other facilities, the removal of the station is not considered likely to result in considerable changes to the existing visual environment.

The visual sensitivity of the location is high, based on the rural and bushland character of the area, and the visibility of the Project from the road and surrounding properties. The magnitude of change is high, particularly as a result of the new station's size, and the resultant restriction of the existing views and the removal of vegetation for the new car park. The potential visual impact at this location is high.

Note: Indicative only, subject to detailed design

Figure 9-9 Perspective of the new Vineyard Station (facing north)

Note: Indicative only, subject to detailed design

Figure 9-10 Perspective of the new Vineyard Station car park (facing south)

Note: Indicative only, subject to detailed design

Figure 9-11 Artist's impression of the new Vineyard Station

Unit 4 — Industrial/commercial

Riverstone

The new track within the industrial/commercial landscape visual unit at Riverstone would be constructed on the western side of the existing track. While visible from Riverstone Parade due to the lack of vegetation screening, the new track would be in keeping with the existing views of the rail corridor and would not significantly alter the existing landscape character.

The visual sensitivity of the industrial/commercial landscape unit is low and the addition of a new track is considered to constitute a low magnitude change. The potential visual impacts are considered to be low.

General visual impacts

Retaining walls

Where the new track would be built in a cutting, a retaining wall would be built at or below natural ground level facing inwards towards the rail tracks. These would be highly visible to rail travellers but not to sensitive receivers such as residential properties or vehicles travelling along the road. Where the new track would be built on an embankment, a retaining wall would be constructed above natural ground level and outward-facing, and so would be visible from the road and nearby properties.

Where possible, retaining walls for embankments would be masonry-faced rather than concrete (subject to the outcomes of the detailed design) as this provides a better visual solution than concrete and is a less attractive target for graffiti. The size of the proposed retaining walls would be approximately 1–2.5 metres high.

New track

The new track would be constructed from rail lengths placed on top of medium duty concrete sleepers. The appearance of the new track would be in keeping with the existing track.

Overhead wiring

Existing Overhead Wiring Structures (OHWS) would be utilised for the existing track where possible and replaced with new structures where deemed to be redundant, unsafe, to infringe on the proposed new track or to not comply with RailCorp standards. The new structures would be constructed to similar dimensions as the existing structures.

Summary of visual impacts during operation

Table 9-1 provides a summary of the visual impacts of operation of the Project on the existing environment. As discussed above, the visual impact was determined based on a combination of the assessment of the sensitivity of the visual landscape and the magnitude of change to that landscape.

Table 9-1 Potential visual impact of the operation of the Project

Viewshed	View changes	Sensitivity	Magnitude of change	Visual impact
Unit 1 — Town centre				
Quakers Hill				
Surrounding properties	▪ Pedestrian footbridge with ramps	Low	Low	**Low**
Quakers Hill Station and Quakers Hill Parkway	▪ Additional track	Low	Low	**Low**
Surrounding properties	▪ Additional overhead wiring	Low	Low	**Low**
Riverstone				
Houses on Richards Avenue	▪ Additional track	Low	Low	**Low**
Riverstone town centre	▪ Addition of footbridge, stairs and lifts to Riverstone Station	Moderate	Moderate	**Moderate**
Unit 2 — Suburban residential				
Quakers Hill				
Houses on Manorhouse Boulevard, Reycroft Avenue, Seldon Street, Oppy Reserve	▪ Additional track and overhead wiring	Moderate	Low	**Low**

Viewshed	View changes	Sensitivity	Magnitude of change	Visual impact
Houses on Manorhouse Boulevard, Reycroft Avenue, Seldon Street	▪ Noise barriers (if required) ▪ Rail dampers ▪ At residence treatments	Moderate	High	**High**
Schofields				
Vehicles on Railway Terrace surrounding properties	▪ Additional track and overhead wiring	Moderate	Low	**Low**
Houses on Tain Place and Bridge Street	▪ Noise barriers (potential)	Moderate	High	**High**
Surrounding properties	▪ Removal of station	Moderate	High	**High**
Railway Terrace and surrounding properties	▪ Pedestrian footbridge with ramps	Moderate	High	**High**
Riverstone				
Railway Terrace and West Parade	▪ Additional track and overhead wiring	Moderate	Low	**Low**
Unit 3 — Rural residential				
Schofields				
Railway Terrace	▪ Additional track and overhead wiring	High	Low	**Low**
Four properties along Railway Terrace, one property on Bridge Street, vehicles on Railway Terrace	▪ New Schofields Station	High	High	**High**
Vehicles and properties along Railway Terrace and Bridge Street	▪ New Westminster Bridge	High	Low	**Low**
Vineyard				
Vehicles on Riverstone Parade	▪ Additional track and overhead wiring	High	Low	**Low**
Vehicles on Riverstone Parade	▪ New Vineyard Station	High	High	**High**
Vehicles on Riverstone Parade, house on Ashford Road	▪ New car park	High	High	**High**
Vehicles on Riverstone Parade	▪ Removal of existing Vineyard Station	High	Low	**Low**
Unit 4 — Industrial/commercial				
Riverstone				
Vehicles and commercial properties on Riverstone Parade	▪ Additional track and overhead wiring	Low	Low	**Low**

9.1.3 Potential visual impacts on the future environment

The impacts on the existing environment are considered to be a more significant issue than the impacts on the potential future environment as they affect the current population and require an immediate response to avoid or mitigate these impacts. Furthermore, some opportunity exists for land use planning of future communities to be undertaken to mitigate visual impacts in relation to the Project. However, it is important to consider the potential visual impacts on the future environment so as to facilitate effective and appropriate planning for the future development of the area.

The future environment surrounding the rail corridor will be extensively modified by the development of the NWGC (refer Section 3.14). In general, the potential visual impact of the Project (in particular the two new stations) would be reduced in the future by the planned substantial increase in urban development. While the initial visual impacts of the Project may be high, it is expected that the duplicated track, new stations and associated facilities would become less visually obtrusive, as they became more integrated into the overall urban fabric, than they would be in the current bushland and rural-residential areas. The character of the Project would also be more compatible with the future planned urban development, rather than the existing suburban, rural and bushland character. As the structure of the NWGC has been developed with the Richmond Branch Line as one of the key transport corridors, there are opportunities for high quality urban design measures to be included in the future planning of these precincts and the Project itself to minimise potential visual impacts.

As discussed in Section 3.1.3, the NWGC has been divided into a number of different precincts, which are at various stages of planning. The main visual changes that can be expected along the rail corridor (based on current precinct planning) are discussed below.

Quakers Hill

Development in this precinct would include the western side of the rail corridor at Quakers Hill, which currently includes the Nirimba Education Precinct and the HMAS Nirimba/former Schofields Aerodrome. This land is part of the Schofields precinct of the NWGC. While planning for this precinct has not yet commenced, the development of this land is likely to affect views across the rail corridor from residential properties on the eastern side of the rail corridor (Manorhouse Boulevard, Seldon Street and Reycroft Avenue), from Oppy Reserve and from the trains operating on the rail line.

Schofields

The new Schofields Station would be located between the Schofields precinct and the Alex Avenue precinct. While planning for the Schofields Precinct has not yet commenced, planning for the Alex Avenue Precinct is underway, and indicates the development of approximately 6,100 homes over the next 25–30 years (refer Section 3.1.3). A town centre is proposed near the new Schofields Station location at the intersection of Burdekin Road and Railway Terrace, Schofields. A smaller neighbourhood centre is also planned towards the eastern side of the Alex Avenue precinct to provide local retail and community services (refer Section 3.1.3).

The development of the town centre and further residential development would substantially alter the existing rural-residential visual landscape.

Riverstone

Based on the draft *Riverstone Precinct Planning Report* (GCC 2008c), a new neighbourhood centre is proposed between Riverstone and Vineyard, in the vicinity of the relocated Vineyard Station (refer Section 3.1.3). A new neighbourhood centre is also proposed at the existing Schofields village. These neighbourhood centres would provide Riverstone residents with local retail and community services (GCC 2008c). The development of these neighbourhood centres would substantially alter the existing rural-residential visual landscape of these areas.

Vineyard

In the vicinity of the existing Vineyard Station, the western side of the rail corridor is included in the Riverstone West precinct. The northern section of this precinct, up to Bandon Road, is proposed for industrial/employment land (refer Section 3.1.3 and Figure 3-4). The development of commercial buildings at this location would considerably alter the existing rural landscape.

The eastern side of the rail corridor is part of the Riverstone Precinct, which is designated primarily for residential development. The existing Riverstone industrial area will also be expanded by approximately 14 hectares to the north (refer Section 3.1.3). The development of approximately 8,900 extra homes over the next 25–30 years would substantially alter the existing bushland visual character.

9.1.4 Management measures

Construction

To avoid unnecessary visual impacts during the construction of the Project, the following mitigation measures would be adopted:

- Work and compound sites would be kept in a tidy condition and within clearly defined boundaries.
- Additional screening of security fencing would be provided to minimise views of the site from sensitive receivers.
- Sites, particularly the construction compound sites, would be restored to their pre-construction condition or better as quickly as possible.

Operation

During the detailed design phase, a detailed urban and landscape design plan would be prepared for the Project in consultation with RailCorp, the GCC, and stakeholders involved in precinct planning. This would include detailed urban design and landscape plans for the proposed station works, the new stations and the corridor as a whole.

Proposed measures to mitigate potential impacts on those view sheds identified as likely to be subject to a moderate or high level of visual impact are outlined in Table 9-2. These recommendations outline more detailed mitigation measures for consideration in the development of the detailed design, and for inclusion in a detailed urban and landscape design plan.

Table 9-2 Proposed specific mitigation measures

Project component	Proposed mitigation measures
Quakers Hill footbridge with ramps	▪ Where possible, landscape screening would be established to soften the visual impact of the ramps.
Noise barriers	▪ Noise barriers (if proposed) would be integrated with and sympathetic to the streetscape. The barriers would be softened by landscaping where feasible.
	▪ Opportunities to maximise light penetration would be explored.
New Schofields Station	▪ High quality urban design would be implemented that is appropriate to both the existing and future environments.
	▪ Where possible, landscape screening would reduce the impact on existing properties.
Removal of existing Schofields Station	▪ High quality urban design (in conjunction with discussions with GCC for the revitalisation of Schofields village) would be implemented to address the rehabilitation of the vacant site.
Schofields footbridge with ramps	▪ Where possible, landscape screening would be established to soften the visual impact of the ramps.
Riverstone Station upgrade	▪ High quality urban design would be implemented to tie the new infrastructure visually to the existing infrastructure, and to reduce the potential visual impacts on the heritage values of the station.
New Vineyard Station	▪ High quality urban design would be implemented that is appropriate to both the existing and future visual environment.
	▪ Where possible, vegetation clearance would be minimised.
	▪ Where possible, landscape screening would help lessen the impact of the new development on the existing rural views from Riverstone Parade.
New Vineyard Station car park	▪ Where possible, existing vegetation would be retained within the car park to soften the visual impact of the car park.
	▪ Where possible, landscape screening would help filter views of the car park site from the residential property on Ashford Road.

The key visual impacts of the Project that would impact future development are the two new stations. Where detailed precinct plans are available, the stations would be designed with consideration of the future land uses. Where precinct planning has not been developed, the potential visual impacts of the new stations could be reduced by appropriate land use zoning of surrounding areas. For example, commercial development, such as that of a town centre, would have a lower visual sensitivity than residential development.

9.2 Geology and soils

The assessment of impacts from the Project on the geology and soils of the Project area was based on previous geotechnical desktop studies completed for the Project (Maunsell 2007b, 2006a). No subsurface testing was undertaken to obtain detailed information on the existing ground conditions in the Project area. Further geotechnical investigations would be undertaken during the detailed design phase of the Project. This section describes the geology and soil impacts likely to be associated with the construction and operation of the Project, and identifies management measures to mitigate these impacts.

9.2.1 Construction impacts

Erosion and sedimentation

The construction of the Project would expose the natural ground surface and subsurface. The exposure of soil to water runoff and wind could increase soil erosion potential. Highly erodible soils in the South Creek soil landscape are located within a 600-metre section of the railway line between 300 and 900 metres north of Quakers Hill Station; within the construction footprint of the Project, this area is most susceptible to erosion.

Construction activities that may result in erosion and sedimentation include the widening of existing fill embankments and cuttings, the excavation of construction footprints for structures and foundations, and the clearing of vegetated land.

Vegetation clearing would primarily be undertaken within the proposed widened rail corridor boundary and utility corridor (refer Section 8.6.2). Vegetation would also be cleared at the site for the new car park and bus interchange at the new Vineyard Station (refer Section 8.6.2). Vegetation clearing within the area of South Creek soils (described above) could particularly increase soil erosion potential. Vegetation clearing at the site of the new Vineyard Station car park and bus interchange is not anticipated to result in substantial soil erosion as the topography of the site is flat.

Potential impacts associated with soil erosion include the removal of topsoil, exposure of buried structures, sedimentation and increased turbidity levels in waterways and/or the local stormwater system, and reduced air and water quality. A number of waterways are located in proximity of the proposed construction works (refer Section 3.7.1), including Eastern Creek and its tributaries, a perennial lake between Quakers Hill and Schofields stations, a number of small dams located primarily on private property and stormwater drains traversing the rail corridor.

Air quality impacts are discussed in Section 9.4; water quality impacts are discussed in Section 8.7.

Stability of embankments, cuttings and excavations

The soils within the Project area comprise soils from the Blacktown and South Creek soil landscape groups. The soils associated with these soil landscapes tend to have poor drainage (Blacktown soils) and are subject to frequent flooding (South Creek soils), which may present issues during construction, particularly during excavation for structures and foundations. Further geotechnical investigations would be required during the detailed design phase of the Project to assess the stability of these soils for construction.

A number of cuttings and excavations would be required for the Project. The design of the cuttings would need to consider prevailing groundwater conditions within the Project area. In areas where groundwater levels are above the proposed formation level, there is the potential for cutting stability to be reduced. Further geotechnical investigation would be required to assess the groundwater conditions at cutting locations to ensure that appropriate drainage measures are implemented to minimise the risk of cutting failure. Excavations in bedrock would also require further geotechnical assessment to determine rock mass strength, weathering and deformation, as the stability of excavation works would be strongly influenced by these factors.

Salinity

The rail corridor traverses areas of moderate to high salinity potential, as such saline soil/groundwater conditions could exist within the Project area. Saline groundwater can contribute to the corrosion of building materials, requiring consideration when selecting construction materials to be used within affected areas. The presence, extent and severity of soil salinity within the Project area is not clearly understood as no subsurface testing has been undertaken for this Environmental Assessment. Further geotechnical investigations would be required during the detailed design phase of the Project to guide the use of salinity-resistant building materials and the design of structures with appropriate durability.

Groundwater salinity issues are discussed in Section 8.7.

Fill

Past construction and maintenance practices have resulted in fill being present in existing embankments. Fill may also be present in areas bordering the rail corridor where re-levelling of the ground has taken place. While the origin and placement of fill is unknown, it is expected to be variable in composition, shear strength, relative density and quality. The variable nature of the fill could present a number of construction issues, including:

- potential for low allowable bearing pressures under structures and embankments
- potential for large post-construction settlements under structure loading
- difficulty undertaking excavation if obstructions in the fill are encountered
- potential requirements for off-site disposal of fill if it is unsuitable for reuse
- potential for perched water to present problems with excavation, compaction and groundwater control.

Fill material is not considered a suitable load bearing stratum for structure foundations due to the uncertainty, and likely highly variable, composition, shear strength, relative density and quality. Further geotechnical investigation would be required during the detailed design phase of the Project to determine the extent of fill material within the construction footprint.

Measures proposed to manage construction issues associated with the presence of fill material are discussed in Section 9.2.3.

9.2.2 Operational impacts

Erosion and sedimentation may occur during the operation of the Project due to increased runoff from newly sealed surfaces (such as the new stations and car parks) and/or as a result of the presence of any exposed surfaces (such as following demolition of the existing Schofields and Vineyard stations). Potential impacts of erosion and sedimentation include reduced air and water quality, sedimentation and increased turbidity levels in waterways and/or the local stormwater system, and reduced air and water quality. Measures proposed to manage these impacts are discussed in Section 9.2.3. Air quality impacts are discussed in Section 9.4 and water quality impacts are discussed in Section 8.7.

9.2.3 Management measures

Erosion and sedimentation

A number of measures would be implemented to control soil erosion and sedimentation during the construction phase of the Project. These measures would be detailed through appropriate soil and water management measures in the CEMP prior to construction. These measures would be consistent with the principles and practices detailed in Landcom's *Managing Urban Stormwater: Soils and Construction* (Landcom 2004). The management measures would address all areas where significant disturbances of land or stockpiling of soils is likely.

Potential erosion and sedimentation impacts during the operational phase of the Project would be managed through the implementation of RailCorp's operational and maintenance procedures. Measures to manage water quality impacts are discussed further in Section 8.7.3.

Stability of embankments, cuttings and excavations

Further geotechnical investigation would be required during the detailed design phase of the Project to determine the presence and extent of soft materials within the surface layers of the alluvial deposits. Where soft materials occur beneath embankments, measures would be implemented to ensure that ground settlement is not excessive and that embankment slopes are stable, including measures where the removal of the soft material is replaced with an engineered fill. All fill would be compacted to an appropriate engineering specification in accordance with Australian Standard (AS) 3798 *Guidelines on Earthworks for Commercial and Residential Developments*.

Further geotechnical investigation would be required during the detailed design phase to determine:

- groundwater conditions at proposed cutting locations to ensure that appropriate drainage measures are implemented to minimise the risk of cutting failure
- rock mass strength, weathering and deformation at proposed excavation sites to ensure the stability of excavation works.

Salinity

Further geotechnical investigation would be undertaken during the detailed design phase of the Project to determine the presence, extent and severity of soil salinity within the Project area. In areas where saline groundwater is considered likely to affect structures and foundations associated with the Project, general construction measures would be employed to assist construction design, as outlined in the Western Sydney Regional Organisation of Councils' (2004) *Western Sydney Salinity Code of Practice* and the guideline *Building in a Saline Environment* (DIPNR 2003). Measures to manage groundwater salinity impacts are discussed further in Section 8.7.3.

Fill

Further geotechnical investigation would be required during the detailed design phase of the Project to determine the extent of fill material within the construction footprint. Where fill material underlies structure foundations, this would be removed and replaced with engineered fill as previously described for stability of embankments, cuttings and excavations.

9.3 Contaminated land

9.3.1 Construction impacts

The primary source of concern with regard to contaminated land would be associated with the direct impact of contaminants in soils and groundwater. As described in Section 3.11, there are a number of locations within the Project area with moderate to high potential of contaminated materials (Maunsell 2007d, 2006b). Those most likely to be impacted during the construction of the Project comprise:

- rail embankments and sidings
- stormwater drains traversing beneath the rail corridor
- former Schofields stock feed and fertiliser store located adjacent to the existing Schofields Station
- vehicle parking areas adjacent to the rail corridor at Quakers Hill and Schofields stations
- substation located adjacent to the existing rail line at Schofields Station
- Commonwealth (Department of Defence) land located adjacent to the rail corridor between Quakers Hill and Schofields stations
- rural land adjacent to the rail corridor.

Based on initial investigations of the Project area, contaminated materials are expected to be encountered during the construction of the Project in these areas. The contaminants may include total petroleum hydrocarbons (TPHs), polychlorinated biphenyls (PCBs), polyaromatic hydrocarbons (PAHs), organochlorine and organophosphorus pesticides (OCP/OPP), heavy metals and asbestos (Maunsell 2006b, 2007d).

Areas with a moderate to high risk of encountering contaminants (Maunsell 2006b, 2007d) during construction are described in Table 9-3. While the risk of identifying potential contaminants is moderate to high, many of the issues identified are downgradient from the proposed rail corridor considered or can be mitigated through typical contaminated land investigation procedures and or construction management practices. These mitigation measures are also provided in Table 9-3.

The uncovering of these contaminants could pose health risks to construction workers and prevent the reuse of spoil for other works within the Project area. Contaminants could also result in off-site impacts associated with the mobilisation of on-site contamination, particularly via stormwater systems, and during the process of transportation and disposal of contaminated spoil.

Table 9-3 Areas with a moderate to high risk of encountering contaminants during construction

Potential contaminant sources	Possible contaminants	Description	Mitigation measures
Stage 1			
Rail embankment and sidings	Total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene and xylene (BTEX), semivolatile organic compounds (sVOC), heavy metals, asbestos	The source and quality of the fill material used for rail embankments and potential former siding areas along the length of corridor is unknown. Coal ash, slag, rail and building waste are possibly present.	Undertake Phase 2 investigation to assess extent of potential contamination and review the remedial options (including re-use or disposal). Unexpected contamination can be managed through the construction environmental management and occupational health and safety plans to be prepared prior to construction.
Former Schofields stock feed and fertiliser store	TPH, organochlorine pesticides (OCPs) and organophosphorous pesticides (OPPs)	The former store building adjoins the Schofields station platform. The corrugated metal building is raised off the ground on pylons. Historical chemical storage on this site is considered possible. Potential for storage of drums, etc underneath building structure.	Undertake Phase 2 investigation to assess extent of potential contamination and review the remedial options (including re-use or disposal). Unexpected contamination can be managed through the construction environmental management and occupational health and safety plans to be prepared prior to construction.
Vehicle parking areas	TPH, BTEX, PAH, heavy metals, asbestos	Parking areas are located adjacent to the corridor, north of Pearce Road at Quakers Hill; and on the eastern side of the station at Schofields. Minor spillage of petroleum products and engine oil is therefore possible. Source of fill in car parks also not documented.	Undertake targeted Phase 2 to assess extent of potential contamination as per NSW DECC contamination guidelines. Review remedial options as necessary. Unexpected contamination can be managed through the construction environmental management and occupational health and safety plans to be prepared prior to construction.
Greenhouses, crops and market gardens	OCPs and OPPs	Intensive cultivation was noted within greenhouses and small plots along the eastern side between Seldon St and Advance St. These industries have potentially had intensive pesticide usage.	Undertake Phase 2 assessment as per NSW DECC contamination guidelines. Review remedial options as necessary. Unexpected contamination can be managed through the construction environmental management and occupational health and safety plans to be prepared prior to construction.

Potential contaminant sources	Possible contaminants	Description	Mitigation measures
Defence land	TPH, BTEX, heavy metals, asbestos, semivolatile organic compounds (sVOCs)	There is a large tract of Defence land adjacent to the railway corridor on the western side between Nirimba Drive and just north of Burdekin Road. An aerodrome is located at the site; however other Defence related activities such as land filling may also have been undertaken here. No visible indication of contamination at surface noted during site inspection of corridor.	These are down-gradient of the proposed rail line. The Department of Defence has completed a Site Audit Statement that confirms the site is suitable for residential use.
Stage 2			
Rail embankment	Total petroleum hydrocarbons (TPH), benzene, toluene, ethylbenzene and xylene (BTEX), semivolatile organic compounds (sVOC), heavy metals, asbestos	The source and quality of the fill material used to construct rail embankments and/or potential former siding areas along the length of corridor is unknown. Coal ash, slag, rail and building waste are possibly present in the fill material.	Undertake Phase 2 investigation to assess extent of potential contamination and review the remedial options (including re-use or disposal). Unexpected contamination can be managed through the construction environmental management and occupational health and safety plans to be prepared prior to construction.
Rail siding	TPH, BTEX, sVOC, heavy metals, asbestos	A rail siding, catchpoint and turnout are located at Riverstone Station behind the existing Downside platform. It was potentially used for stabling and maintenance of trains. Potential exists for spillage of oils and lubricants.	Undertake targeted Phase 2 investigation to assess extent of potential contamination and review the remedial options (including re-use or disposal). Unexpected contamination can be managed through the construction environmental management and occupational health and safety plans to be prepared prior to construction.

Potential contaminant sources	Possible contaminants	Description	Mitigation measures
Fill Stockpiles	TPH, BTEX, Polyaromatic hydrocarbons (PAH), heavy metals	Three fill stockpiles of unknown origin are located adjacent to the sidings at Riverstone Station. The largest stockpile, estimated to be approximately 32m x 10m x 4m appeared to consist of mixed fill. Two additional but smaller stockpiles to the north appeared to consist of blue metal gravel.	Undertake targeted Phase 2 investigation to assess extent of potential contamination and review the remedial options (including re-use or disposal). Assess stockpiles against NSW DECC Waste Classification Guidelines and assess suitability for reuse. Unexpected contamination can be managed through the construction environmental management and occupational health and safety plans to be prepared prior to construction.

Note: TPH = Total petroleum hydrocarbons; BTEX = benzene, toluene, ethylbenzene and xylene; sVOC = semi-volitile organic compounds; PAH = Polyaromatic hydrocarbons; OCPs = organochlorine pesticides; OPPs = organophosphorous pesticides

Source: Maunsell 2006b, 2007d

9.3.2 Management measures

A Phase 2 contamination assessment is currently underway for the Project. The results of this assessment would form a key input to the detailed design phase of the Project. Any measures required to manage contaminated materials during construction would be implemented through the CEMP.

Contaminated material identified during the Phase 2 assessment would be managed and disposed of appropriately in accordance with all relevant legislation and guidelines, including the *Protection of the Environment Operations Act 1997*, the *Waste Avoidance and Resource Recovery Act 2001* and the *Waste Classification Guidelines* (Department of Environment and Climate Change (DECC) 2008).

Where the presence of contaminants is confirmed to be in concentrations above the intended land use criteria, the assessment will identify opportunities for remediation of affected areas prior to or during construction. Remediation work would be planned and undertaken in accordance with the approved guidelines under the *Contaminated Land Management Act 1997* and SEPP 55 – *Remediation of Land*. On-site remediation or retention/reuse of contaminated materials would be undertaken wherever reasonable and feasible. Offsite disposal of contaminated material may also be required, depending on the type of contaminants encountered on-site. Remediation would be dependent on the extent and nature of any contamination detected in the Phase 2 investigations and would be undertaken generally in accordance with the remediation hierarchy outlines in the NSW DECC (2006) Site Auditor Guidelines but may include:

- Bioremediation of hydrocarbons (by in situ or ex situ methods)
- Reuse of material against waste classification exemptions (e.g. ballast)
- Excavation and offsite treatment or disposal
- Containment of non-leachable contaminants such as asbestos, heavy metals and pesticides.

The areas requiring remediation should be validated to confirm that the surrounding soil meets site land use criteria requirements. In the event of any previously unidentified contaminated materials being identified on site during construction, works in the affected area would cease and would not recommence until sampling, waste classification and remedial actions had been instigated. This would be undertaken in accordance with the applicable DECC guidelines and statutory requirements.

Occupational Health and Safety (OHS) requirements and appropriate management measures would be followed for works that have the potential to contain contaminated soil.

9.4 Air quality and greenhouse gases

9.4.1 Construction impacts

Air quality

Ambient air quality may be temporarily affected as a result of particulate emissions (dust) during the construction of the Project. Dust-generating activities would include loading of aggregate materials onto trucks, operation of bulldozers, scrapers and excavators, movement of vehicles on unsealed roads and wind erosion from exposed surfaces. The amount of dust generated during each of these activities would depend on soil properties (silt and moisture content); dust emissions would generally be greater during unfavourable weather conditions (such as dry, windy conditions).

Dust generated during construction works may affect the amenity of nearby sensitive land uses, particularly residential properties located adjacent to the existing rail line at Quakers Hill and Schofields (refer Section 3.1.2). It is noted that the impact of dust at potentially affected receptors decreases with increasing distance from dust generating sources.

Particulate emissions could exceed the relevant air quality criteria unless a comprehensive dust control strategy was implemented throughout the construction period. Specific corrective measures would be particularly important during unfavourable weather conditions.

Greenhouse gases

An increase in greenhouse gas emissions, primarily carbon dioxide, would be expected during construction of the Project. Greenhouse gas emissions may be emitted directly or indirectly. The main directly emitted greenhouse gas sources associated with construction activities would comprise transport of materials to site (vehicle emissions), fuel consumption associated with construction machinery (particularly from the movement of spoil by heavy vehicles) and the removal of vegetation. Indirect greenhouse gas emissions as a result of the Project would include emissions associated with the consumption of electricity within site compounds and construction equipment, extraction of diesel and the emissions embodied in the products used on-site, particularly steel and concrete.

With the application of standard mitigation and best practice construction methods, the dust load and greenhouse gas emissions generated over a typical construction day are not expected to result in reduced local air quality at the nearest potentially affected receptors. Measures that would be implemented to manage air quality impacts during construction are discussed in Section 9.4.3.

9.4.2 Operational impacts

Air quality

Air quality impacts associated with the operation of the Project would be minimal. The main air quality impact during operation would be emissions from private vehicles using car parking, kiss-and-ride and taxi facilities at the stations. The introduction of bus interchange facilities at the new railway stations at Schofields and Vineyard may introduce new air pollutant emission sources. Exhaust emissions from these vehicles would be localised and, given the relatively low level of traffic likely to be generated by the Project, are unlikely to affect sensitive receptors. The Project would also generate air pollution emissions during the

operation and maintenance of stations, track work and associated infrastructure. It is not expected that these activities would generate a significant increase in emissions compared to existing rail operations and maintenance activities.

Greenhouse gases

The operation of additional train services on the upgraded rail line would result in increased greenhouse gas emissions through increased electricity use. However, this increase is expected to be small on a per capita basis (i.e. the amount of electricity consumed relative to the number of passengers using the Project), and is likely to be offset by minimising increases in greenhouse gas emissions from private motor vehicles — on the basis that the Project is expected to generate a mode shift from private cars to public transport (i.e. existing motorists use the train service instead of private vehicles). Such a mode shift in travel behaviour is likely to be facilitated by continuing increases in the cost of fuel as a result of global crude oil prices (Australasian Railway Association 2006). The average cost of unleaded fuel within Sydney increased by approximately 155% between October 2000 and October 2008 (Australian Automobile Association 2008a), while crude oil prices increased by approximately 190% between July 2002 and July 2008 (Australian Automobile Association 2008b).

Increasing fuel prices are likely to generate an increased demand for public transport as motorists seek alternative and more economical modes of transport (Australasian Railway Association 2006). Such a mode shift would reduce the amount of fuel consumed in private motor vehicles and thus would result in a relative reduction in associated greenhouse gas emissions.

The Bureau of Transport and Communication Economics estimates carbon dioxide emissions from a typical suburban train at 150 grams per passenger kilometre (including emissions from electricity generated to power trains), which is relatively less than the 210 grams per passenger kilometre emissions generated by private vehicles (State Rail Authority 1995). In addition, it is estimated that an eight-car Tangara train at full passenger capacity could replace up to 1,400 cars on the Sydney road network (DEC 1995).

In the long term, the Project is expected to benefit local and regional air quality through the provision of more frequent public transport services into an area that would otherwise be heavily reliant on private vehicle use. The commencement of operation of the Project is expected to generate a mode shift from private cars to public transport. This would result in substantially reduced combustion of diesel and petrol fuel in private vehicles, in comparison to the ‘do-nothing’ scenario (refer Section 5.3) and, consequently, would reduce greenhouse gases emissions that would otherwise occur without the Project.

The delivery of the Project during the early stages of development of the NWGC is likely to encourage patronage of public transport by future residents and visitors to the area; and thus would maximise the benefits of the Project. Public transport patronage would likely be lower if the Project was delivered during the later stages of the development of the growth centre at which time private vehicle use would likely have become the dominant mode of transport in the absence of other options. This would result in an increase in transport-related greenhouse gas emissions. Once the community has become reliant on private vehicle use as their primary mode of transport, it would be difficult to change the community’s travel behaviour patterns, which would limit the opportunity to reduce transport-related greenhouse gas emissions.

Odour

The Project would not contribute to offensive odours within the region. However, due its location, there is the potential for odours to impact the patrons of the Project. To facilitate the development of the NWGC, Sydney Water is currently seeking approval for *Water Related Services for Stage One Precincts of the North West Growth Centre* from the Minister for Planning, which includes the provision of:

- potable water trunk mains
- recycled water trunk mains
- wastewater carriers
- water pumping stations
- new and upgraded sewage pumping stations
- amplification of the Riverstone Sewage Treatment Plant (STP)
- provision of recycled water facilities at Quakers Hill STP
- water and recycled water reservoir infrastructure at Cudgegong Road.

An odour assessment was completed as part of the assessment for the amplification of the Riverstone STP. This assessment modelled the odour contours of two odour units for 99% of the STP's operational time at full capacity in 2031. Under this scenario, Vineyard Station is located within the above-mentioned odour contour. Accordingly, the contour mapping indicates than an odour could be detectable on average 88 hours per year; however this is dependant on localised weather conditions.

9.4.3 Management measures

Construction

Air quality management measures would be prepared and implemented as part of the CEMP for the Project. This plan would include measures to address the management of dust during construction, emissions from construction plant and vehicles, and other fugitive emissions. Such measures would include the following:

- Water carts would be used to hose down exposed soils during dry and/or windy conditions.
- Trafficked areas would be defined for construction vehicles (access routes are likely to be unsealed; however, the surfaces would be housed down during dry and/or windy conditions).
- Construction vehicles would be washed down.
- Site vehicle speed limits would be set.
- Constraints would be placed on construction work under extreme, unfavourable weather conditions.
- Exposed areas would be stabilised as quickly as possible.
- Air quality would be monitored to assess compliance with DECC guidelines.

Management measures to reduce construction-related greenhouse gas emissions are limited. Notwithstanding this, the following measures would be implemented to minimise greenhouse gas emissions during construction:

- Energy (fuel/electrical) efficiency would be considered when selecting equipment.
- Equipment would be regularly maintained to retain fuel efficiency.
- Where feasible, biofuels would be used (biodiesel, ethanol, or blends such as E10 and B80), to reduce greenhouse gas emissions from construction plant and equipment.
- Vegetation clearance would be minimised and revegetation would be undertaken where feasible.
- Energy efficient work practices would be adopted to limit energy use, including conducting energy conservation awareness programs for all site personnel and undertaking energy audits to identify and address energy waste.
- Plant and office-based equipment (including lights and computers) would be operated in an efficient manner and would be regularly maintained.
- If available, electrical energy derived from a renewable energy source accredited by the National Green Power Accreditation Steering Group (or equivalent) would be used for the supply of at least 50% of the on-site electrical energy required during construction.
- Locally-sourced materials and staff would be used wherever possible, to reduce transport-related emissions.
- Recycled materials, such as replacement of cement with fly ash, recycled aggregate, and recycled content in steel, would be used to minimise the lifespan impact of greenhouse gas emissions in production.
- Low greenhouse-intensity materials would be substituted where appropriate.

Operation

During the operation phase of the Project, measures would be implemented to minimise vehicle emissions generated from patrons using the Project. Such measures should include the application of strict parking and speed controls around station car park and kiss-and-ride facilities, and the use of signs requesting car and bus drivers to switch off idling engines while waiting for passengers arriving on the Project.

To maximise the opportunity to reduce transport-related greenhouse gas emissions (and other vehicle emissions), measures would be implemented to encourage the use of public transport. These measures would be developed during the detailed design and could include:

- incorporating sustainability-promoting interpretation (SPI) units and urban information systems (such as including bus timetable information) into the bus stops/interchanges, car parking areas, bicycle storage areas and key locations within town centres (e.g. shopping centres) to increase customer confidence in schedules and travel times, and to promote patronage
- using urban information systems to collect information on how people access the train and other public transport services
- establishment of an ongoing monitoring program of parking demand and a management of parking supplies, to ensure that more sustainable access modes are being encouraged.

9.5 Waste, energy and demand on resources

9.5.1 Construction impacts

Waste

The construction of the Project would generate various types of wastes, including:

- construction waste, such as excavated soil, rock and building materials (e.g. disused track and waste from the demolition of the stations)
- vegetation waste from the clearing of the proposed new Vineyard Station car park site and the widening of the existing rail corridor
- domestic waste from construction personnel
- possibly contaminated material (refer Section 3.11 and 9.3).

Energy

The construction of the Project would require the use of energy for a number of construction activities. Fuel would be used for machinery (such as cranes and excavators), vehicles (such as trucks, staff vehicles and freight trains), equipment and generators (particularly during any night works; refer Section 6.3.5). Electricity would be required at the site compounds.

Track construction would require the delivery of approximately 2,500 tonnes of materials for the proposed scope of works, which would be delivered to the site in 100 loads (i.e. 25 tonnes per load). The preferred method of delivery of track materials would be via rail as it would require less fuel than transport by road.

The potential impacts of energy use and greenhouse gas emissions during construction are discussed in Section 9.4.1.

Demand on resources

The construction of the Project would require the use of resources such as electricity, water, fuel, concrete and paving materials (such as asphalt). Other resources required for tracks, signals and for the construction of the new station buildings would be determined during detailed design phase.

While the construction of the Project would increase demand on local and regional resources, it is unlikely that the development of the Project alone would result in any resource becoming scarce or in short supply.

9.5.2 Operational impacts

Waste

Waste generated during operation would include domestic waste from the operation of the stations, ballast, and wastewater from ballast cleaning and replacement), oils and other materials used during track maintenance.

Energy

The operation of the Project would require electricity for passenger trains, station facilities and operation of signalling equipment. While total electricity consumption would increase during the operation of the Project, this increase is likely to be small on a per capita basis

(i.e. the amount of electricity consumed relative to the number of passengers using the Project), particularly as future rail patronage demand increases. The operation of the Project would also consume energy during maintenance of the rail corridor, such as ballast cleaning and track levelling. This would require vehicles and equipment, and would rely on fuel. It is anticipated that the Project would result in a mode shift away from private vehicles to public transport, thus resulting in long-term energy savings (refer Section 9.4.2).

Demand on resources

The new Vineyard and Schofield stations would be provided with rainwater tanks. This water would be used to reduce the stations' requirement for potable water.

9.5.3 Management measures

Construction

Construction waste would be managed through the waste hierarchy established under the *Waste Avoidance Recovery Act 2001*, which comprises the following principles:

1. Avoidance of waste — minimising the amount of waste generated during construction by avoiding unnecessary resource consumption (i.e. avoiding the use of inefficient plant and construction equipment and avoiding materials with excess embodied energy, waste and excessive packaging).
2. Resource recovery — reusing, reprocessing and recycling waste products generated during the construction to minimise the amount of waste requiring disposal.
3. Disposal — where resources cannot be recovered, they would be appropriately disposed of to minimise the potential adverse environmental impacts likely to be associated with their disposal.

All waste generated during construction would be disposed of in accordance with the requirements of *Waste Classification Guidelines* (DECC 2008). Waste management measures would be developed for the Project, and would form part of the overall CEMP and would detail standard environmental mitigation measures to avoid, reuse and dispose of waste during construction. These measures would include the following:

- Any wastewater collected would be appropriately treated prior to discharge in accordance with current standards.
- Opportunities would be investigated to maximise re-use of construction spoil, including cut/fill balance during design (refer Section 6.3.2).
- Opportunities would be investigated for potential reuse or recycling of other construction and demolition waste.
- Leaf material and small branches of native vegetation would be chipped for use as mulch in revegetation or landscaping works.
- All other green waste from vegetation removal would be disposed of to a green waste recycling facility.
- Work sites would be maintained in a tidy state and all general litter (such as food scraps) would be disposed of appropriately.

Mitigation measures to reduce energy usage and demand on resources (and any associated greenhouse gas emissions) are discussed in Section 9.4.3.

Operation

To minimise/manage the operational waste produced on-site, rubbish bins with lockable lids would be provided to prevent animals accessing the bins.

9.6 Hazard and risk

9.6.1 Construction

Risks associated with the construction phase of the Project can be categorised as:

- environmental hazards — including potential discharge of hazards or other material to the environment
- occupational health and safety hazards — including any activity or outcome that may affect the health and/or safety of site personnel and visitors, which may arise due to the failure of health and safety procedures
- construction hazards — including operation and maintenance of plant and machinery, and use/stockpiling of materials required for construction.

Environmental hazards

Environmental hazards associated with construction of the Project could arise during the transporting, use and storage of hazardous materials on site, as well as the unearthing of contaminated soils/groundwater and their subsequent disposal.

During construction, hazardous materials would be stored on site at the construction compounds (refer Figure 10-1). The refuelling and maintenance of construction plant and equipment would be undertaken within designated areas at these construction sites, and typically using specialised refuelling contractors equipped with appropriate spillage response equipment and training. Table 9-4 summarises the types of hazardous materials that would be stored and used on site during the construction of the Project.

Hazardous materials would also be required to be transported to and from construction sites on public roads. Spills and leaks during transportation could result in the contamination of land and waterways outside of the Project area.

Table 9-4 Hazardous materials and dangerous goods stored on site during construction

Hazardous material	Dangerous goods class	Mode of storage on site
Diesel	Not applicable[1] C1 combustible liquid	20L Drums and Carry Cans
Lubricating oil	Not applicable[1] C2 combustible liquid	20L Drums
Oxy-acetylene	2.1–Flammable gases	Cylinders (up to 55 kilograms) in rack
Hydrated lime	8 - Corrosive substances	Bags/Pallets
Safety detonators	1.4S-Explosives	Box (<10kg) Double locked area
Petrol	3 – Flammable liquid	20L Drums
Cement	Not applicable	Bags/Pallets (in container)
Premix concrete	Not applicable	Bags/Pallets (in container)
Coldmix asphalt	Not applicable	Bags/Pallets (in container)

Note 1: Not listed as a ‘dangerous good’; however is listed as a ‘hazardous material’.

Occupational health and safety hazards

Occupational health and safety hazards would include undertaking construction works adjacent to roads and within an operating rail corridor. As discussed in Section 6.3.2, the Westminster Street overbridge would remain in operation during the majority of the proposed bridge reconstruction works. The overbridge would be closed for 3 days and partially closed for approximately 30 days. Construction works and associated truck movements on the overbridge could pose health and safety risks to the construction workers and community, particularly as the overbridge includes a footpath. Risks include the potential for injury as a result of construction activities (e.g. noise, dust and flying debris if loads are not covered) and vehicle accidents. Moving vehicles on the Westminster Street overbridge could also pose health and safety risks to construction workers.

The construction of the new Quakers Hill footbridge could also pose health and safety risks to the community. The new footbridge would be constructed next to the existing pedestrian level crossing, which would remain operational until completion of the footbridge. Without appropriate safety precautions, there is potential for members of the community to be injured during construction of the new structure. Risks would include falling debris or tools, dust and noise impacts.

The undertaking of construction works within an operational rail corridor would pose risks to construction workers and potentially to train operations. As discussed in Section 6.3.2, the Richmond Branch Line would remain operational for the majority of the works. Construction works required for new footbridges and other works could be undertaken during normal rail operations. Moving trains would pose injury risks to construction workers undertaking works adjacent to the operating rail line.

Overhead wires and subsurface utilities (gas, water, electrical and sewer mains) could also present occupational health and safety hazards to construction workers. The management of utilities and services are discussed further in Section 9.8.

Construction hazards

As discussed in sections 3.11 and 9.3.1, there are a number of locations within the Project area that have a moderate to high potential for contaminated materials to be uncovered. The uncovering of contaminated materials could result in health impacts to construction workers, the environment and members of the community that come into contact with such materials. The contamination of land and waterways outside of the Project area could result in the case of spills or accidents during the transportation of contaminated materials from the construction site or through the implementation of inadequate measures to manage/mitigate stormwater runoff and dust generation.

Overhead wires and subsurface utilities could also pose construction hazards to site workers and the environment. In particular, a 100 millimetres high pressure gas main (owned by Jemena) crosses the rail corridor within the vicinity of the proposed Quakers Hill footbridge (refer Section 3.13). Damage to this utility during construction could result in injury to site workers and members of the community.

A number of underground electricity cables have also been identified within the vicinity of the proposed works. Damage to these cables could result in the transmission of large electrical currents through the ground surface (known as Earth Potential Rise), which has the potential to injure construction workers and members of the community standing close to the damaged power utility. The management of utilities and services are discussed further in Section 9.8.

9.6.2 Operation

In general, the main hazards that would be associated with the operation of the Project include:

- natural events (including flood and bushfire)
- impacts of climate change (changed frequency of natural events)
- external events (events occurring at adjacent facilities)
- utility failure (power or communication failure)
- train accident (including derailment, collision or impact)
- station or train fire
- structural failure (bridge or pedestrian overpass collapse)
- longer walking distances for pedestrians using the Riverstone pedestrian crossing, which has the potential to encourage unauthorised access to the rail corridor by pedestrians crossing the train tracks at the Garfield Road level crossing (if not replaced with an overbridge prior to the operation of the Project) instead of using the footbridge at Riverstone Station.

Climate change

The effects of climate change on the region in which the Project is located can be assessed in terms of:

- weather changes
- storm intensity
- flooding
- increased risk of fire.

Climate change has the potential to change weather patterns within the Blacktown LGA. This could be in the form of:

- temperature increases
- precipitation decreases
- increase in intensity of rainfall events
- increase in fire weather frequency.

The Commonwealth Scientific and Industrial Research Organisation (CSIRO), in conjunction with the Bureau of Meteorology, has published a technical report titled *Climate Change in Australia: Technical Report 2007* (CSIRO 2007). The key findings of the report for the Blacktown LGA include:

- average increases in temperatures across the Australian continent of 1°C by 2030 (relative to 1990 temperatures)
- a decrease in annual precipitation of between 2% and 5% by 2030 (relative to 1990 precipitation)

- an increase in the annual average number of days with a 'very high' to 'extreme' fire risk from 11.5 days/year to 13.1–14.3 days per year in 2020 (data presented for Richmond, the closest site reported in the CSIRO report) depending on the greenhouse gas emission scenario adopted (CSIRO 2007)
- an increase in the intensity of rainfall events.

Increased temperatures within the Blacktown LGA, in conjunction with decreased precipitation and increased fire weather frequency, could have an impact on the Project through increased fire risk, which would pose risks to built structures and may require train operations to be suspended during fire events.

Climate change could also lead to an increase in the intensity of rainfall events. Essentially, this would mean that the rainfall expected to occur in a 100-year average recurrence interval (ARI) flood event would occur more frequently (on average once every 50 years; CSIRO 2007). Rainfall projections and intensity have been included in the CSIRO report (CSIRO 2007) and a number of scenarios can be accessed at the climate change website (CSIRO 2008) with variable emissions levels and for different future years. By selecting annual changes for 2030 and assuming low emission levels, the changes in rainfall pattern for the area of the Project could vary from -5% to -2% relative to the 1990 baseline (CSIRO 2008).

There is still a large fluctuation in data, which makes it difficult to provide any conclusive assessment on the expected increases in rainfall intensity. However, in terms of the impact on the Project, increased rainfall intensity could result in increased flooding within the Project area and increased frequency of overtopping of the rail track. Flooding within the Project area is likely as parts of the Project area are already susceptible to flooding (refer Section 3.7.1).

The impact of increased flood events as a result of climate change would need to be considered further during the detailed design of rail corridor culvert crossings and stormwater drainage systems. As discussed in Section 3.7.1, potential flooding across the rail corridor is governed by the headwater levels of the railway crossing culverts. Therefore, the design of the culvert crossings would need to ensure that sufficient rail freeboard capacity has been provided to prevent any additional overtopping of the rail track during larger and/or more frequent flood events as a result of climate change. Potential impacts of climate change on the culverts would be considered during the detailed design to minimise future exacerbation of flooding impacts as a result of the Project. Flooding impacts for the Project are discussed further in Section 8.7.

Train accidents

The level of risk associated with train accidents would be dependent on the Project's scheduled commencement of operations. As discussed in Section 6.2.6, the RTA proposes to replace the vehicle level crossing at Garfield Road, which is anticipated to be completed prior to an increase in rail services. If RailCorp was to introduce the new timetable prior to the replacement of the level crossing, increasing train services would result in more frequent road closures and longer traffic delays at the level crossing. If the vehicle level crossing remains open upon the introduction of the new timetable, the existing pedestrian level crossing would be closed and pedestrians directed to the new pedestrian footbridge with stairs and lifts at the southern end of Riverstone Station (refer Section 6.2.1). However, this alternative pedestrian crossing may be perceived as inconvenient by some pedestrians and subsequently avoided due to the longer walking distance required to use the new facility. As such, there is the risk that pedestrians could continue to cross the tracks at the Garfield

Road level crossing (which would remain open to vehicle traffic until it is replaced with an overbridge), which has the potential to result in increased accidents. However, this is unlikely as the construction of Stage 2 would be coordinated with RailCorp, RTA, TIDC and the GCC.

Pedestrian and vehicle collisions

The posted speed limit along Railway Terrace and Riverstone Parade at the locations of the new Schofields and Vineyard stations is currently 80 kilometres per hour. There may be a risk of collision between pedestrians and cars at the at-grade pedestrian crossings if the posted speed limit is not reduced at these locations. This would be a particular risk at the new Vineyard Station where the car park would be located on the opposite side of Riverstone Parade to the new station.

Traffic and transport issues associated with the Project are discussed further in Section 8.2.

9.6.3 Management measures

Construction

Construction hazard and risk issues associated with the Project would be addressed through risk and opportunity management measures, which would be developed by the construction contractor prior to construction as part of the overall CEMP. These measures would include:

- The storage of hazardous materials, and refuelling/maintenance of construction plant and equipment would be undertaken in clearly marked designated areas that are designed to contain spills and leaks.
- Chemical spill kits would be readily available and accessible to construction workers. Kits would be kept at site compounds and on specific construction vehicles.
- All hazardous materials spills and leaks would be reported to site managers and actions would be immediately taken to remedy spills and leaks.
- Construction sites adjacent to public areas would be screened to minimise the risk of injury as a result of unsecured debris, tools and other objects.
- Where work would be undertaken adjacent to the road (e.g. the new stations and Vineyard car park), it is recommended that the speed limit be reduced from 80 kilometres per hour to 40 kilometres per hour in accordance with the requirement of the RTA's *Traffic Control at Work Sites Manual 2003*. This measure would be detailed in traffic management plans that would be developed prior to the commencement of construction (refer Section 8.2.3).

Operation

The Project would be designed to achieve RailCorp's operational safety, signalling and operating procedures. Operational hazards would be managed through RailCorp's standard procedures for hazard and risk that are currently in place across the entire rail network.

It is also recommended that the appropriate roads authority be consulted with regard to revising the posted 80 kilometre per hour speed limit along Railway Terrace and Riverstone Parade at the locations of the new Schofields and Vineyard stations, or providing traffic signals at the pedestrian crossings. Traffic and transport hazards associated with the Garfield Road crossing are discussed further in Section 8.2.

9.7 Public safety

9.7.1 Construction

There is the potential for public safety issues during the construction of the Project, including the unauthorised access of construction sites and compounds by members of the public and the safety of alternative access provisions (refer Section 8.2). Construction of the Project may also locally disrupt emergency services through temporarily restricting access across the rail corridor.

9.7.2 Operation

There is the potential for security/public safety issues to arise for passengers on trains, and in and around station facilities, car parks and bus interchanges, particularly at night or during off-peak periods when there is limited opportunity for passive surveillance.

There is also the potential for public safety impacts associated with public access to the new stations. The proposed new Vineyard Station includes an at-grade pedestrian crossing of Riverstone Parade, which commuters parking in the Vineyard Station commuter car park would need to use to access Vineyard Station. The Preliminary Concept Design Report (Maunsell 2008) notes that the posted 80 kilometre per hour speed limit may be too high for this unprotected at-grade crossing.

The Project would improve public safety by removing the at-grade pedestrian level crossings at Quakers Hill, Schofields and Riverstone, and replacing these with footbridges.

A grade separated crossing of the rail line would be needed to achieve the optimal benefit from Stage 2 of the Project. The construction of Stage 2 would be coordinated with RailCorp, RTA, TIDC and the GCC. If the Riverstone Railway Overpass is not competed prior to the proposed increase in train services, then the level of service of the Garfield Road level crossing is expected to degrade.

9.7.3 Management measures

Construction

The following measures would be implemented to maximise public safety during construction of the Project:

- All construction compounds and work areas would be fenced to limit public access during construction.
- Where necessary, footpaths and other public facilities located within close proximity to compounds and work areas would be relocated to minimise risk of injury to the community.
- Safety issues would also be addressed in the traffic management plans to be prepared for the Project (refer Section 8.2).
- Consultation would be undertaken with emergency services departments (including the NSW Fire, Police and Ambulance services) during the detailed design phase of the Project to ensure that impacts to these services are minimised (refer Section 4.6).

- Construction activities would be undertaken in accordance with applicable RailCorp and WorkCover standards, policies and procedures.

Operation

To minimise the risk to public safety during operation of the Project, the following measures would be implemented:

- The principles of Crime Prevention Through Environmental Design (CPTED) would be applied to all new facilities to be installed as part of the Project, including appropriate lighting, fencing of the rail corridor, installation of surveillance cameras and help points at stations. These would be included as part of the detailed design process and would be based on similar measures adopted at existing railway stations in the Sydney rail network.
- Potential safety impacts associated with existing speed limits and pedestrians using the at-grade level crossings at the new Vineyard Station would be addressed during detailed design, and in consultation with Blacktown City Council and the RTA. Potential mitigation measures include lowering the speed limit to at least 60 kilometres per hour or providing signalised crossings.

A grade separated crossing of the rail line would be needed to achieve the optimal benefit from Stage 2 of the Project. The construction of Stage 2 would be coordinated with RailCorp, RTA, TIDC and the GCC. If the Riverstone Railway Overpass is not competed prior to the proposed increase in train services, then the level of service of the Garfield Road level crossing is expected to degrade.

9.8 Services and utilities

9.8.1 Construction impacts

The construction of the Project could result in disruption of utility services. Users may experience short disruptions to telecommunication connections, street lighting, gas and water mains when these are relocated as part of the proposed works. Interruptions to services or potential damage to existing utilities have the potential to occur during the movement and access of construction traffic. Utility services that are likely to conflict with the Project are described in Table 9-5.

Construction impacts with respect to services and utilities include potential for damage to services and utilities, and plant and/or equipment; as well as injury to persons should cables, mains or pipelines be accidentally damaged during excavation or plant movement. Transmission of large electrical currents through the ground surface (known as Earth Potential Rise) could occur as a result of damaged power cables and mains, and has the potential to injure construction workers and members of the community standing close to the damaged power utility. Damage to gas mains could also result in injury to construction workers and community members. Investigations would be carried out during the detailed design phase of the Project to ensure that appropriate measures are in place to minimise the risk of Earth Potential Rise.

The damage of existing utility services during the construction of the Project could also result in the disruption of existing utilities.

As described in Section 3.13, a 100 millimetre high pressure gas main (owned by Jemena) crosses the rail corridor within the vicinity of the existing Quakers Hill pedestrian level crossing (refer Table 3-34). Test pitting would be undertaken during the detailed design to confirm the exact location of this utility to ensure that the Project is designed around the utility.

A high pressure petroleum pipeline (Caltex's Sydney-Newcastle high pressure petroleum pipeline) has been identified as running parallel to the Project at a distance of between 700 metres-1000 metres, and is not in the vicinity of the proposed works. As such, the Caltex pipeline is not expected to be impacted by the Project.

Table 9-5 Construction impacts and proposed management measures to existing services and utilities within the rail corridor for Stage 1 and 2 of the Project

Service/Utility	Provider	Impact	Management Measure
Stage 1			
Telecommunication	Telstra	At the new Quakers Hill footbridge, construction of footbridge and track duplication has potential to impact two telecommunication cables. Other locations where the cable cross the corridor or run parallel to the track within the rail corridor may be impacted by construction works.	Services at the Quakers Hill Footbridge would require protection under the new track. In other locations, the Telstra line would be moved out of the rail corridor or protected under the track.
Water	Sydney Water Corporation	Water mains that cross the rail corridor near Quakers Hill pedestrian level crossing and the existing Schofields Station (near proposed pedestrian overbridge) may be impacted by the construction works.	Protection may be required for the during construction works however, confirmation of management measures will be determined during detailed design.
		Water mains running parallel along up main of the rail corridor to the proposed new Schofields Station bus interchange and car park and beyond the existing Schofields Station will be impacted, including construction of the shared user path. There are also water mains on the eastern side of Railway Terrace that may be impacted. Impacts will occur from the extension of culverts for the additional track.	Where culverts are extended to support additional railway track, water mains will be realigned.
Sewer	Sydney Water Corporation	Sewer mains cross the rail corridor in three locations and are likely to be impacted during the expansion of the culvert system.	Protection may be required for the during construction works however, confirmation of management measures will be determined during detailed design.
	TAFE NSW	Sewer mains run parallel along down main of the rail corridor and cross the rail at approximately 42.460 km. Mains continue to run parallel along the up main of the	Culvert extension works will require either the realignment of mains or relocation of mains outside the proposed

Service/Utility	Provider	Impact	Management Measure
		rail corridor to the proposed new Schofields Station bus interchange and car park. Culvert extension works may impact sewer rising mains.	culvert footprint. Confirmation of management measures will be determined during detailed design.
Electrical	Integral Energy	Aerial and underground cables may be impacted during construction works. Construction of the Schofields pedestrian overbridge may conflict with low voltage overhead lines that cross the tracks.	Protection to occur during construction works within rail corridor for aerial cables and underground cables where required. Where conflicts occur with low voltage overhead lines, a new underline crossing (particularly for Schofields pedestrian overbridge) may be required.
Gas	Jemena	Construction works may impact on the 100 mm high pressured gas main which crosses the rail corridor in one location (near the existing Quakers Hill pedestrian level crossing).	Protection of this gas main may be required during and after construction.
Local council services	Blacktown City Council	Street lighting and station lighting in and adjacent to the rail corridor may be impacted (removed, replaced and/or relocated) during construction works.	Confirmation of management measures will be determined during detailed design.
		Council stormwater infrastructure along the rail corridor may be impacted during construction works.	Coordination with BCC would be required during the concept design phase to confirm existing infrastructure and any future proposed works.
Communications and Signalling	RailCorp	Communication and signalling cables cross the rail in six locations and have the potential to be impacted during construction works. This will be particularly evident for new Schofields Station.	Coordination with RailCorp would be required during the concept design phase to confirm existing infrastructure and any future proposed works.
Stage 2			
Telecommunication	Telstra	Telecommunications cables in five locations	Services that cross the rail corridor would require protection under the new track. In other locations, the Telstra line would be moved out of the rail corridor or protected under the track.
Water	Sydney Water Corporation	Water mains cross the rail corridor in six locations and will be impacted during construction works.	Co-ordination of works will be undertaken in communication with Sydney Water. Confirmation of management measures will be determined during detailed design.

Service/Utility	Provider	Impact	Management Measure
Sewer	Sydney Water Corporation	Sewer mains cross the rail corridor in eight locations and will be impacted during construction works and during culvert extension works.	Protection may be required for the during construction works however, confirmation of management measures will be determined during detailed design. Culvert extension works may require either the realignment of mains or relocation of mains outside the proposed culvert footprint. Confirmation of management measures will be determined during detailed design.
Electrical	Integral Energy, Transgrid and Railcorp	Aerial cables and underground cables have the potential to be impacted during construction.	It is anticipated protection may be required however confirmation of management measures will be determined during detailed design.
Gas	Jemena	Pressured gas main crosses the rail corridor in one location which is likely to be impacted during construction works.	Protection of this gas main may be required during and after construction.
Local Council services	Blacktown City Council	Street lighting and station lighting in and adjacent to the rail corridor may be impacted (removed, replaced and/or relocated) during construction works. Council stormwater infrastructure along the rail corridor may be impacted during construction works.	Coordination with BCC would be required during the concept design phase to confirm existing infrastructure and any future proposed works.
Communications and Signalling	RailCorp	Communication and signalling cables cross the rail in 13 locations with cables also running parallel to the rail corridor to Vineyard Station.	Coordination with RailCorp would be required during the concept design phase to confirm existing infrastructure and any future proposed works.

9.8.2 Operation impacts

The operation of the Project is not expected to affect existing services and utilities.

9.8.3 Management measures

Construction

Consultation with utility owners and service providers

Prior to the commencement of any external works, detailed consultation would be undertaken with utility owners, including Integral Energy, Jemena, Telstra, Sydney Water, TAFE NSW and Caltex. Services or utilities that may conflict with the Project (as outlined in

Section 3.13 and Table 9-5) would be protected and/or relocated. This would include protection of the Sydney Water Corporation sewer and water mains, Telstra cables and Jemena gas main where they cross the rail corridor (refer Table 9-5). It would also include the relocation of a section of Telstra cables in the vicinity of the Westminster Street overbridge and the 33 kilovolt (kV) high voltage RailCorp power lines where they cross the rail corridor adjacent to the proposed pedestrian footbridges at Quakers Hill and at Schofields Station. Existing street and station lighting would also be relocated and replaced as part of the Project.

Further investigation

Further investigation would be undertaken during the detailed design phase to clarify the location of Jemena's 100mm high pressure gas main to determine whether protection of this utility is required. Should the location of this utility be in conflict with the Project, Jemena would be requested to undertake a formal review of the proposed works, and provide the contractor with construction constraints and details of the exact on-site location of the pipeline; these would be implemented through the CEMP.

Management of construction works

All construction personnel involved in ground penetration activities must have a permit to disturb, prior to commencing work and received appropriate safety training for working around underground and overhead utilities. Construction works under overhead lines will require special plant and supervision to ensure there is no potential for arcing or contact with the wires.

The construction contractors would check the locations of existing underground utilities and services prior to commencing works. This would be undertaken through potholing and/or hand digging and in accordance with guidelines provided by the relevant utility authority (e.g. Integral Energy, Telstra).

In addition, all works would be carried out in accordance with the following guidelines:

- AS4799-2000 *Installation of underground utility services and pipelines within railway boundaries*
- RailCorp Standard G5000-G5007-2001 *Management Systems for Pipe, Electrical Telephone Crossings Under and Over Railway Property*
- RailCorp Standard ESC540 v1.1 *Utility Service Crossings*.

Operation

The operation of the Project is not expected to affect existing services and utilities and, as such, no mitigation would be required.

9.9 Cumulative impacts

Cumulative impacts could occur if the construction or operation of the Project coincided with the construction or operation of other local development, such as road upgrades or residential development. As the Project falls almost entirely within the boundaries of the NWGC, there is potential for cumulative impacts to occur as a result of the development of precincts within this growth centre (refer Sections 2.3 and 8.1). The exact timing of precinct

development within the NWGC is currently unknown; however it is likely that this development would coincide with the construction of the Project, particularly Stage 2, which has been deferred until a date yet to be determined. As the timing of Stage 2 is unknown, this assessment has assumed a worst case scenario in that the Project would coincide with the development of the NWGC.

9.9.1 Construction

Cumulative construction impacts may include:

- increased construction vehicle traffic on public roads causing congestion and delays, and increased air pollution and noise for local residents
- cumulative noise impacts associated with multiple construction works, particularly during the night-time period
- reduced local biodiversity as a result of vegetation clearing
- loss of Indigenous heritage artefacts
- changes to water quality of nearby waterways
- changes to the visual amenity of the area.

Developments that have been approved, or are proposed to be undertaken in the vicinity of the Project are provided in Table 9-6. Cumulative construction impacts would be expected if the timing of these developments coincided with construction of the Project.

Cumulative construction impacts in the Riverstone town centre would be expected if the timing of the Garfield Road level crossing replacement coincided with the upgrading of Riverstone Station. Potential cumulative impacts may include traffic delays, and noise, dust and visual impacts.

Cumulative impacts may also affect the rail network if unrelated maintenance work is required during construction of the Project. It is expected that RailCorp and TIDC would work closely to ensure that essential non-Project maintenance work within the rail corridor during construction of the Project could be undertaken with minimal disruption to the rail network.

Table 9-6 Approved and proposed developments registered with Blacktown City Council in the vicinity of the Project

Development application (DA) number	Type of development	Location	Approval status
DA: 07-329	Partial demolition of, and major extensions to, the Market town shopping centre	Riverstone Parade, Riverstone	Yet to be determined
DA: 07-1000	Demolition of an existing industrial building and construction of two new industrial units	Riverstone Parade, Riverstone	Approved
DA: 06-2458	Construction of a two-storey dwelling	Riverstone Parade, Riverstone	Approved
DA: 08-1569	Dwelling demolition	Bridge Street, Schofields	Approved
DA: 07-1078	Construction of a two-storey dwelling at the rear of the existing dwelling	Railway Terrace, Schofields	Approved
DA: 08-1399	Subdivision, including demolition of a residential dwelling	Railway Terrace, Schofields	Approved

Development application (DA) number	Type of development	Location	Approval status
DA: 08-2152	Subdivision into nine Residential Torrens Titles and construction of nine integrated housing developments	Railway Terrace, Schofields	Approved
DA: 07-2519	Alterations and additions to fire damaged building.	Riverstone Parade, Riverstone	Approved

Cumulative construction impacts may occur with the release of the first precincts of the NWGC (Riverstone, Alex Avenue, North Kellyville and Riverstone West). It is expected that development within these precincts will commence in the near future and, thus, could overlap with construction works for the Project. This is particularly likely to be the case for Stage 2 of the Project, which has been deferred until a date to be determined. The deferred construction of Stage 2 is more likely coincide with the development of the Riverstone and Riverstone West precincts.

Potential cumulative impacts may include traffic delays, and noise, dust and visual impacts, as well as reduced local biodiversity and loss of Indigenous heritage artefacts. While cumulative traffic delays, and noise, dust and visual impacts would be temporary in nature, impacts to local biodiversity and Indigenous heritage artefacts would be permanent.

Cumulative biodiversity impacts associated with this Project are likely to be greatest at the site of the proposed new Vineyard Station car park. This area contains good condition Shale Gravel Transition Forest (listed as an EEC under the TSC Act), which has been identified as a core habitat (refer Figure 3-19 in Section 3.6.1). While the Project would require the clearing of approximately 0.97 hectares of this area (comprising 0.44 hectares for Phase 1 of the new Vineyard Station car park and 0.53 hectares for phase 2), this vegetation is within the NWGC's biodiversity certified area and may be further cleared during the development of the NWGC.

The cumulative impacts to biodiversity during the development of the NWGC will be managed though the biodiversity certification strategy for the growth centre. Biodiversity certification identifies areas within the growth centres as either certified or non-certified. Certified areas are those that are likely to be of lower conservation value. Non-certified areas generally correspond with areas of higher conservation value (such as known locations of threatened species habitat), and flood-prone and transitional land.

As discussed in Section 8.6.1, the majority of the study area has been certified (refer Figure 3-20) with all threatened biodiversity in the study area occurring within certified areas. Biodiversity certification has considered the NWGC as a whole and, as such, the cumulative impacts have been assessed and offsets have been calculated on a regional basis through planning mechanisms. As such, the impacts are considered at a larger scale to this Project and take into consideration the cumulative impacts of projects within the region.

Cumulative impacts to Indigenous heritage artefacts may also occur during the construction of the Project and the development of the NWGC. As discussed in Section 8.8, the proposed construction works for the Project would directly impact seven Indigenous heritage items and ten areas of Potential Archaeological Deposit (PAD). The Project is likely to encounter undisturbed and/or partially disturbed archaeological remains within the areas of PAD identified as Q1, Q2, Q3, Q4, QVP, S1, S2, V1, V2 and V3 in the Indigenous Heritage Technical Paper (refer Volume 2). The Project would impact on the full extent of PAD S2 and PAD V1. All other PADs would be partially impacted by the Project. The wider study area

contains an additional 39 places or objects registered on the DECC's Aboriginal Heritage Information Management System (AHIMS) register (refer Section 3.9.1). While the Project is not expected to have a significant impact on Indigenous heritage items, the significance of such impacts are likely to increase with the expected development within the NWGC.

9.9.2 Operation

Cumulative impacts as a result of the operation of the Project may include:

- increased vehicle traffic associated with commuters travelling to and from the stations and increased residential development in the area
- changes to the visual amenity of the area as a result of the new stations and other infrastructure associated with the development of the precincts
- changes to the character of the Riverstone town centre as a result of the upgrade of the station and replacement of the Garfield Road level crossing.

The timing of the development of the 16 precincts comprising the NWGC is yet to be confirmed. Planning for the Alex Avenue, Riverstone, and Riverstone West precincts has commenced and it is, therefore, likely that these will be the first precincts to undergo development. Draft precinct plans for Riverstone and Alex Avenue were placed on public exhibition between November 2008 and February 2009 (GCC 2008a, 2008c), while plans for Riverstone West were placed on public exhibition between March and April 2009 (GCC 2009a). The development timing for these four precincts depends on a number of factors, including provision of water and sewer infrastructure, the undertaking of essential road building and sufficient market interest in the land.

The commencement of operation of the Project may generate an increase in traffic on the local road network around the existing and new stations as a result of an expected increased patronage on the Richmond Branch Line. However, in the long-term, the Project is expected to generate a mode shift from private cars to public transport, which would have a benefit to regional traffic within north-western Sydney.

The Project would create an opportunity for public transport to be more attractive to the community by providing more frequent rail services and allowing for the greater integration of other modes of public transport, through the creation of bus interchange facilities at Schofields and Vineyard stations. The provision of an attractive, integrated and accessible public transport link for existing and future residents in this area would help to reduce the already high reliance on private cars as the main mode of transport for journeys to and from the area.

The Project would aid in achieving the appropriate levels of urban consolidation and commercial development around established and reliable transport nodes. In achieving these levels of urban consolidation, the objectives of the Sydney Metropolitan Strategy (refer Section 2.5.1) relating to the provision of housing choice could also be achieved.

Through undertaking the proposed works described in Section 6, the Project would provide a significant improvement to the existing services on the Richmond Branch Line by increasing train frequency and reliability, thereby attracting increased patronage to rail transportation in the region. The increased rail capacity would also meet the future increased patronage demand expected as a result of the development of the NWGC.

9.9.3 Management measures

Construction

The potential cumulative construction impacts associated with the Project would be further considered as the design develops and as further information regarding development plans for the NWGC are released. Mitigation measures would be developed and implemented as appropriate.

TIDC would work closely with RailCorp and utility/asset owners to ensure that essential non-Project related maintenance work scheduled during the construction of the Project could be undertaken with minimal disruption to the rail network.

Operation

The potential cumulative impacts associated with operation of the Project are expected to be manageable as the Project would continue to be considered in future planning for the area. Measures should be implemented during the development of the NWGC to encourage the use of public transport by new and existing residents.