Chapter 9. Key assessment requirements

9.1 Land use, acquisition and infrastructure planning

9.1.1 Impact assessment - construction

The potential for land use impacts associated with construction of the project would focus on and around the construction sites, station areas and dive structures along the proposed alignment (as described in section 7.2). Potential impacts could result from:

- Land use changes around construction sites during construction periods;
- Modifications to established stations (such as Cheltenham); and
- Modifications to roads, pedestrian ways, bus stops, carparking and other transport access points.

The total construction period would we be approximately six years and nine months, however construction periods would vary at each site depending on the construction timetable and the methodology employed.

Potential issues that may arise during the construction on land uses along the route are noted in Table 9.1.

Table 9.1 Potential land use impacts - construction

Location	Construction issues
Cheltenham Station	Cheltenham station would undergo a significant upgrade as part of the project. This may affect patronage amenity currently experienced.
Tunnel portal to Franklin Road Station	Property within the rail corridor would be required on the east side of Beecroft Road for permanent works and a construction work site associated with the tunnel dive structures. Cut and cover construction would occur adjacent to The Crescent resulting in demolition of the existing Scout Hall building. The scout facilities would be relocated or replaced. At this stage of design it is envisaged that some temporary work during construction such as an access road, staff/worker accommodation and the storage of plant may encroach outside of the rail corridor into the road corridor of The Crescent and/or into Beecroft Village Green. The extent of this possible encroachment would be clarified during future design work and would be planned to protect access along The Crescent, protect the Tennis Courts and minimise impacts on the Beecroft Village Green.
Franklin Road Station	The Franklin Road construction site is also likely to produce a significant land use change. The land would change in use from a residential setting to a construction site. This land use change would be in place for the duration of the construction period. Surrounding areas may be undergoing residential

Location	Construction issues
	development.
Castle Hill Station site	The construction site would use areas of Arthur Whiting Park. Site boundaries would be clarified and refined during future design work to maintain pedestrian access and protect important features/structure of the Park. Construction would be managed to minimise impacts on events in the park. Affected areas of the park would be restored in consultation with Council, local community and other stakeholders.
Hills Centre Station site	The construction site would use an area to the south west of the Castle Hill Showground. This area is currently occupied by showground buildings, which would be relocated. Potential use of the Council Depot site would be considered in consultation with Baulkham Hills Council.
Norwest Station to Burns Road Station	Balmoral Road construction site is also likely to produce a significant land use change. The land would change in use from a rural setting to a construction site with large spoil storage. This land use change would be in place for the duration of the construction period. Surrounding areas may be undergoing residential development.
Rouse Hill Station	Construction would occur within the future Rouse Hill Town Centre. Considerable construction planning would be required for works which would occur within an operating and growing town centre.
Rouse Hill Station to stabling facility	The stabling facility would result in direct land use changes from the existing environment (i.e. rural residential) and planned land uses (i.e. urban residential). Future plans for urban housing (that is, Area 20 precinct planning) may require revision to accommodate land uses more sympathetic to a stabling facility.

9.1.2 Impact assessment - operation

Potential impacts could occur as a result of permanent physical changes directly associated with the project and land use changes in adjacent/nearby areas due to the presence of the project.

Potential issues that may arise during the operation on land uses along the route are noted in Table 9.2. Potential impacts associated with the interrelationship between the project and future land use planning and development; and corridor protection requirements, are discussed following the table.

Table 9.2 Potential land use impacts - operation

Station	Operation issues
Franklin Road Station	Introduction of new transit oriented land uses, including the station and commuter parking. The presence of a new rail station in this area may act as a catalyst for residential and commercial development around the station and pedestrian catchment area. Properties acquired would be permanently changed to that associated with a transit precinct or with land use more sympathetic to a rail station. Commuter parking facilities would be introduced.
Castle Hill Station	The proposed station location is underneath Arthur Whitling Park. A large section of Arthur Whitling Park would be required to be used for permanent access arrangement for the station including pedestrian access, emergency exist, service shafts and ventilation buildings.
Hills Centre Station	Introduction of new transit oriented land uses, including the station and commuter parking. Increased access and modern station design is likely to compliment existing land uses such as Baulkham Hills Shire Council and the Hills Centre.
Norwest Station	Introduction of new transit oriented land uses. The presence of a new rail station in this area may act as a catalyst for further residential and commercial development around the station and pedestrian catchment area.
Norwest Station to Burns Road Station	Properties acquired would be permanently changed to that associated with a transit precinct. Permanent changes may result in land use more sympathetic to a transit precinct, consistent with zonings under the LEP.
Burns Road Station	Introduction of new transit oriented land uses, including the station and commuter parking. Increased access and modern station design is likely to compliment existing land uses and transitway infrastructure. The presence of a new rail station in this area is likely to act as a catalyst for residential and commercial development in the station and pedestrian catchment area. The potential interrelationship with future land use planning and development is discussed below. Properties acquired would be permanently changed to that associated with a transit precinct or with land use more sympathetic to a transit precinct consistent with zonings under the LEP. Commuter parking would be provided.
Rouse Hill Station	Opportunity to develop an urban form which takes advantage of the proposed station (discussed below).
Rouse Hill stabling facility	Future planned land uses for this area may require review to accommodate land uses more sympathetic to a stabling facility, such as light industrial and/or commercial.

Interrelationship with future land use planning and development

Land use planning is generally the responsibility of local Councils and the Department of Planning. Within the North West Growth Centre, precinct planning is to be coordinated by the Growth Centres Commission. To manage the land uses and development changes likely to occur in the vicinity of stations and in the walking catchment areas for the project, planning authorities have a variety of planning instruments and control mechanisms available, including:

» State environmental planning policies and regional environmental plans; and

» Local environmental plans and development control plans.

Granting of concept approval for the project would mean that planning authorities would be provided with some degree of certainty in relation to the location and key features of the project. This would assist in future planning for land use change in local areas.

The project would traverse and become part of proposed new release areas in North West Sydney including, the Balmoral Road Release Area, Rouse Hill Regional Centre, and the North West Growth Centre (Area 20 precinct). The preparation of development control plans by local Councils for many of these areas is underway.

Balmoral Road Release Area

Baulkham Hills Shire Council has modified the Baulkham Hills Local Environmental Plan 2005 to include provisions to protect and integrate the project with future land uses. For example the LEP includes special provisions (clause 59) for development in the vicinity of the North West rail corridor. These provisions impose standards (such as appropriate noise attenuation measures in developments) and protection of the project from adverse development impacts for land within 60m of the corridor.

The Balmoral Road Local Environmental Plan was gazetted on 13 April 2006. This LEP rezoned rural land to allow residential and urban development. The part of the land release area, which is partially affected by the project, has been identified and zoned as land for railway purposes, including the major construction site.

The planning of the Balmoral Road Release Area would need to take the location of the project into account. There is an opportunity to develop an urban form that takes advantage of the proposed station, and the role it can play in terms of shaping the urban structure. For the majority of the release area, the project would be located in tunnel, and no ongoing operational impacts are predicted other than the opportunities for access presented by the proximity of the station.

However, the Balmoral Road Release Area is proposed to be the major construction work site for the project, with 24 hour construction required for the duration of the construction period. It is considered likely that substantial noise mitigation measures would be required at the proposed construction site in order to minimise the number of potentially affected receivers.

Rouse Hill Regional Centre

Clause 55 (1) (b) of the Baulkham Hills Local Environmental Plan 2005 concerns the Rouse Hill Regional Centre and the project. This clause states that consent must not be granted to the carrying out of development on land within the Rouse Hill Regional Centre unless the Council has taken into consideration any recommendations and observations made by the Department

of Planning with respect to the future provision of a rail link to and through the Rouse Hill Regional Centre.

TIDC and Railcorp have been undertaking consultation with Lend Lease/GPT (the developers of Rouse Hill Regional Centre) in relation to the project, and Lend Lease/GPT is incorporating the project into the design of the centre. Similar to the Balmoral Road Release Area, there is an opportunity to develop an urban form which takes advantage of the proposed station, and the role it can play in terms of shaping the urban structure.

Area 20 and the North West Growth Centre

The stabling facility would be located in Area 20, which forms part of the North West Growth Centre.

Precinct planning for Area 20 is expected to commence in 2007/8. An opportunity exists to plan for potential impacts of the proposed stabling facility within Area 20 by designating adjacent land uses appropriate for a train stabling facility, such as light industrial and/or commercial.

In Area 20, residential development is planned prior to the commencement of operations. It may be possible to minimise impacts on residential areas by providing buffer distances between the proposed stabling facility and residential development, or by locating less sensitive land uses closest to the facility. Industrial and commercial receivers are unlikely to be affected by noise emissions during the night-time period when intrusive noise impacts are greatest.

In particular, the environmental assessment (section 9.3) has identified the potential for noise impacts on Area 20. On the northern and western sides of the stabling facility, the construction of noise barriers/mounds or incorporating mitigation into the design would reduce the number of exceedances. In addition, the stabling facility is located in a cutting, which reduces the potential for noise impacts.

Until precinct planning is finalised, provisions within State Environmental Planning Policy (Sydney Region Growth Centre) 2006 (clause 16 (1) (f)) include that consent is not to be granted to the carrying out of development on land within a growth centre unless the consent authority (local council) has considered whether proposed development(s) will hinder the orderly and co-ordinated provision of infrastructure that is planned for the growth centre. As a result, future planning for release areas within the North West Growth Centre would need to take the project into account. TIDC would need to work with the Growth Centres Commission and Blacktown City Council to ensure that the stabling facility is integrated with the planning and development of Area 20.

Other planned major infrastructure

As the North West Transitway is currently under construction and due to be operational for bus services by late 2007, impacts on its development are unlikely. However, operational impacts may include modifications to bus access points. The interrelationship between the project and the transitway would need to be considered during design development.

The project does not preclude the long term plans to extend the North West Rail Link to the Richmond Line.

Corridor protection

The property requirements for the project are as follows:

» Rail trackwork within the proposed corridor alignment;

» Stations;

» Public transport interchanges and car parks;

» Associated infrastructure; and

» Construction sites and access requirements.

Based on preliminary investigations, approximately 140 properties would be potentially affected by the project. However, the exact number of affected properties would be subject to further investigation. A breakdown of the potentially affected properties according to broad ownership patterns is provided below:

» Privately owned properties (approximately 108):
  – Residential – 37
  – Commercial/employment – 40
  – Rural acreage – 10
  – Industrial – 1
  – Other – 18

» Government owned land/properties (approximately 34):
  – Roads & Traffic Authority – 17
  – Council – 7
  – Department of Planning – 7
  – Other – 3

Major land holdings potentially affected by the project include:

» A large commercial site owned by the Department of Planning (30.2 hectares) in Windsor Road Rouse Hill (partial acquisition);

» A large commercial site owned by the Department of Planning (20.23 hectares) in Windsor Road Kellyville; and

» A large residential site owned by Australand in Windsor Road Kellyville (partial acquisition).

The majority of properties potentially affected by the project fall into four land use zonings: Residential, Special Uses 5(a), Rural 1(a) and Special Business 3(b).

A number of properties towards the Rouse Hill end of the proposed alignment are zoned Rural 1(a), which may be suitable for future residential subdivision.

Approximately 700 properties would be located beneath the proposed 60 metre wide tunnel corridor, including over 400 properties within residential areas. Other land uses above the tunnel would include business, rural, employment, light industrial, special uses and open space. Importantly, a high proportion of the land above the proposed 60 metre wide tunnel corridor

would include roads, public land and areas specifically zoned as a transport corridor (refer to Figures 7.1 to 7.4). The zone required for the rail tunnel would be acquired in stratum (i.e. defined in space) under these properties.

Impacts associated with residential growth

The project would result in greater efficiency in transport. This is likely to attract residential growth that aims to take advantage of locating near the project. This has been acknowledged in the Sydney Metropolitan Strategy and actions have been identified to plan for this anticipated impact, including:

» Planning for a housing mix near jobs, transport and services;

» Provide 60-70 per cent of new housing in existing urban areas;

» Set subregional housing capacity targets; and

» Undertake subregional planning with local government.

Impacts associated with employment and industry growth

The project would provide greater alternatives in travel. The project has the potential to attract employment and industry growth wishing to take advantage of access to a rail line. An increase in employment and industry growth in close proximity to the project is anticipated, and in some cases, the project directly encourages such growth, by locating within existing employment centres (such as Castle Hill, Norwest Business Park and Rouse Hill Regional Centre).

This has been acknowledged in the Metropolitan Strategy and actions have been identified to plan for this anticipated impact. These include:

» A preference to locate jobs in strategic centres or employment lands (Norwest Business Park);

» Adopt employment capacity targets for strategic centres; and

» Increase densities in centres whilst improving liveability.

Further information on potential economic impacts is provided in section 9.12.

9.1.3 Summary of results

The project has the potential to act as a catalyst for residential and commercial development, with an increase in land use intensity, in the vicinity of the six new station sites. In particular, there is the potential for development with a transit-oriented focus in the vicinity of Franklin Road, Burns Road and Rouse Hill Stations. Burns Road and Rouse Hill Stations are located within new release areas (the Balmoral Road Release Area and the Rouse Hill Regional Centre) and the presence of a station has already been taken into account in the planning and development of these areas. Existing land uses within the vicinity of the other stations would be able to take advantage of the increased access that the stations provide. Intensification of existing land uses around Castle Hill, Hills Centre and Norwest Stations may also occur.

The stabling facility would be located in Area 20, which forms part of the North West Growth Centre. Precinct planning for Area 20 is expected to commence in 2007/8. An opportunity exists to plan for potential impacts of the proposed stabling facility within Area 20 and avoid the

potential for noise impacts by incorporating adjacent land uses appropriate for a train stabling facility, such as light industrial and/or commercial.

Based on preliminary investigations, part or full acquisition of approximately 140 properties in accordance with the requirements of the *Land Acquisition (Just Terms Compensation) Act 1991* may be required.

During construction, impacts and disruption to adjacent properties would occur in the vicinity of construction sites. Careful construction planning would be required to minimise impacts.

9.1.4 Recommended mitigation measures

The following mitigation measures are recommended for land use impacts associated with the project:

Further investigations

» Further detailed studies should be undertaken as part of the further design work focusing on identification of potential impacts on a lot-by-lot basis and impacts on infrastructure in the immediate vicinity of construction sites, existing stations, spoil removal areas and the proposed alignment.

» Continue to liaise with statutory organisations, local Councils and the Growth Centres Commission to ensure the project is integrated with local and regional land use planning, and that environmental planning instruments reflect the planning, construction and operation of the project, and include integrated planning provisions to enhance potential future development.

Recommended mitigation measures

» Continue to liaise with utility and service providers to ensure infrastructure such as energy, water supply and sewerage provision are compatible with the project and include integrated planning provisions to enhance potential future development of such services.

» Land that is modified for construction would be rehabilitated and restored to the pre-construction condition as far as practicable, or to a use compatible with surrounding land uses upon completion of construction.

9.2 Traffic, transport, parking and access

This section provides a summary of the traffic transport, parking and access assessment undertaken by GHD. A copy of the full report is included in Appendix B.

9.2.1 Assessment methodology

As the traffic, transport, parking and access assessment has been prepared for a concept plan for the project, detailed information on all aspects and therefore associated impacts is not yet available. The assessment has therefore been undertaken to a broad level. Numbers provided are indicative at this stage of the project, and would be subject to review.

Tasks undertaken included:

» A review of relevant documents and previous reports to identify key data sources.

» Inspection of existing road and traffic conditions.

» Consideration of existing public transport networks and sensitive land uses.

» Consultation with the RTA and RailCorp's Network Development Department.

» Identification of the potential construction impacts of the project, with a particular focus on regional road network performance, public transport and local access.

» Identification of the potential operation impacts of the project, including:

  – Regional road network performance;

  – Local access issues;

  – Sensitive land uses;

  – Interaction with regional cycle and pedestrian infrastructure;

  – Rail patronage and performance;

  – Bus patronage and performance; and

  – Car parking and commuter interchange facilities.

» Identification of further assessment required and recommended mitigation measures.

9.2.2 Impact assessment - construction

The potential impacts that could result from the construction phase include:

» Safety and capacity issues associated with the movement of construction related materials and equipment by trucks along the regional road network;

» Congestion and amenity issues caused by construction traffic accessing the proposed construction sites from the local road network; and

» Temporary disruption to traffic flows, car parking, pedestrian and cycle links, bus service routes as a result of staged construction works.

Potential impacts at each site are described below. Information in relation to spoil haulage routes is provided in Section 9.5.

Quadruplication between Epping and Beecroft

Traffic generation

Traffic generation has been estimated based on a worst-case scenario associated with the transporting of spoil and the movement of equipment. This information is summarised in Table 9.3.

Table 9.3 Construction period traffic movements at the quadruplication section

Activity	Daily traffic movements (vtpd)[1]	AM and PM construction traffic movements (vtph)[2]
Spoil truck movements (heavy vehicles)	67	7
Construction truck movements (heavy vehicles)	7	1
Light vehicles (workers)	100	50
Total	174	58

Notes: 1. vtpd = vehicle trips per day 2. vtph = vehicle trips per hour

Site access

Access to the construction site would be primarily off The Crescent approximately 50 metres from the intersection with Beecroft Road. It is anticipated that two additional access points would be required to obtain access. These access points could be situated along The Crescent, with one west of The Promenade and the second in the vicinity of Lynne Road.

It is envisaged that the majority of the construction activity would occur within the rail corridor.

Parking

It is expected that construction workers would park on The Crescent between Cheltenham Road and Beecroft Road for the duration of the works. The removal of some commuter parking associated with quadruplication and modification to Cheltenham Station is likely to result in more commuters parking in local streets in the short term.

Impacts on intersections

The intersection of Beecroft Road and The Crescent currently operates under stop priority control. Based on site observations it is likely that controls at this intersection would need to be upgraded in order to provide safe access for trucks turning right from The Crescent onto Beecroft Road.

The installation of traffic signals at The Crescent and Beecroft Road intersection would provide appropriate intersection arrangements for trucks wanting to access the designated B-Double route of Beecroft Road and then Pennant Hills Road from The Crescent.

Impacts on existing station access

Cheltenham Station would remain operational during construction. Pedestrian access would be maintained to the platforms through the installation of temporary pedestrian overbridges.

Commuter parking areas are currently provided on both sides of Cheltenham Station with 13 spaces accessed from Sutherland Road and 68 spaces accessed from The Crescent. It is likely that both of these parking areas would largely be removed during construction. Commuters driving to the station would need to use available unrestricted on-street parking spaces situated along surrounding local streets.

Cheltenham Road overbridge

During the reconstruction of Cheltenham Road overbridge abutments, temporary road closures may be necessary. Full road closures at this site are likely to only occur at night and the alternative route during these times would be via the Copeland Road bridge at Beecroft.

M2 overbridge

During the duplication of the M2 rail bridge, lane closures on the M2 would need to occur during construction of the central pier. It is expected that this work would occur over a two-month period as part of weekday night and weekend work. It is possible that the M2 would need to be closed to lift the bridge beams into place, it is anticipated that this would occur at night over a weekend. Access to the abutments would be from the rail corridor and therefore construction traffic would not impact on M2 traffic.

Franklin Road Station

Traffic generation

Potential traffic generation for the construction period has been estimated based on a worst case scenario. It includes the removal of spoil from site, other construction truck movements and construction worker traffic.

The expected period for the transporting of spoil, which represents the worse case scenario for traffic generation at Franklin Road Station, is approximately two months. Estimated construction traffic during this period is summarised in Table 9.4.

Table 9.4 Construction period traffic movements at Franklin Road Station

Activity	Daily traffic movements (vtpd)[1]	AM and PM construction traffic movements (vtph)[2]
Spoil truck movements	78	8
Construction truck movements	8	1
Light vehicles	100	50
Total	186	59

Notes: 1. vtpd = vehicle trips per day 2. vtph = vehicle trips per hour

Site access

Two site access point options have been identified:

» Access from the western side of Franklin Road. This could impact on access to surrounding residential properties and schools within the vicinity of the site; or

» Access from Castle Hill Road, by creating a four way signalised intersection with Glenhope Road.

Further investigation is required to determine the preferred access.

Parking

It is expected that construction workers would park within the construction site for the duration of the works.

Impacts on intersections

Upgrading the existing intersection of Castle Hill Road with Glenhope Road would be the preferred access option as it allows construction traffic to directly access the site, has minimal impact on surrounding land uses and adequate sight distances.

The impact on the operation of Castle Hill Road from a new intersection at this location would need to be considered as part of further investigations.

Castle Hill Station

Traffic generation

The expected period for transporting spoil, which represents the worse case scenario for traffic generation at the Castle Hill Station, is approximately three months. Estimated traffic generation during this period is summarised in Table 9.5.

Table 9.5 Construction period traffic movements at Castle Hill Station

Activity	Daily traffic movements (vtpd)[1]	AM and PM construction traffic movements (vtph)[2]
Spoil truck movements	72	8
Construction truck movements	8	1
Light vehicles	100	50
Total	180	59

Notes: 1. vtpd = vehicle trips per day 2. vtph = vehicle trips per hour

Site access

This is a highly constrained site. Access to the site would be dependant upon the timing of completion of the Eastern Ring Road bypass. Access via Old Castle Hill Road should be avoided where possible, as this access point has the potential to conflict with pedestrian and bus movements.

Parking

Parking opportunities for construction workers in the vicinity of the work site are limited. A suitable number of parking spaces for employees would be required within close proximity of the site. This could be achieved through an arrangement with local property owners.

Impacts on intersections

The development of an Eastern Ring Road around the Castle Hill town centre would change traffic flow conditions in the vicinity of the station construction site and potentially offer opportunities for improved construction access compared to existing opportunities. As a result of the planned upgrades, the impact on intersection operations is likely to be minimal.

Hills Centre Station

Traffic generation

The expected period for the transporting of spoil, which represents the worse case scenario for traffic generation at the Hills Centre Station, is approximately two months. Estimated construction traffic during this period is summarised in the Table 9.6

Table 9.6 Construction period traffic movements at Hills Centre Station

Activity	Daily traffic movements (vtpd)[1]	AM and PM construction traffic movements (vtph)[2]
Spoil truck movements	74	8
Construction truck movements	8	1
Light vehicles	100	50
Total	182	59

Notes: 1. vtpd = vehicle trips per day 2. vtph = vehicle trips per hour

Site access

Access to the site would be from Doran Drive, which currently provides access to the Council depot, Showground and the Hills Centre.

Parking

If appropriate, and in consultation with Council, construction workers could park within the Council depot area for the duration of the works.

Impacts on intersections

The intersection of Doran Drive and Carrington Road is currently under 'give way' control. The movement of construction vehicles at this intersection could impact on the operation of this intersection during the peak periods. Further investigation into the future projected traffic volumes and likely operation of this intersection during the planned construction period would be required.

Staged delivery

Under staged delivery, the project between Epping and Hills Centre Station would be operational by 2015. Therefore, the Hills Centre site would be required for launching the tunnel

boring machines. Additionally, spoil removal for the tunnel up to this point and two underground stations (Franklin Road and Castle Hill) would be from the Hills Centre site.

The estimated period for the generation of construction traffic associated with spoil removal at this site under this scenario (stage 1) would then be extended to approximately two years. Concurrent excavation of both stations would take up to approximately six months. Spoil truck movements would be consistent with those described for the Balmoral Road construction site in Table 9.8. Spoil trucks would use an access route directly onto Showground Road.

Norwest Station

Traffic generation

The expected period for the transporting of spoil, which represents the worse case scenario for traffic generation at the Norwest Station, is approximately two months. Estimated construction traffic during this period is summarised in Table 9.7.

Table 9.7 Construction period traffic movements at Norwest Station

Activity	Daily traffic movements (vtpd)[1]	AM and PM construction traffic movements (vtph)[2]
Spoil truck movements	76	8
Construction truck movements	8	1
Light vehicles	100	50
Total	184	59

Notes: 1. vtpd = vehicle trips per day 2. vtph = vehicle trips per hour

Site access

It is likely that site access would be in the vicinity of the existing roundabout on Brookhollow Avenue. The potential for conflicts with traffic accessing the Norwest Marketown Shopping Centre and Hillsong Church would need to be appropriately managed.

Parking

Parking opportunities for construction workers in the vicinity of the work site are limited. A suitable number of parking spaces for employees would be required within close proximity of the site. This could potentially include an arrangement with local property owners.

Impacts on intersections

The intersection of Norwest Boulevard and Brookhollow Avenue would be directly affected by construction traffic. This intersection is a roundabout with two circulating lanes. The movement of construction vehicles at this intersection could impact on the operation of this intersection during the peak periods. Further investigation into the future projected traffic volumes, ability to accommodate heavy vehicle turning paths, and the likely operation of this intersection during the planned construction period would be required.

Balmoral Road construction site and Burns Road Station

Traffic generation

The Balmoral Road construction site (within the Balmoral Road Release Area) would be the main construction site for the project. The estimated period for the generation of construction traffic associated with spoil removal at this site is approximately two and half years. Each station excavation would take up to approximately six months each, with up to three stations being excavated at one time.

Estimated construction traffic is summarised in Table.9.8.

Staged delivery

Under staged delivery, the project between Epping and Hills Centre Station would be operational by 2015. Therefore, the Balmoral Road site would only be required for Stage 2 between Hills Centre and Rouse Hill, which includes tunnel section of approximately 5 km.

Construction activities would be consistent with those already described, however the number of spoil truck movements would be significantly reduced.

Table.9.8 Construction period traffic movements at the Balmoral Road site and Burns Road Station

Activity	Daily traffic movements (vtpd)[1]	AM and PM construction traffic movements (vtph)[2]
Spoil truck movements	786	79
Construction truck movements	400	40
Light vehicles	200	100
Total	1386	219

Notes: 1. vtpd = vehicle trips per day 2. vtph = vehicle trips per hour

Site access

The proposed main construction site access points would be located off Balmoral Road. Other potential access options would be via Burns Road and Celebration Drive.

The majority of construction traffic would be encouraged to use the Balmoral Road entrance to access the external road network and transport material and equipment to Burns Road Station.

It is recommended that further investigation of future traffic levels along Balmoral Road be undertaken in order to understand potential network operational impacts.

Parking

A suitable number of parking spaces for employees would be required on site or within close proximity of the site.

Impacts on Transitway

The Parramatta-Rouse Hill Transitway is currently under construction and runs along the western boundary of the construction site and Burns Road Station. Construction works for the North West Rail Link would be undertaken outside of the Transitway corridor, however

construction traffic as a result of the project may impact on Transitway operations where it uses Balmoral Road.

The design of Burns Road Station would need to be integrated with the Burns Road Transitway interchange. This may require modification to the current Transitway station and park and ride facility design in order to improve connectivity with the proposed Burns Road railway station.

Mitigation measures may be required to ensure that delays to Transitway services are minimised. This may include temporary deviations to traffic or the Transitway route, temporary traffic control, and restrictions on queuing over Transitway intersections, to be confirmed by further investigation.

Impacts on intersections

Further investigation is required to understand the potential construction traffic impacts on the performance of intersections under peak hour conditions. The main intersections associated with proposed construction traffic movements are:

» Balmoral Road and Old Windsor Road;

» Sunnyholt Road/ Burns Road and Old Windsor Road; and

» Celebration Drive and Old Windsor Road.

Rouse Hill Station

Traffic generation

The expected period for the generation of construction traffic associated with spoil removal at Rouse Hill Station is approximately seven months. Spoil quantities for this site also include the surface cut/fill railway through to Samantha Riley Drive. Estimated construction traffic is summarised in Table.9.9.

Table.9.9 Construction period traffic movements at Rouse Hill Station

Activity	Daily traffic movements (vtpd)[1]	AM and PM construction traffic movements (vtph)[2]
Spoil truck movements	376	40
Construction truck movements	40	4
Light vehicles	100	50
Total	516	94

Notes: 1. vtpd = vehicle trips per day 2. vtph = vehicle trips per hour

Site access

Access to the site could be incorporated with the existing signalised intersection of Windsor Road and Schofields Road, which would provide direct access onto Windsor Road.

Parking

Parking opportunities for construction workers in the vicinity of the work site would be expected to be limited following development of the Rouse Hill Regional Centre. A suitable number of

parking spaces for employees would be required within close proximity of the site. This could potentially include an arrangement with local property developers such as Lend Lease/GPT.

Impacts on Transitway

The Parramatta-Rouse Hill Transitway is currently under construction on the eastern side of Windsor Road. Construction works for the project would be undertaken underneath the Transitway corridor, this is likely to require temporary deviations around cut and cover sections. Modification of the Rouse Hill Transitway interchange may also be required in order to integrate the interchange and Rouse Hill Station.

Mitigation measures may be required to ensure the potential for delays to Transitway services are minimised. This may include temporary deviations to traffic or the Transitway route, temporary traffic control, and restrictions on queuing over Transitway intersections, to be confirmed by further investigation.

Impacts on Intersections

The main intersections associated with proposed construction traffic movements are:

» Schofields Road and Windsor Road; and

» Commercial Road and Windsor Road.

Both intersections are currently under signalised control.

It is recommended that the site access be integrated with the existing signalised intersection of Schofield Road and Windsor Road. Further investigation into the future projected traffic volumes and performance operation of this intersection during the planned construction period would be required.

Rouse Hill stabling facility

Traffic generation

The expected period for the generation of construction traffic associated with spoil removal at the Rouse Hill stabling facility is approximately seven months (see Table 9.10).

Table 9.10 Construction period traffic movements at the stabling facility

Activity	Daily traffic movements (vtpd)[1]	AM and PM construction traffic movements (vtph)[2]
Spoil truck movements	168	17
Construction truck movements	18	2
Light vehicles	100	50
Total	268	60

Notes: 1. vtpd = vehicle trips per day 2. vtph = vehicle trips per hour

Site access

Rouse Road has a signalised intersection with Windsor Road and this intersection is likely to be the preferred access route to the site. Direct access to Windsor Road should be avoided.

Parking

A suitable number of parking spaces for employees would be required on site or within close proximity of the site. This could include an arrangement with local property owners.

Impacts on intersections

Rouse Road and Windsor Road is likely to be impacted by construction vehicles. This intersection is currently controlled by traffic signals.

Further investigation into the future projected traffic volumes and performance operation of this intersection during the planned construction period would be required.

Construction of road crossings

A number of major road crossings may be impacted by the construction of rail tunnels and bridges associated with the project. Locations where such road crossings would occur are:

» Cheltenham Road Bridge; M2

» Windsor Road (North of Schofields Road) - Cut and cover tunnel;

» Windsor Road (East of Old Windsor Road) - Overbridge;

» Samantha Riley Drive (East of Old Windsor Road) - Overbridge;

» Burns Road (East of Old Windsor Road) - Cut and cover tunnel; and

» Balmoral Road (East of Old Windsor Road) - Cut and cover tunnel.

At each location, staged construction techniques would be required, which would be confirmed during the design development stage. Construction work may result in the following:

» Temporary lane closures; and

» Temporary road diversions around the area of construction.

Where full road closures are required (if any) the duration would be minimised and, where possible, they would occur at night or during a weekend.

9.2.3 Impact assessment - operation

This section of the report provides a summary of potential traffic and transport impacts during operation of the project.

Cheltenham Station

» A decrease in overall passenger demand as passengers join rail services west of Cheltenham.

» A reduction in the number of dedicated commuter parking spaces available. It is possible that this may be mitigated by the decrease in passenger demand and relative availability of unrestricted kerbside parking near the station (refer to section 7.2.1).

» Improved facilities at the station, including easy access lifts to be constructed as part of the quadruplication works, would provide a higher quality station for passengers.

» The potential to provide a shared walking and cycling path in the Epping-Beecroft corridor should be considered. This path could connect to local walking and cycling routes, providing

improved access between residential areas, town centres and train stations. Key issues that would need to be considered in developing any potential concept for this route would be the provision of direct links to rail stations; crossing of the M2 Motorway; possible links to the M2 cycleway; and potential for co-location within the rail corridor, subject to the corridor upgrading works.

Franklin Road Station

» An increase in the number of local traffic movements and potential for congestion, the extent of which would be largely determined by the capacity and access arrangements of the park and ride facility.

» An improved environment for pedestrians as new road crossings, footpaths and interchange areas provide access to the rail station.

» Improved accessibility of the Franklin Road area to Sydney's public transport network, providing travel choice and potential for travel time savings.

Castle Hill Station

» An increased focus on, and requirement for, prioritised bus, pedestrian and cycle movements in the town centre providing access to the centre and interchange, with through traffic to be diverted around the centre.

» Improved accessibility of the Castle Hill town centre to Sydney's public transport network, providing improved travel choice and potential for travel time savings.

Hills Centre Station

» An increase in the number of local traffic movements and potential for congestion, the extent of which would be largely determined by the capacity and access arrangements of the park and ride facility.

» An improved environment for pedestrians as new road crossings, footpaths and interchange areas provide access to the rail station.

» Improved accessibility of the Hills Centre area (including the showground) to Sydney's public transport network, providing improved travel choice and potential for travel time savings.

Norwest Station

» An increase in the number of local traffic movements and potential for congestion.

» An improved environment for pedestrians as new road crossings, footpaths and interchange areas provide access to the rail station.

» Improved accessibility of the Norwest Business Park to Sydney's public transport network, providing improved travel choice and potential for travel time savings.

Burns Road Station

» An increase in the number of local traffic movements and potential for congestion, the extent of which would be largely determined by the capacity and access arrangements of the park and ride facility and the design of the future local road network.

» An improved environment for pedestrians as new road crossings, footpaths and interchange areas provide access to the rail station.

» Improved accessibility of the Burns Road area to Sydney's public transport network, providing improved travel choice and potential for travel time savings.

Rouse Hill Station

» An increased focus on and requirement for prioritised bus, pedestrian and cycle movements in the town centre providing access to land uses and the interchange.

» An increase in the number of local traffic movements and potential for congestion.

» Improved accessibility of Rouse Hill Regional Centre to Sydney's public transport network, providing improved travel choice and potential for travel time savings.

Rouse Hill stabling facility

» The stabling facility is not expected to significantly affect the transport network (inclusive of traffic, pedestrians, cyclists and public transport) during operation.

9.2.4 Summary of results

Construction of the project has the potential to impact on local and regional traffic flows. Potential impacts include:

» Increase in the volumes of light and heavy vehicles on local roads surrounding construction work sites and arterial roads, potentially leading to some delays at intersections;

» Temporary deviations to roads, property accesses, footpaths, bicycle routes and bus services, which would need to be carefully managed throughout construction; and

» Temporary increase in parking demand on local streets where construction workers could not be accommodated within construction sites.

Further investigations and construction planning would determine the extent of these impacts and appropriate mitigation measures. This would occur in consultation with the RTA, local Councils, public transport operators, local communities and other stakeholders to minimise the impacts as far as practicable.

After the project is constructed, a number of operational impacts and benefits could be expected at and around each station. These may include:

» An increase in the number of local traffic movements, which may impact upon the operation of local roads and intersections;

» An improved pedestrian environment and better integration with other transport modes around rail stations; and

» Improved access to Sydney's public transport network, providing improved travel choice and potential for travel time savings.

Future investigations would be undertaken for station precincts to provide adequate priority for pedestrians, cyclists and public transport services, with appropriate traffic management for kiss and ride and park and ride movements. Commuter parking facilities are proposed at Franklin Road, Hills Centre and Burns Road stations and the potential for 'shared use parking' of existing

facilities at Norwest Station and Castle Hill is under consideration. Intersections surrounding the proposed station locations require further investigation to ensure that acceptable operation can be achieved and that all road users can be accommodated.

9.2.5 Recommended mitigation measures

Further investigations

A number of further studies are recommended to maximise the potential project benefits, as described below.

Specific traffic, transport, parking and access issues that should be considered during design development are summarised in Table 9.11.

Table 9.11 Traffic, transport, parking and access issues to be considered during design development

Location	Issue
All stations	Local connectivity requirements to enable efficient pedestrian, cyclist and vehicular access between the stations and surrounding areas. Develop designs which minimise the potential for impacts on local residential streets, the operation of intersections on nearby arterial roads, and minimise delays to bus services. Confirm parking requirements and investigate designs that maximise the efficient operation of park and ride facilities (where these are proposed). Integration of the station with bus/rail interchanges.
Quadruplication	Potential provision and integration of pedestrian/cyclist facilities adjacent to the rail line between Epping Station and the Beecroft village green, including over the M2.
Cheltenham Station	Determine parking demand and investigate designs for the station that minimise the long term loss of commuter parking facilities.
Franklin Road Station	Feasibility of providing direct access to the site from Castle Hill Road. Potential impact of a four way signalised intersection at the existing intersection of Glenhope Road with Castle Hill Road.
Castle Hill Station	Potential impacts on planned construction activities associated with Castle Hill station on Castle Towers Shopping Centre. Construction vehicle access to the planned construction site for Castle Hill Station. Underground pedestrian connections to surrounding retail.
Hills Centre Station	Projected traffic volumes and likely operation of the Doran Drive and Carrington Road intersection during construction period and Showground Road.
Norwest Station	Projected traffic volumes and likely operation of the Norwest Boulevard and Brookhollow Avenue roundabout during construction period. Shared use parking arrangements.
Balmoral Road construction site and Burns Road Station	Projected traffic volumes and traffic arrangements at the Balmoral Road and Old Windsor Road Intersection. Performance of the surrounding road network under AM and PM peak

Location	Issue
	construction traffic.
Rouse Hill Station	Projected traffic volumes on Old Windsor Road and Schofield Road during the construction period.
Rouse Hill stabling facility	Projected traffic volumes and potential impacts on Rouse Road and Schofield Road during the construction period.
Construction of road crossings	At each of the proposed road crossings, further assessment of peak hour traffic volumes to determine the timing of any lane closures and minimise the impact on the surrounding road network.

Recommended mitigation measures

The following construction related mitigation measures are recommended.

Traffic impacts

» Prior to and during construction, consultation with the community would ensure that the local community, including road users, are informed regularly on changed conditions including likely disruptions to access. Specific access measures to minimise disruption to access and parking would be detailed in a traffic management plan.

» Appropriate traffic management to control access to work areas and minimise delays would be implemented, including temporary speed restrictions, precautionary signs, illuminated warning devices, manual and/or electronic traffic control and provision of temporary barriers and markers. Managed traffic control arrangements would also be necessary during periods of reduced lane flow.

» Establishment of safe access points to work areas from the adjacent road network including safety measures such as barriers, maintaining sight distance requirements and signage and the provision of traffic management measures such as those identified above.

» Disruptive works would be scheduled to take place generally outside peak commuting hours and peak weekend times.

» Temporary deviations may be required to allow traffic to pass the work-site while roadworks are taking place. Establishment and operation of deviations would be in accordance with Australian Standard 1742.3-1996 Traffic Control Devices for Works on Roads as a minimum.

» Any additional measures for traffic management should be undertaken in accordance with relevant standards.

Parking

» Ensure that adequate employee parking is provided either on or in close proximity to the site.

Property access

» Property access would be maintained at all times where feasible.

» Property access points would be separated from work areas (through the installation of fencing for example) to ensure safety.

Bus services

» Impacts on bus and Transitway services would be minimised.

» Bus stops and associated footpaths would be separated from work areas (through the installation of fencing for example) to ensure safety.

Footpaths and bicycle routes

» Existing footpaths and bicycle facilities would be maintained at all times where feasible. This may require the temporary relocation of footpaths and bicycle facilities whilst construction works occur.

» Temporary footpaths and bicycle facilities would be separated from work areas (through the installation of fencing for example) to ensure safety.

9.3 Noise and vibration

This section summarises the results of the noise and vibration assessment undertaken by Heggies Australia. The full report is located in Appendix C.

9.3.1 Assessment methodology

The main steps involved the noise and vibration assessment were:

» Characterise the existing noise environment based on previous noise surveys supplemented with additional surveys where gaps existed;

» Calculate noise and vibration criteria in accordance with relevant guidelines;

» Establish potential noise emissions associated with the project;

» Modelling to determine noise and vibration impacts;

» Assessment of the significance of potential impacts identified; and

» Recommend additional investigations to be undertaken as part of further design work and, where appropriate, recommend mitigation measures.

For the existing noise and vibration assessment undertaken by Heggies, discussion of potential mitigation measures was limited to typical measures that may be required, subject to determining future criteria and the outcome of the feasibility and reasonableness assessment process. The determination of prescriptive noise and vibration mitigation measures was considered to be inappropriate at this at this concept plan stage. The design goals presented in this preliminary assessment should therefore be regarded as indicative only. The adopted design goals for preliminary assessment are similar to those applied on recent rail infrastructure projects for new works.

9.3.2 Noise monitoring results

The existing noise environment varies along the length of the proposed alignment, as would be expected from the wide range of commercial, suburban and rural land uses within the study area and from the proximity of each location to major roads and to the existing rail corridor.

In 2002, SKM undertook an extensive noise survey along the proposed alignment as part of the North West Rail Link – Assessment of Environmental Issues Report (SKM, 2003). The results of the SKM surveys are considered in most parts to be a reasonable indication of the prevailing noise environment. An extract from this report, which summarises the results of the SKM survey, is presented in Table 9.12. A full copy of the SKM report is included in Appendix Y of Appendix C.

Table 9.12 2002 noise monitoring results (SKM, 2003)

Monitoring location		Rating background level (RBL)			Typical LA10 levels	Laeq (24hr)	Laeq (15hr)	Laeq (9hr)
		7am - 6pm	6pm - 10pm	10pm - 7am	7am - 6pm			
1	2 Sutherland Road, Cheltenham	39	38	34	58	59	59	59
2	52 The Crescent, Cheltenham	39	37	31	55	58	58	57
3	30 Sutherland Road Beecroft	43	41	36	63	60	60	59
4	2A The Crescent, Beecroft	44	44	34	59	62	61	62
5	10 Fleur Close, West Pennant Hills	41	36	30	56	51	53	45
6	113 Castle Hill Road, Cherrybrook	43	42	30	52	49	50	45
7	128 Franklin Road, Cherrybrook	49	47	35	64	59	60	56
8	18 Old Castle Hill Road, Cherrybrook	54	49	38	63	59	60	55
9	2 Brisbane Road, Castle Hill	51	46	37	62	58	59	55
10	49 Showground Road, Castle Hill	57	51	39	68	64	65	60
11	112 Showground Road Castle Hill	58	52	33	71	66	67	62
12	20 Carrington Road Castle Hill	48	43	35	65	60	62	53
13	31 Fairway Drive, Castle Hill	41	39	36	52	50	52	46
14	10 Emmanuel Tce Glenwood - facing Old Windsor Road	48	44	34	65	61	62	58
15	21 Balmoral Road Kellyville	38	40	35	58	54	55	52
16	27 Burns Road Kellyville	55	51	38	65	60	61	57
16b	15 Burns Road Kellyville	47	44	32	64	61	60	55
17	Lot 26, Old Windsor Rd Kellyville	46	46	35	60	57	57	56
18	11 Weynden Avenue Kellyville	38	41	36	48	49	50	48
19	7 Austin Place Kellyville	41	41	34	51	49	49	47
20	9 Terry Road Rouse Hill	41	41	37	53	49	49	46
21	109 Rouse Road Rouse Hill	37	36	32	53	49	50	47

Additional noise surveys were undertaken in July 2006 as part of the current environmental assessment to supplement the SKM surveys in areas where no or very limited surveys were previously undertaken. Surveys were undertaken near the proposed stabling facility, near Norwest Business Park, and in the vicinity of the proposed quadruplication (see Table 9.13).

The L_{A90} background noise levels were processed in accordance with the procedure in the DEC Industrial Noise Policy (INP) to determine the Rating Background Level (RBL) during the daytime, evening and night-time periods.

The existing L_{Aeq} noise levels for the daytime, evening and night-time periods were also processed in accordance with the procedure in the INP. These values represent the typical 'energy-averaged' noise levels during each assessment period.

A summary of processed noise levels is presented in Table 9.13.

Table 9.13 Summary of ambient noise levels at unattended noise monitoring locations

Monitoring location		Daytime noise level[1] (dBA)		Evening noise level[1] (dBA)		Night-time noise level[1] (dBA)	
		LA90 RBL	LAeq	LA90 RBL	LAeq	LA90 RBL	LAeq
NWBG 1	18 O'Reilly Way Rouse Hill	42[2]	46[2]	39[2]	42[2]	35[2]	40[2]
NWBG 2	19 Bridgeview CCT Bella Vista	42	50	40	46	37	44
NWBG 3	2/23 Derby Street Epping	46	57	46	58	38	57
NWBG 4	5 Sutherland Road Cheltenham	45	54	43	54	38	52

Note 1 DEC's preferred definition of daytime, evening and night-time hours. Daytime refers to standard daytime construction hours, namely 7.00 am to 6.00 pm Monday to Friday and 8.00 am to 1.00 pm on Saturday. Evening refers to the period 6.00 pm to 10.00 pm. Night-time refers to the period 10.00 pm to 7.00 am.

Note 2 At NWBG1, the noise logger periodically stopped during the unattended noise survey. The summary noise levels are based on only limited information and should be considered preliminary only. Additional background noise monitoring would be required in this area as part of any additional assessment.

Three noise sensitive buildings were identified by SKM (2003) along the proposed alignment:

» The Hills Entertainment Centre;

» Baulkham Hills Council Chambers; and

» Hillsong Church.

Additionally, a number of commercial buildings within Norwest Business Park have been identified as being potentially sensitive to noise and vibration. A detailed assessment of sensitive equipment located within these buildings would be undertaken at a later stage in the assessment process and mitigation measures incorporated into the track design if required.

Electro-magnetic radiation (EMR) from train systems does not normally cause electromagnetic radiation compatibility problems with nearby sensitive equipment. During the further design

stage a more detailed investigation into possible EMR impacts of the railway line would be undertaken focussing on areas such as within Norwest Business Park where there may be sensitive equipment located in close proximity to the proposed tunnel.

9.3.3 Noise and vibration goals

Construction noise

The DEC's '*Environmental Noise Control Manual'* provides guidelines for assessing the noise impact from construction sites. The DEC's general approach to the control of noise from construction sites involves the following:

» Limiting hours of operation for 'noisy' construction work - The DEC normally limits construction works to the following time periods: 7.00 am to 6.00 pm from Monday to Friday, 8.00 am to 1.00 pm on Saturdays and no work on Sundays and public holidays.

» Use of silenced equipment - All practical measures should be used to silence equipment, particularly in instances where extended hours of operation are required.

» Compliance with noise emission objectives:

  – For a construction period of up to 4 weeks duration, the L_{A10} noise level when measured over a period of not less than 15 minutes should not exceed the L_{A90} background noise level by more than 20 dBA.

  – For a construction period of between 4 and 26 weeks, the L_{A10} noise level should not exceed the L_{A90} background noise level by more than 10 dBA.

  – For a construction period of greater than 26 weeks, the L_{A10} noise level should not exceed the L_{A90} background noise level by more than 5 dBA.

As the overall duration of the proposed construction program is greater than 26 weeks, the L_{A90} background + 5 dBA noise goal is applicable to residential and other noise sensitive receiver locations (eg, schools, hospitals, nursing homes, etc). The $L_{A10(15\ minute)}$ construction noise goal is based on the local L_{A90} background noise level during the relevant time period (day, evening or night).

For retail and commercial buildings, it is generally accepted that receivers are 5 dBA to 10 dBA less sensitive to noise emissions than residential receivers. For these receivers, an L_{A10} noise objective of L_{A90} background + 10 dBA has been conservatively applied.

Operation noise - general

DEC's '*Environmental Noise Control Manual'* provides noise criteria for rail traffic, specified as a 24-hour average ($L_{Aeq(24hour)}$) and maximum passby level (L_{Amax}), neither of which should be exceeded. The noise criteria are expressed in terms of 'planning levels' and 'maximum levels', evaluated one metre from the facade of affected residential properties:

» Planning levels

  – L_{Aeq}(24hour) - 55 dBA

  – L_{Amax} - 80 dBA

» Maximum levels

– $L_{Aeq(24hour)}$ - 60 dBA

– L_{Amax} - 85 dBA

For the noise and vibration assessment, a conservation approach was taken, and predicted future noise levels were compared with the planning levels for the new sections of railway, and the maximum levels for the proposed quadruplication of the existing railway between Epping and Beecroft.

Operation noise – stabling facility

The proposed stabling facility would be regarded as a fixed facility, and all operational noise emissions including train movements would need to be assessed in accordance with the DEC's *Industrial Noise Policy* (INP).

For the proposed stabling facility, the intrusive, amenity and sleep disturbance noise goals would apply. A summary of the operational night-time noise goals are provided in Table 9.14**.**

Table 9.14 Summary of operational noise goals for the stabling facility

Location	Period	Rating background level (dBA)	Operational noise goals (dBA)		
		LA90 Background	LAeq(15 min) Intrusive	LAeq(Period) Amenity	LA1(60 s) Sleep Disturbance
Residential receivers west of stabling facility	Daytime	40[1]	45	55	N/A
	Evening	39[1]	44	45	N/A
	Night-time	35[1]	40	40	50
Residential receivers east of stabling facility	Daytime	42	47	55	N/A
	Evening	39	44	45	N/A
	Night-time	35	40	40	50

Note 1: The RBL's at this location have been increased by 3 dBA on the basis that future background noise levels are likely increase due to the significant amount of development proposed in this area prior to opening of the proposed stabling facility in 2017.

Groundborne Noise

For the preliminary noise assessment, groundborne noise criteria were based on the approval conditions for the Epping to Chatswood Rail Line, namely 50% of train passby events within the excavated tunnel should not exceed a groundborne noise level of 30 dBA (fast meter response) in any residential building. 95% of train passby events should not exceed a groundborne noise level of 35 dBA.

Vibration

The standards normally used as a basis for assessing the risk of vibration damage to structures are German Standard DIN 4150 Part 3 1999 and British Standard BS 7385 Part 2 1993. For continuous vibration or repetitive vibration with potential to cause fatigue effects, DIN 4150

provides the following peak particle velocity values as safe limits, below which even superficial cosmetic damage is not to be expected:

» 10 mm/s for commercial buildings and buildings of similar design.

» 5 mm/s for dwellings and buildings of similar design.

» 2.5 mm/s for buildings of great intrinsic value (eg heritage listed buildings).

Human comfort is normally assessed with reference to British Standard BS 6472 1992 or Australian Standard AS 2670.2 1990. For daytime activities, the limiting objective for continuous vibration at residential or commercial receivers is V_{rms} 0.4 mm/s.

As a guide, safe working distances for typical items of vibration intensive plant are listed in Table 9.15**.** Safe working distances are quoted for both 'cosmetic' damage (refer DIN 4150) and human comfort (refer BS 6472).

Table 9.15 Recommended safe working distances for vibration intensive plant

Plant item	Rating/description	Safe working distance	
		Cosmetic damage (DIN 4150)	**Human response (BS 6472)**
Vibratory roller	< 50 kN (Typically 1-2 tonnes)	5 metres	15 metres to 20 metres
	< 100 kN (Typically 2-4 tonnes)	6 metres	20 metres
	< 200 kN (Typically 4-6 tonnes)	12 metres	40 metres
	< 300 kN (Typically 7-13 tonnes)	15 metres	100 metres
	> 300 kN (Typically 13-18 tonnes)	20 metres	100 metres
	> 300 kN (> 18 tonnes)	25 metres	100 metres
Vibratory pile driver	Sheet piles	2 metres to 20 metres	20 metres
Pile boring	≤ 800 mm	2 metres (nominal)	N/A
Jackhammer	Hand held	1 metres (nominal)	Avoid contact with structure

The safe working distances apply to typical buildings and typical geotechnical conditions. They do not address heritage structures. Vibration monitoring is recommended to confirm the safe working distances at specific sites.

9.3.4 Impact assessment – construction

Sound pressure levels for typical items of plant required during construction are listed in Table 9.16**.** These noise levels are representative of modern plant operating with noise control measures in good condition.

Table 9.16 Sound pressure levels for plant items

Item	Typical plant type	Noise level at 7 metres (dBA)	
		Typical maximum level (LAmax)	Noise level for modelling (LA10)
Heavy rockbreaker	On excavator KATO 750	103	98
Excavator KATO	KATO 750	86	83
Boring rig (diesel)	-	85	82
Bulldozer	Caterpillar D9	88	83
Skidsteer	-	85	82
Crane	60 tonne crawler or truck mounted	85	80
Backhoe/front end loader	Wheeled	86	82
Semi trailer	25-28 tonne	87	82
Dump truck	15 tonne	83	82
Product truck	12-15 tonne	83	82
Vibratory pile driver	-	96	90
Impact piling rig	-	109	105
Generator	Diesel	79	78
Concrete saw	-	95	92
Jackhammer	Hand held	88	84
Lighting tower	Lunar lighting tower	55	55
Flood lights	Daymaker	75	75
Concrete truck	-	88	85
Concrete pump	-	84	82
Concrete vibrator	-	80	78
Ballast regulator	-	96	93
Ballast tamper	-	96	93

Quadruplication

Construction activities would move progressively along the rail corridor and would include excavation works associated with embankment widening and cuttings; bridge construction over the M2 Motorway; construction of overhead wiring; and track construction. Potential impacts are considered below.

Excavation works

The typical $L_{A10(15minute)}$ noise levels from construction works associated with embankment widening and cuttings would be approximately 60 dBA to 70 dBA at the nearest residential

receiver locations. These levels are dependent upon the number and type of plant items operating at the same time in close proximity to individual receiver locations.

As the existing noise level (L_{A90} RBL) during the daytime period (see Table 9.12 and Table 9.13) in the vicinity of the project varies from 39 dBA to 46 dBA during the daytime period, the predicted $L_{A10(15minute)}$ construction noise levels represent a moderately high (albeit brief) exceedance of the noise goals.

There is the potential for noise exceedances of up to 30 dBA over the construction noise goal during intensive activities such as piling works. As a result, all feasible and reasonable noise mitigation and management strategies would need to be implemented. Exceedance of noise goals during construction can be common on major infrastructure projects, particularly where there is no opportunity to provide a large buffer zone.

Track possessions would be required as part of the project, and these usually involve night-time works. A track possession is a planned shutdown of a section of the rail network, generally taking place on a weekend between 2 am Saturday to 2 am Monday.

Night-time works may be required at other locations to reduce traffic impacts on existing roads.

Bridge construction over M2 Motorway

For the bridge construction works, the typical $L_{A10(15minute)}$ noise levels would be approximately 5 dBA quieter than the excavation works at the nearest residential receiver locations, but would occur over a longer period of time.

If vibratory piling or rockbreaking is required at the bridge abutments, $L_{A10(15minute)}$ noise levels would be approximately 70 dBA to 80 dBA at the nearest residential receiver locations. These works would generally be limited to daytime only, including weekend track possessions. However, it is anticipated that night-time works would be required on occasions in order to minimise traffic impacts on the M2. Where possible, bored piling would be used in lieu of vibratory piling to reduce noise emission to the surrounding community.

Overhead wiring and track construction

For the track construction works, the construction noise levels would be approximately 5 dBA higher than the excavation phase. However, the duration of these works would be much shorter. Construction works would need to be managed to minimise the noise levels and duration of exposure.

Tunnel construction

SKM (2003) concluded that the predicted upper limits of groundborne noise from tunnel boring machines would be below 40 dBA beyond a nominal 40 metres offset distance. The proposed tunnel depth would be less than 40 metres for approximately 70% to 80% of the proposed alignment. Construction over a 24 hour period would be required. Groundborne noise levels are predicted to exceed the anticipated night-time noise goal of 40 dBA when tunnel boring machines are operating in close proximity to nearby residential receiver locations. Depending on the tunnel depth and rate of progression, noise emissions would increase to a maximum over a period of typically one week and then subside. In the shallowest sections, where the tunnel depth is approximately 25 metres, groundborne noise levels could be up to 50 dBA. However, this would only occur over a period of approximately 2 to 3 days.

Residents would need to be kept informed about the progress of construction in the vicinity of their property, and the potential noise levels that could be expected.

Surface track construction (Burns Road to Rouse Hill)

In this section, the project follows essentially the same alignment as previously assessed by SKM (2003) and hence the previous assessment of construction noise in this area is valid.

Noise emissions from the proposed track works, including earthworks, overhead wiring, signalling and tracklaying would move progressively along the railway corridor in stages, such that most residential receivers would not be exposed to high levels of construction noise emissions for periods longer than approximately one month. Depending on the locations of access points, construction traffic may continue to pass individual receivers for a longer duration.

SKM (2003) concluded that given the nature of the works it is estimated that construction noise levels would vary as listed in Table 9.17. For this section of the rail line, SKM (2003) concluded that the construction noise emissions would be likely to comply with the design objectives, and therefore not result in any significant impacts.

Table 9.17 Predicted construction noise levels between Burns Road and Rouse Hill

Construction works	Predicted L_{A10} levels		Typical construction design objective
	Earthworks	Construction of viaduct	
Residences to the east of Old Windsor Road (south Kellyville)	30 to 36	30 to 36	43
Residences to the east of Old Windsor Road (north Kellyville)	30 to 36	30 to 36	46
Residences to the West of Windsor Road	47-51	47-51	51-53

The daytime construction noise objectives are based on the 'background +5 dBA' design goals, in recognition of the overall duration of the project, although some track construction activities would have only a short duration at any given location. SKM (2003) presents the long-term construction noise levels along the at-grade section of track, noting that short-term noise levels may be 10 dBA to 15 dBA higher than the long-term construction noise.

For short periods of time, moderate exceedances of the noise goals would be expected at the closest receivers. Construction works would need to be managed to minimise the noise levels and duration of exposure.

Construction worksites - tunnelling

Construction 24 hours a day is proposed at the Balmoral Road site (and the Hills Centre site under the staged delivery scenario). As a result, it is likely that substantial noise mitigation measures would be required in order to comply achieve compliance with the construction noise goals.

Residential receiver locations potentially impacted by construction works at the Balmoral Road site include the residential areas on the western side of Old Windsor Road, located approximately 100 metres from the site boundary, and 300 metres from the proposed tunnel portals. Residential receiver locations in Brighton Drive and Craigend Place (located approximately 100 metres to 150 metres from the tunnel portals) would also be potentially impacted by construction works. Future residential development within the Balmoral Road Release Area would also need to be considered as part of any further assessment.

The main noise sources are likely to comprise haul trucks, excavators, conveyor, dump truck movements and other diesel operated plant.

It is anticipated that noise could be minimised (by implementation of the measures recommended in section 9.3.7) to avoid excessive emissions during the night.

A detailed assessment of the proposed construction activities and mitigations measures would be undertaken at a later stage in the assessment process as part of further design work. This would include investigation of the potential need for a building to be erected around the portal to reduce noise from vehicles and spoil removal at night-time. Truck traffic noise assessments on nearby roads would also need to be addressed and impacts would be managed through controls on timing or entry and egress of vehicles, and the provision of adequate on-site holding points and stockpile areas to facilitate these control measures.

Stabling facility

The stabling facility would be approximately 80 metres from existing residences along Windsor Road. It is expected that the daytime construction criteria would be in the order of 47 dBA.

It is estimated that construction noise levels of 65 dBA could occur at the nearest existing residential receiver locations, and levels of 70 dBA during track installation. This represents an exceedance of the design goals. Appropriate mitigation and management measures would need to be considered, as construction planning is progressively refined.

It is understood that development of Area 20 would be largely complete by the time the proposed stabling facility begins operating. Construction noise levels are likely to be exceeded at the nearest residential receiver locations. Where feasible and reasonable, appropriate mitigation and management measures would need to be designed and implemented as construction planning is progressively refined.

It may be possible to minimise impacts on residential areas by providing buffer distances between the proposed stabling facility and residential development, or by locating less sensitive land uses (such as light industrial and/or commerical) closest to the facility.

Potential impacts on individual facilities

Council Chambers and Hills Centre

An internal construction noise objective of 30 dBA should apply when the Hills Centre is in use. When not in use, higher noise levels could apply. Given the offset distances, it is predicted that the Hills Centre would experience internal levels of up to 33 dBA during construction. For intensive construction works such as rockbreaking, vibratory or impact piling, concrete sawing etc, it may be necessary to schedule such works during periods when the facility is not in use.

The Council Chambers building can be classed as a 'board or conference rooms' in an office building, and an internal construction noise of objective of 45 dBA would normally apply. SKM (2003) predicted marginal impacts of up to 4 dBA above the groundborne construction noise objectives from the in-tunnel construction works. The revised tunnel alignment for the project brings it marginally closer to these buildings, potentially increasing the impacts by approximately 1 dBA to 2 dBA.

Hillsong Church

On the basis that the Church and the proposed TV/film/drama studio would be located approximately 100 metres and 200 metres respectively from the proposed alignment, it is considered unlikely that airborne or groundborne noise during construction would cause any significant impact on these facilities.

Noise from construction traffic on local roads

In general, construction traffic would use major roads such as Old Windsor Road, Windsor Road or the M2 Motorway where possible. However, construction vehicles may need to travel short distances on local roads to access some worksites. On local roads immediately adjacent to the project, the community may associate truck movements with construction. Once trucks move onto collector and arterial roads, traffic noise is likely to be perceived as part of the general road traffic.

At the Balmoral Road construction site the maximum number of truck movements during intensive spoil operations is estimated to be up to 134 per hour (during the day). Preliminary calculations show that truck noise levels in the busiest periods would result in traffic $L_{Aeq(1hour)}$ noise level increases of less than 2 dBA on major roads such as Old Windsor Road.

At other worksites, the typical number of truck movements is estimated to be up to nine per hour. During the busiest periods, this is expected to result in traffic $L_{Aeq(1hour)}$ noise level increases of less than 2 dBA, which would not have a major impact on the acoustic amenity of residential areas.

Potential traffic noise from individual worksites would need to be considered in more detail as the construction site plans are refined. Where feasible, access to the proposed construction sites should be via major roads.

Noise from idling trucks near construction sites can also impact on amenity. It is recommended that any queuing of trucks awaiting entry to a site outside normal construction hours should be restricted to locations away from residences, and if trucks are required to queue in such locations during construction hours, engines should be shut down.

Construction of railway stations

SKM (2003) assessed the potential noise impacts associated with construction of the stations. Although the proposed construction methodology has changed at some stations, it is anticipated that construction noise levels would be similar due to use of similar equipment, duration of construction and location. For the previous assessment, it was assumed that the stations fall into three types:

» Underground stations: Franklin Road, Castle Hill, and the Hills Centre Station constructed within bored/mined caverns or in cuttings and then filled over;

» Stations in cuttings: Norwest Business Park and Rouse Hill Town Centre Stations; and

» Above ground stations: Burns Road built above the ground.

The results of the SKM assessment (2003) for construction at stations is summarised in Table 9.18. A review of the construction noise emissions at these locations should be undertaken once a detailed construction plan has been prepared; particularly since the construction methodology has changed at some stations.

Table 9.18 Station construction impacts (based on SKM, 2003)

Station	Construction assumptions	Construction works	Typical construction design objective	Predicated L_{A10} levels	Comment
Franklin Road Station	The general area around the station is largely undeveloped with residential to the north and south.	General earthworks	54	60-68	Predicted noise levels during construction would exceed the typical construction design objective. Therefore, all feasible noise mitigation measures should be examined, particularly with regard to piling.
		Piling	54	Up to 76 (depending on method and location)	
Castle Hill Station	The station would be located within a commercial area, but close to some residents on Old Northern Road and the surrounding local roads.	Cavern construction	55	59-66	Some minor impacts may be expected whilst works are being undertaken.
		Rockbolting and shotcreteing	55	57-62	
Hills Centre Station	The station is located within a commercial/ recreational area, with residents located approximately 200m to the south.	Cavern construction	53	50-56	Impacts are expected to be relatively minor, although some exceedences of the criteria are predicted at residents having line-of-sight to the works.
		Rockbolting and shotcreteing	53	52-58	
Norwest Station	No predicted noise levels were provided for this station. The overall impacts were considered small and manageable.				
Burns Road Station	The existing residences are likely to be at least 150m from the station.	Earthworks	52	55	Although exceedances of the design objectives are predicted, these are low. Actual measures would depend on how advanced surrounding development is.
		Trackwork	52	55	
Rouse Hill Station	The future residences are likely to be 250m from the station.	Earthworks	52	48	No exceedances of the design objectives are predicted for local residents.
		Trackwork	52	50	

Construction vibration

The recommended safe working distances to avoid any cosmetic or structural damage are shown in column 3 of Table 9.15 should be observed. If it is necessary to work within these zones, vibration monitoring should be undertaken.

The potential impact would therefore be mainly in relation to human response. Measured data on recent projects has been used to obtain indicative vibration levels for medium size vibratory rollers (that is, 12 to 14 tonnes). Peak particle velocity values of 2 mm/s to 4 mm/s on the ground surface at 10 metres were typical. This would correspond to maximum floor vibration values of approximately 1 mm/s to 2 mm/s at a receiver at this distance.

This vibration would be clearly perceptible but would not be expected to cause damage to buildings.

It is recommended that any roller be selected to minimise vibration, as far as practicable and that monitoring be carried out on commencement of vibratory rolling to determine an acceptable duration consistent with BS 6472.

Ground vibration levels for vibratory sheet piling are typically less than 2 mm/s at 10 metres and are likely to comply with the human comfort criteria at distances exceeding 20 metres from piling work. Vibration levels vary considerably with ground conditions, and vibratory piles are sometimes used at closer distances without significant vibration impact.

If impact piling is required, the vibration impacts should be assessed on a case-by-case basis.

9.3.5 Impact assessment - operation

Operational noise modelling was undertaken by Heggies for the quadruplication section of the project. The section of proposed surface track west of Norwest Business Park to Rouse Hill was previously modelled by SKM (2003) and has been used in this assessment.

Input noise levels

Passenger rail services

The SoundPLAN input data used in the modelling were adapted to ensure that the calculated noise levels accurately reflect local conditions. The reference noise levels used for the noise modelling (Table 9.19) were based on measurements undertaken on recent projects. Intercity trains are not proposed to operate on the project.

Table 9.19 Reference noise levels used for electric passenger train modelling

Train types	Reference conditions	LAmax	LAE
Tangara / Millennium	15 metres, 80 km/h	87	89
Double Deck Suburban	15 metres, 80 km/h	89	92
Intercity	15 metres, 80 km/h	92	93

Freight rail services

For the section of track between Epping and Beecroft with an uphill grade, it has been assumed that freight locomotives in the Down (northerly) direction would use a high notch setting, resulting in a modelled L_{Amax} noise level of 94 dBA at 15 metres and L_{AE} level of 92 dBA (for two locomotives at 60 km/h).

For freight trains in the Up (southerly) direction, it has been assumed that freight trains would use the dynamic brake north of the M2 (L_{Amax} 93 dBA and L_{AE} 91 dBA) and a medium notch setting south of the M2 (L_{Amax} 88 dBA and L_{AE} 86 dBA).

A detailed list of the assumptions on which the modelling was based is provided in Appendix C.

Noise modelling results - quadruplication

The following noise modelling scenarios were evaluated for the proposed quadruplication:

» Scenario 1: Noise contour plots were developed for Year 2017 at calculation heights of 1.5 metres and 4.2 metres above ground level, representing 1st and 2nd floor receivers. Separate noise contour plots were provided for both the L_{Amax} and $L_{Aeq(24hour)}$ noise parameter, for freight and electric passenger trains separately.

» Scenarios 2 to 4: As per Scenario 1, except that notional noise barriers (2.0 metres, 3.0 metres and 4.0 metres) were included in the noise model at an offset distance of 4.3 metres from the outermost track centreline.

The results of the computer noise modelling with and without noise barriers (Scenarios 1 to 4) have been presented in the form of L_{Amax} and $L_{Aeq(24hour)}$ noise contour plots as detailed in Appendices D – O of Appendix C. Each of the plots shows the predicted noise level contours with varying height barriers, together with the 'no barrier' noise levels contours for direct comparison. The noise contours are calculated at fixed heights of 1.5 metres and 4.2 metres above ground which is indicative of the 1st floor and 2nd floor receivers respectively.

On the basis of the proposed increase in rail traffic in this section of the Northern Line as a result of the project, and given that freight and express passenger trains are expected to operate on the new outermost tracks (closer to the nearest residential receiver locations), it is anticipated that the future $L_{Aeq(24hour)}$ noise levels would increase by approximately 3 dBA to 4 dBA as a result of the project. Similarly, L_{Amax} noise levels would increase by approximately 1 dBA to 2 dBA as a result of the reduced offset distances.

Typical noise mitigation measures that could be applied as part of the project are discussed in section 9.3.7. Feasible and reasonable mitigation measures would be determined as part of the further design process.

Figure 9.1 provides a summary of the predicted L_{Amax} 85 dBA (maximum level noise goal) noise contours without mitigation for electric passenger and diesel freight trains. A discussion of the predicted future noise levels from both of these sources with and without potential noise barriers is provided below.

Electric passenger trains

In this section of existing track, the existing noise levels already exceed the DEC maximum noise goals and hence, without mitigation and with the addition of the quadruplication, the L_{Amax} and $L_{Aeq(24hour)}$ noise levels from electric passenger trains are predicted to exceed DEC's 'Maximum Levels' at the following locations:

» Chester Street, Epping to end of Cambridge Street Epping - Up Side (towards Sydney);

» The Crescent, between the M2 and Lyne Road Cheltenham - Down Side (away from Sydney);

» Economic impacts – addressed in section 9.12.

The management of other environmental issues that were not considered to be key issues, including air quality, water quality, waste management and contaminated land, are considered in Chapter 10.

» Sutherland Road, between the M2 and Day Road Cheltenham (receivers on upper levels) - Up Side;

» Between Chorley Avenue and Kethel Road, Cheltenham - Up Side; and

» The Crescent, between Cheltenham Girls High School and Kirkham Street, Cheltenham - Down Side.

The noise contour plots show that at most locations, noise barriers are potentially an effective noise mitigation option for reducing noise emissions from electric passenger trains, with two metres high barriers providing a typical noise reduction of 5 dBA at the lower floors. At some locations, however, two metres barriers or higher would not be an effective measure (eg at the upper floors of unit blocks in Cambridge Street, Epping), as residential receivers would still have a clear line-of-sight to the tracks.

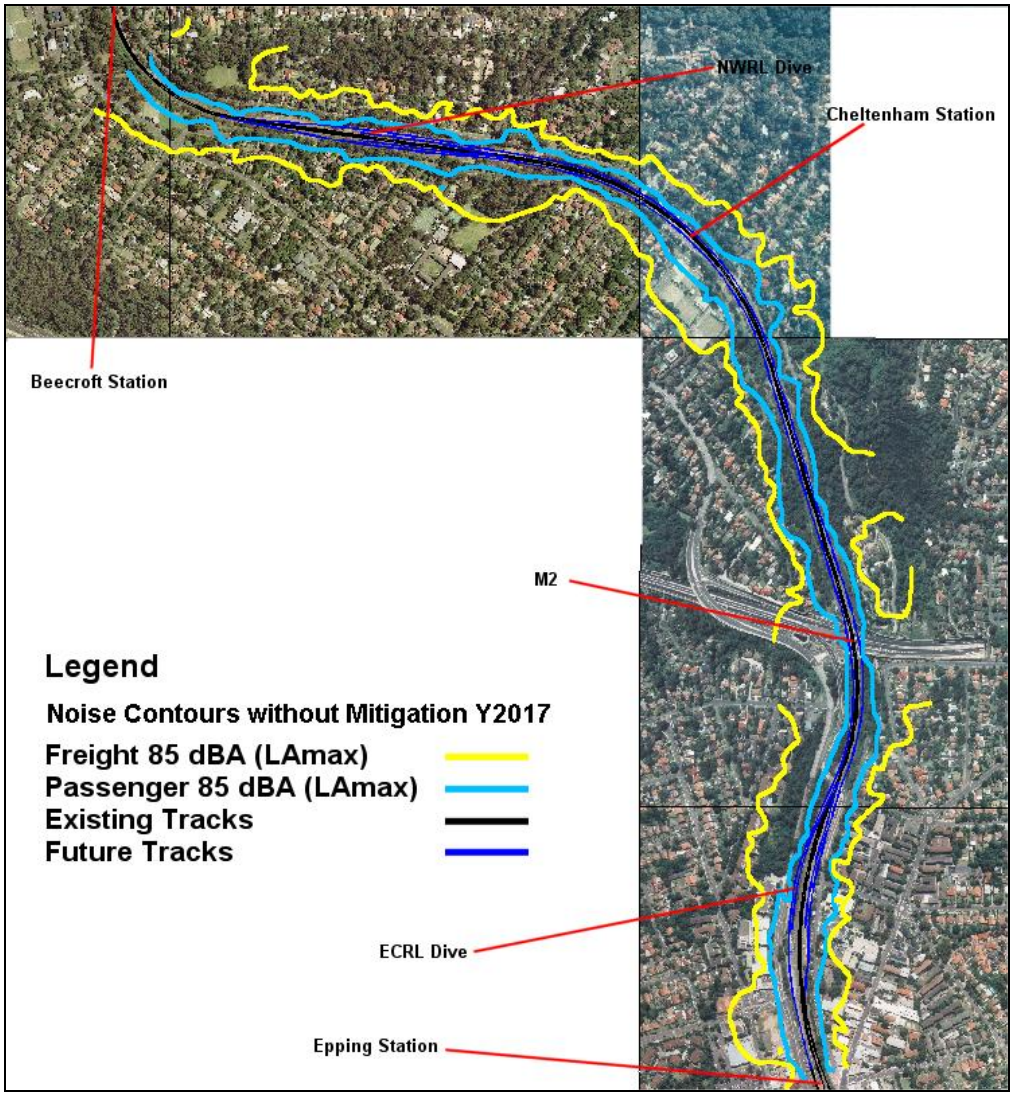

Figure 9.1 Predicted L_{Amax} 85 dBA noise contours for quadruplication (passenger and freight)

Diesel freight trains

Potential exceedances of DEC's 'Maximum Levels' are greater for diesel freight train operations. Additional locations predicted to exceed the DEC's 'Maximum Levels' without mitigation are:

» Edensor Street and Kandy Avenue, Epping - Down side;

» Sutherland Road, between the M2 and Day Road Cheltenham (receivers on upper and lower levels) - Up side;

» The Crescent, between Lyne Road and Cheltenham Girls High School, Cheltenham - Down side; and

» Sutherland Road, between Day Road, Cheltenham and Copeland Road East, Beecroft.

The noise contour plots show that at most locations, 2 metrs and 3 metre high noise barriers have almost no effect on the predicted L_{Amax} and $L_{Aeq(24hour)}$ noise levels from diesel freight trains, except for locations where the tracks are located within a cutting. This results from the source height of the diesel locomotive noise emissions (approximately 4 metres above rail) being higher than the barriers. At most ground floor locations, 4 metre barriers would be required to achieve a noise reduction of approximately 5 dBA. 4 metre high barriers, however, would not provide any significant benefit to residential receivers located on upper floors of unit blocks (eg Cambridge Street and Edensor Street).

Noise modelling results - between Norwest Business Park and Rouse Hill

Predicted noise levels between Norwest Business Park and Rouse Hill are provided in Appendix P of Appendix C (SKM, 2003). In this report, L_{Amax} noise contours were provided (as this was determined to be the dominant criterion) for the following scenarios:

» No noise controls;

» Erection of a 1.8 metre barrier;

» Erection of a 2.4 metre barrier;

» Erection of a 3.0 metre barrier; and

» Erection of a 3 metre barrier together with speed restriction on the viaduct.

The noise contours (see Appendix P of Appendix C) indicate that for some sections, where the proposed track is located within cutting, noise mitigation in the form of barriers is not required to achieve compliance with the noise goals at the nearest existing residential receiver locations. At other locations, where the track is at-grade, on embankment or on viaduct, noise mitigation in the form of barriers would be required to achieve compliance with the noise goals at existing and future residential receiver locations.

South of Burns Road (just north of Burns Road Station), the project would be located within a cut and cover tunnel and hence there would be no operational airborne noise impact as part of the project to the south of Burns Road. For a distance of approximately 500 metres north of Burns Road, the proposed alignment is located marginally closer to residential receiver locations on the western side of Old Windsor Road, compared with the alignment considered by SKM (2003).

Groundborne noise – tunnel sections

Groundborne noise (also known as regenerated noise) can occur in the vicinity of railway tunnels where receivers are located in buildings above or in close proximity to the railway tunnels. Groundborne noise results from the transmission of groundborne vibration rather than the direct transmission of noise through the air. The vibration is generated by wheel/rail interaction and is transmitted from the trackbed, via the ground and into the building structure.

The vibration entering the building then causes the walls and floors to vibrate faintly and to radiate noise.

An assessment of the groundborne noise associated with the tunnels was undertaken by SKM (2003). For the purposes of assessment, two modifications have been investigated as part of the project which affect these previous predictions:

» Tunnel construction - The noise and vibration assessment undertaken by SKM (2003) was based on a tunnel design which included ballasted track. The project design is based on a slab track design.

» Proposed alignment - The proposed horizontal alignment of the tunnels has been modified between Beecroft and West Pennant Hills, where the proposed alignment has been shifted towards the south, and the other change in alignment is to the west of the proposed Hills Centre Station.

For slab track (in which the rail is fixed to a concrete base, rather than to sleepers sitting on ballast), different types of track treatments from ballasted track would be required in order to mitigate noise and vibration emissions. These include:

» Standard slab track - Rail directly fixed onto a concrete slab using steel plates and standard rail pads and clips.

» Resilient track fixings - Rail sits on composite steel and rubber acoustic rail fixings, which are bolted to the concrete slab.

» Floating slab track - Rails are fixed to separate concrete slabs which sit or 'float' on top of rubber bearings which sit on the concrete slab. The rails can either be fixed to the floating slab using standard rail pads or if a higher degree of attenuation is required, resilient track fixings can be provided.

On the basis of the preliminary information available, it is anticipated that the track within the tunnels could be designed to comply with the project's design goals for groundborne noise and vibration.

A more detailed assessment of the potential groundborne noise and vibration from the tunnel section would be undertaken at a later stage. This would include a more detailed assessment of the proposed vertical and horizontal alignments, calculations of groundborne noise levels at nearby buildings and an assessment of mitigation measures that would need to be incorporated into the detailed track design.

Stabling facility

Potential noise emissions

Stabled trains often stand for long periods with their electrical systems operating, including alternators, inverters, air compressors and possibly also air-conditioning systems. Some of these systems may need to be left on for the use of train cleaning staff.

There may also be transient sources of noise, including compressed air discharges and train horn operation (either for warning during movements within the yard or for the purposes of testing prior to trains entering service each day).

The L_{Aeq} sound power levels in Table 9.20 are representative of the equivalent steady noise level when trains are stabled powered up. The L_{A1} sound power levels are representative of the compressed air discharges and horn operation.

Table 9.20 Sound power levels for stabling noise

Train type	Noise source	Sound power level	Location of noise source
Tangara	Full compressed air cycle [1]	90 dBA – LAeq 107 dBA - LA1(60 second)	Under floor
Tangara	Inverter noise	83 dBA – LAeq	Top of train
Tangara	Air conditioner	80 dBA - LAeq 50% duty <62 dBA - LAeq Ventilation only	Top of train
Tangara	Brake test	120 dBA - LA1(60second)	End of train, under floor
Double Deck Suburban	Full compressed air cycle [1]	93 dBA – LAeq 107 dBA - LA1(60 second)	Under floor
Double Deck Suburban	Brake test	120 dBA - LA1(60second)	End of train, under floor
Tangara and Double Deck Suburban	Horn	115 to 145 dBA - LA1(60second)	End of train, under floor

Note 1 The term 'compressed air cycle' refers to the air compressor plus the cyclic air discharge noise associated with the air dryers, valves, etc.

Brake testing and horn testing are currently undertaken at both ends of trains prior to trains entering service. This would typically occur in the early hours of the morning as trains start up and prior to the afternoon peak.

Noise modelling scenarios

In order to assess the operational noise emissions from the proposed stabling facility, representative 'worst case' noise modelling scenarios have been considered, incorporating the existing ground terrain and proposed stabling operations. The noise model includes eight trains located at the stabling facility, 75% of which are assumed to be Tangara or Millennium sets.

Four operating conditions have been assessed. These include:

» The simultaneous day-time operation of the air-conditioning system, ventilation and compressor – termed 'air conditioning system' in the contour plots;

» The simultaneous night-time operation of the ventilation and compressor – termed 'ventilation system' in the contour plots;

» The night-time operation of the brake – termed 'brake test' in the contour plots; and

» The night-time operation of the horn – termed 'horn test' in the contour plots.

Noise contour plots for receiver heights 1.5 metres above ground (representing ground floor receiver locations) are presented in Table 13 and Table 15 of Appendix C.

For the daytime and night-time stabling operations, the $L_{Aeq(15minute)}$ predictions represent the typical maximum noise levels averaged over a 15-minute period. Since the intrusive noise goals are more stringent than the amenity noise goals, compliance with the $L_{Aeq(15minute)}$ intrusive noise goals would also result in compliance with the amenity noise goals.

For the brake and horn tests, the predicted $L_{A1(60second)}$ noise levels represent the typical maximum noise levels that occur during the tests. These tests are usually undertaken prior to the train entering service.

Predicted noise levels

A representative noise plot is provided in Figure 9.2 for the night-time scenario ('ventilation system') with 3 metres high noise barriers.

Figure 9.2 Night-time $L_{Aeq(15minute)}$ noise levels with 3 metres high barriers

$L_{Aeq(15minute)}$ noise levels

For the proposed daytime and night-time stabling operations, the highest noise levels at existing residential receiver locations would occur at locations to the east of the stabling facility adjacent to Windsor Road.

Without noise mitigation measures, existing residences to the east of the proposed stabling facility are predicted to receive noise levels up to 45 dBA during the daytime period and up to 40 dBA during the night-time period. These levels are equal to the daytime and night-time noise goals. Windsor Road is an arterial road, and therefore traffic noise criteria during the daytime and night-time periods would be $L_{Aeq(15hour)}$ 60 dBA and $L_{Aeq(9hour)}$ 55 dBA respectively. The $L_{Aeq(15minute)}$ noise emissions from the night-time operations at the stabling facility would therefore be approximately 10 dBA to 15 dBA lower than the existing road traffic noise levels at the nearest residential receiver locations on the eastern side of Windsor Road.

On the western side of the stabling facility, the criteria would be exceeded approximately 100 metres from the facility boundary (without mitigation) at ground floor residential receiver locations. With a 3 metres noise barrier at the top of the cutting on the western side of the stabling facility, this distance would be reduced to approximately 50 metres for the night-time stabling scenario. Providing a higher noise barrier could reduce this exceedance area further.

Night-time $L_{A1(60second)}$ noise levels - brake testing

Brake testing is currently undertaken as part of the testing procedure before trains are put into service. The predicted $L_{A1(60second)}$ noise levels indicate that the typical maximum noise levels from brake testing (without mitigation) exceed the DEC's rating background level (RBL) + 15 dBA screening criterion for sleep disturbance at the nearest existing residential receiver locations on the eastern side of the stabling facility. The typical maximum noise levels are approximately 20 dBA higher than the screening criterion.

The noise levels from brake testing (occurring once at each end of the train before entering service) would be approximately 5 dBA to 10 dBA lower than the typical L_{Amax} noise levels from road traffic on Windsor Road during night-time periods. On this basis, noise from brake testing is not considered to be a significant source of noise emission for residential receivers adjacent to Windsor Road.

On the western side of the stabling facility south of Rouse Road, the criteria would be exceeded approximately 200 metres from the facility boundary (without mitigation). This would be reduced to approximately 100 metres with the provision of a 3 metres noise barrier. North of Rouse Road, the area where the criteria would be exceeded would be larger due to the reduction in depth of the cutting in which the trains are proposed to be stabled.

$L_{A1(60second)}$ noise levels - horn noise

The predicted $L_{A1(60second)}$ noise levels from a full horn blast are up to 85 dBA at the nearest residential receiver locations to the east of the stabling facility. Whilst this represents a 35 dBA exceedance of the DEC's sleep disturbance screening criterion (without mitigation), the typical L_{Amax} noise level from road traffic would be approximately 75 dBA to 80 dBA at the nearest residential locations. On this basis, the noise levels of the train horns (without mitigation) would be approximately 5 dBA to 10 dBA higher than the existing traffic noise on Windsor Road.

With a three metres noise barrier located at the top of the cutting on the northern and eastern site boundaries, the $L_{A1(60second)}$ noise levels from horns could be reduced at the above locations by approximately 5 dBA and would be equivalent to the typical maximum noise levels from road traffic on Windsor Road.

On the western side of the stabling facility further from Windsor Road, the noise from train horns would be more noticeable. The criteria would be exceeded for greater than 200 metres, even with six metres high noise barriers.

RailCorp is investigating the feasibility of a low level horn test mode for trains. If this proves to be feasible, the predicted noise levels could be up to 30 dBA quieter than predicted for a full horn blast and hence compliance with the noise goals may be possible at future residential receiver locations on all sides of the stabling facility. The stabling facility is proposed within the future Area 20 precinct of the North West Growth Centre. There is an opportunity in the precinct planning for this area to consider the stabling facility. Less sensitive land uses such as light industrial and/or commercial should be considered around the facility.

Other noise sources

Train arrivals and departures within the stabling facility would include intermittent noise similar to that included above for brake tests.

Train cleaning would not contribute significantly to noise emissions from the site.

Emergency train maintenance is unlikely to be sufficiently frequent or definable for inclusion in this assessment.

Operation vibration

Quadruplication section

In this section of track, the highest electric passenger train speed is assumed to be 100 km/h and the highest freight train speed is assumed to be 80 km/h.

For passenger trains, the 103 dB night-time vibration contour (for perception) lies approximately 35 metres from the nearest track centreline. The 106 dB daytime vibration contour (for perception) lies approximately 25 metres from the nearest track centreline. The 110 dB criterion vibration contour lies approximately 15 metres from the nearest track centreline. These levels are based on the 95th percentile (or highest 1 in 20 trains). The vibration levels from the average train would be approximately 8 dB lower.

For freight trains, the source vibration levels are higher, but the operating speeds are lower. As such, the predicted vibration levels from freight trains are expected to lie within the 95th percentile vibration level range for electric passenger trains.

As the nearest residential receiver locations are approximately 30 metres from the nearest track, it is concluded that vibration from passenger and freight trains would comply with the 110 dB criterion by significant margins. During the night-time period, vibration from freight trains and the occasional high-speed passenger train may be perceptible at some locations.

Vibration adjacent to the proposed surface section

For the surface section between Burns Road Station and Rouse Hill Station, the maximum track speed is assumed to be 115 km/h. Adjacent to this section of track, existing and proposed residential developments are located on both sides of the railway corridor.

For passenger trains, the 103 dB night-time vibration contour (for perception) lies approximately 38 metres from the nearest track centreline. The 106 dB daytime vibration contour (for perception) lies approximately 27 metres from the nearest track centreline. The 110 dB criterion vibration contour lies approximately 15 metres from the nearest track centreline. As noted above, these levels are based on the 95th percentile (or highest 1 in 20 trains). The vibration levels from the average train would be approximately 8 dB lower.

On the Down (western) side of the railway corridor, Windsor Road is located between the railway corridor and the nearest residential receiver locations. These locations are unlikely to be affected by railway vibration.

On the Up (eastern) side of the railway corridor, vibration from train passbys could be perceptible at residential buildings within approximately 40 metres from the nearest track, however, compliance with the vibration criterion for human comfort would be achieved at all locations, provided that a buffer distance of approximately 15 metres or greater is maintained.

9.3.6 Summary of results

Preliminary noise modelling has been undertaken. As a result, the design goals presented should be regarded as indicative only, and would be subject to refinement as the development of the project progresses.

For the proposed quadruplication, the assessment indicated that without mitigation measures such as noise barriers or bund walls, there is the potential for existing noise criteria to be exceeded. For electric passenger trains, most of these exceedances could be minimised through the use of noise barriers. However, compliance would be more difficult to achieve with noise barriers for diesel locomotives (freight trains) due to the increased source height of the noise emissions.

For the new sections of proposed surface track, compliance with noise criteria could be achieved at most locations via construction of noise barriers/mounds or incorporating noise mitigation measures as part of the viaduct design. In new release areas, it may be possible to minimise impacts on residential areas by providing buffer distances between the railway corridor and residential development, or locating less sensitive land uses closest to the railway corridor.

The need for mitigation measures for operations, such as source controls, the location and height of noise barriers or bund walls, and building treatments, would be further assessed and determined as part of the further design process.

For the tunnel section, it is anticipated that compliance with the groundborne noise design goals would be achieved through use of feasible and reasonable mitigation measures such as track bed treatment where appropriate.

The preliminary operational vibration modelling results indicate that none of the existing dwellings lie inside the 110 dB human comfort criterion contour.

For the proposed interim stabling facility, without noise mitigation, the continuous noise emissions would comply with the design goals at existing residential receiver locations on the eastern side of Windsor Road. Without noise mitigation, the noise levels from horn testing during night-time periods would exceed the sleep disturbance screening criterion. Further consultation with the Growth Centre Commission and local councils is required to consider appropriate low sensitivity land uses around the stabling. Further investigation into developing and implementing a low horn test mode is currently being undertaken by RailCorp to reduce this noise source as part of the proposed interim stabling facility.

At the majority of construction sites, exceedances of the noise goals when plant and equipment are located in close proximity to residential receiver locations have been identified. For new track sections, construction works would be limited to daytime hours only (unless essential for traffic management or safety reasons) in order to reduce any potential impacts as much as possible.

Twenty-four hours per day construction is proposed as part of the tunnelling activities including at the proposed tunnelling construction sites located at Hills Centre Station and within the Balmoral Road Release Area. It is considered likely that noise mitigation measures would be required.

9.3.7 Recommended mitigation measures

Further investigations

» Operational noise impacts (including groundbourne noise) and potential mitigation measures would be assessed in more detail as part of the further design process.

» Operational vibration impacts would be reassessed at a later stage of the design process if proposed buildings are located within the vibration buffer zones described in this report.

» A detailed assessment of the proposed construction activities would be undertaken as part of design development. This would include investigation of the potential need for a building to be erected around the portal so that vehicles and spoil removal can proceed at night-time. Truck traffic noise assessments on nearby roads would also be addressed and impacts would be managed through controls on timing or entry and egress of vehicles - and the provision of adequate on-site holding points and stockpile areas to facilitate these control measures.

» Detailed land use assessment studies would need to be undertaken around the Balmoral Road Release Area and the North West Growth Centre, where additional development is proposed.

» It is not anticipated that impact pile driving would be required for construction. In the event that it is found to be necessary, further assessment would be required.

Recommended mitigation measures

Construction noise

A site-specific construction noise and vibration management plan would be developed and implemented.

Specific additional measures likely to be required at construction work sites proposed to operate 24 hours per day, including:

» The site offices and amenity buildings should be located in positions that would shield noise emissions to nearby receiver locations.

» At the southern end of the Balmoral Road construction compound, near Brighton Drive and Craigend Place, it is anticipated that an earth mound (made from tunnel spoil), approximately 5 metres or more high may be required to shield noise emissions to the south and south east of the construction compound.

» Where possible, the site layout should be designed to maximise the offset distance between the noisiest plant items and nearby residential receiver locations.

» Where possible, noise from bulldozers should be shielded by noise barriers or other structures and grades minimised to prevent excessive revving of engines.

» All plant on site would need to be fitted with non-tonal reversing alarms, sized appropriately to avoid excessive noise.

» The design of any tunnel spoil conveyor should incorporate noise control measures on the drive components.

» The tunnel ventilation system and dust collection systems would require silencers and possibly an enclosure or building to reduce noise emissions, particularly at night-time.

Construction vibration

» Buffer zones would be established and work within these zones limited to activities that have been assessed as safe or to activities undertaken in conjunction with strict vibration monitoring.

» The smallest suitable size of vibratory roller would be selected when working close to occupied and heritage buildings to minimise vibration impact.

Operational noise mitigation

» Undertake to work with the relevant authorities regarding land use decisions and to set acoustic standards in the consent conditions for new residential buildings.

» Provide acoustic mitigation measures (noise barriers/mounds) to meet, where reasonable and feasible, the design goals (in situations where the above land use planning and consent condition measures do not provide adequate protection).

» Low level parapets be used (where feasible and reasonable) on bridges and viaducts to minimise noise.

» Station PA systems (if required) to be designed to avoid excessive noise.

Stabling facility

» Physical noise mitigation measures (noise barriers) are recommended in conjunction with land use planning (where possible) to reduce the potential noise impacts upon future residential communities on the western and northern sides of the proposed stabling facility. Consideration may need to be given to fully or partially enclosing the facility in order to reduce the potential noise impacts in the adjacent community.

» Investigate (in consultation with Railcorp) the feasibility of developing and implementing a low volume horn test mode as part of the proposed stabling facility.

Operational vibration

» No mitigation measures are required at this stage.

Recommended environmental management measures

The contractor(s) would prepare and implement a site-specific construction noise and vibration management plan including the measures listed below:

» Noise intensive construction works would be carried out during normal construction hours. Where works involving the operating line need to be carried out during weekend possessions, noise intensive activities should be scheduled to occur during the daytime, where possible.

» Quietest available plant suitable for the relevant tasks would be used.

» The duration of noise intensive activities would be minimised insofar as possible.

» Where feasible and reasonable, site hoardings or temporary noise barriers would be used to provide acoustic shielding of noise intensive activities. In order to be effective, these must at least break the line of sight between the receiver and the source of noise emission.

» Rock breakers would be of the 'Vibro-silenced' or 'City' type, where feasible and reasonable.

» Activities resulting in highly impulsive or tonal noise emission (eg rock breaking and vibratory or impact pile driving) would be limited to 8 am to 12 pm Monday to Saturday and 2 pm to 5 pm Monday to Friday (except where essential during track possessions).

» Noise awareness training would be included in inductions for site staff and contractors.

» Noise generating plant would be orientated away from sensitive receivers, where possible.

» Notification would be provided to residents via newspaper advertising and letterbox drops, advising of the nature and timing of works, contact number and complaint procedures.

» Noise monitoring would be carried out to confirm that noise levels do not significantly exceed the predictions and that noise levels of individual plant items do not significantly exceed the levels shown in Table 9.16.

» Deliveries would be carried out within standard construction hours, except as directed by the Police or RTA.

» Non-tonal reversing beepers or equivalent must be fitted and used on all construction vehicles and mobile plant regularly used on site and other vehicles where possible.

» Trucking routes to be via major roads, where possible.

» Trucks would not be permitted to queue near residential dwellings with engines running.

9.4 Ecological impacts

This section summarises the results of the ecological assessment undertaken by GHD. The full report is located in Appendix D.

9.4.1 Assessment methodology

The assessment methodology consisted of a review of literature and database records of environmental features along the proposed alignment and within a 10 kilometre radius, and field surveys of the proposed alignment.

Field surveys were undertaken to supplement existing information over the period 17 to 20 July 2006 using a methodology designed to meet the requirements of the DEC's Draft Threatened Biodiversity Survey and Assessment Guidelines (DEC, 2004). This included:

» Mapping of vegetation communities within the study area. Previous vegetation mapping (SKM, 2003) was relied upon. Ground-verification of this mapping, as well as broad scale mapping of vegetation communities in previously unassessed areas was undertaken, focussing on areas with potential to be Endangered Ecological Communities listed under the *Threatened Species Conservation Act 1995* (TSC Act) and/or the Commonwealth EPBC Act.

» A general fauna habitat assessment to identify areas of potential habitat within the study area. Specific resources were noted such as shelter, basking, roosting, nesting and foraging sites for amphibians, birds, bats, arboreal mammals, ground-dwelling mammals and reptiles.

» Targeted surveys for the Cumberland Land Snail in the area north of Norwest Business Park within habitat deemed suitable for this species. Empty snail shells were collected and sent to the Australian Museum for verification.

» Incidental records of bird, amphibian and mammal species.

» An assessment under State Environmental Planning Policy 44 – Koala Habitat Protection (SEPP 44) to determine the presence of habitat to support a Koala population using a three-stage technique in accordance with Hornsby Shire Council Flora and Fauna Assessment Guidelines for Development Applications.

» An assessment of the likely impacts of this project on species, populations and ecological communities listed on Schedules 1, 1A and 2 of the NSW TSC Act in accordance with the DEC's Draft Guidelines for Threatened Species Assessment (DEC, 2005).

Surveys were undertaken outside the optimal survey period for some species, therefore it is likely that some species may use the study area but were not detected during the survey period. Consequently, this survey aimed to provide an overall assessment of the ecological values of the site and study area with particular emphasis on threatened species to allow an assessment of the likely impacts of the project.

9.4.2 Impact assessment

Results of the literature review indicated that a number of threatened flora and fauna have been recorded within the locality or have the potential to occur within the locality. Not all species identified in the literature review are likely to occur within the study area. Field surveys and

subsequent assessments determined which of these species are likely to be present and the potential impacts of the development.

Key threatening processes

The following key threatening processes are considered relevant to the project:

» Clearing of native vegetation (TSC Act) and land clearance (EPBC Act);

» Removal of dead wood and trees (TSC Act);

» Invasion of native plant communities by exotic perennial grasses (TSC Act);

» Infection of native plants by *Phytopthora cinnamomi* (TSC Act & EPBC Act);

» Predation by the European Red Fox (TSC Act & EPBC Act); and

» Competition and grazing by the feral European Rabbit (TSC Act and EPBC Act).

Clearing of vegetation along with the removal of dead wood and trees would result in removal of habitat for ground-dwelling and arboreal mammals as well as some bird species and reptiles.

Exotic grasses now dominate much of the previously cleared land within the study area. It is likely that, without correct precautions, additional clearance would result in the continued spread of these weeds.

The apparent death of trees around the Cattai Creek area near the proposed Hills Centre Station may be due to infection by the root-rot fungus *Phytopthora cinnamomi*, however other factors may be causing these deaths and the presence of this pathogen can only be determined by laboratory testings. This project may facilitate the spread of this pathogen if work (for the potential cut and cover of this site) is to be carried out in the area.

The threat of predation on native fauna from non-native species such as the European Red Fox (*Vulpes vulpes*) currently exists within the study area. The vegetation clearance required for the rail corridor is unlikely to increase this risk substantially as much of the environment is currently highly disturbed and very open, processes that facilitate predation by the Red Fox.

The European Wild Rabbit is currently at very high numbers within the study area and the threat of competition and grazing by this species already exists. These populations are degrading the current habitat and potentially competing with native fauna in the area. The current project would result in additional land clearance at the shrub and ground level. This would increase suitable habitat for this pest species and potentially facilitate its continued range expansion into surrounding native vegetation.

Table 9.21 lists terrestrial fauna and flora species that have been recorded in the locality, or are likely to occur within the locality, together with their conservation status and likelihood of occurring at the site (DEC and DEH) and potential impacts from the proposed development. An estimate of the potential clearance of vegetation communities as part of the project is provided in Table 9.22.

Table 9.21 Threatened fauna and flora recorded within the locality or that have potential to occur within the locality (DEC 2006; DEH 2006) and potential impacts of the proposed development

Common name	Species name	TSC Act status	EPBC Act status	Potential to occur within study area	Potential impact
Amphibians					
Giant Burrowing Frog	*Heleioporus australiacus*	V	V	May occur in suitable woodland and forest habitat. However soil type may not be suitable, as this species prefers loose sandy soils.	Potential habitat of the Giant Burrowing Frog and the Giant Barred Frog would not be directly impacted by the project. Indirect impacts such as runoff from construction may affect these species. Habitat exists for the Green and Golden Bell Frog within the study area, notably south of Balmoral Road within a large dam area and its adjoining drainage line, but this site does not fall directly in the indicative 50 metre impact corridor. The Giant Burrowing Frog and Green and Golden Bell Frog are not at the limits of their distribution. As the proposed alignment does not impact directly on the areas of potential habitat it is considered unlikely that the project would disrupt the lifecycle of or have an impact on these species or their habitat.
Giant Barred Frog	*Mixophyes iteratus*	E	E	This species has not been recorded in the locality. May occur within suitable forest habitat. This species requires deep moist leaf litter and rocky streams for breeding.	
Green and Golden Bell Frog	*Litoria aurea*	E	V	May occur within suitable stream or dam habitat present along the route. This species often occurs within highly disturbed habitats.	
Avifauna					
Barking Owl	*Ninox connivens*	V		May occur. Suitable woodland and forest habitat exists. Hollows are required by this species for roosting and nesting.	The areas of woodland and forest likely to be impacted by this project are currently either highly modified remnants or very disturbed vegetated areas with substantial levels of weed invasion. A proportion of the canopy trees present in the area are winter flowering species (e.g. Forest Red Gum, Narrow-leaved Ironbark and Spotted Gum) which would provide an important foraging source for many bird species in this area, especially considering the small amount of remnant vegetation in the area. However, considering this isolation, the small areas of remnant vegetation and the disturbed nature of such stands along the proposed
Black-chinned Honeyeater (eastern subspecies)	*Melithreptus gularis gularis*	V		May occur. Suitable eucalypt woodland and forest foraging habitat may be present.	
Brown Treecreeper	*Climacteris picumnus*	V		May occur. Suitable eucalypt woodland and forest habitat may be present.	
Diamond Firetail	*Stagonopleura guttata*	V		May occur. Suitable grassy eucalypt woodland habitat may be present.	

Common name	Species name	TSC Act status	EPBC Act status	Potential to occur within study area	Potential impact
Gang Gang Cockatoo Population, Hornsby & Ku-ring-gai LGA	*Callocephalon fimbriatum*	EP		This population may extend into the study area. Potential habitat for this population exists within the woodland areas along the proposed rail alignment.	alignment, these areas may provide limited foraging, however they are unlikely to support substantial populations as habitat requirements would be limited. Habitat requirements beyond foraging may not be supported in the remnant communities present in this area. While the project would require the removal of canopy trees within the above ground sections of the corridor, it is highly recommended that all other canopy trees be retained as a food source and remnants of the endangered ecological communities present in the area. It is considered unlikely that the proposed vegetation removal would have a substantial impact on the lifecycle of any threatened woodland birds or their habitat or place any local populations at risk of extinction. Furthermore, although a number of threatened woodland birds and owls are known to occur within or in close proximity to the study area, none are at the limits of their distribution.
Gang-gang Cockatoo	*Callocephalon fimbriatum*	V		Potential habitat for this species exists within the woodland areas along the proposed rail alignment.	
Hooded Robin	*Melanodryas cucullata*	V		May occur. Suitable woodland and forest habitat exists. Although the absence of a substantial groundcover and shrub layer may be limiting.	
Masked Owl	*Tyto novaehollandiae*	V		May occur. Suitable woodland and forest foraging habitat exists. This species mostly breeds in moist eucalypt gullies in hollows or caves.	
Pink Robin	*Petroica rodinogaster*	V	M	Suitable forested habitat occurs within the route although this species occurs mostly in densely vegetated gullies.	
Powerful Owl	*Ninox strenua*	V		May occur. Suitable woodland and forest habitat exists. Hollows are required by this species for roosting and nesting as well as habitat components for prey species. This species can occur in fragmented landscapes.	
Regent Honeyeater	*Xanthomyza phrygia*	E	E	May occur. Suitable eucalypt woodland and forest habitat may be present.	
Speckled Warbler	*Pyrrholaemus sagittatus*	V		May occur. Suitable eucalypt communities with grassy understorey are present along the proposed alignment. Although large undisturbed remnants are required.	
Superb Parrot	*Polytelis swainsonii*	V	V	Habitat for this species may occur within the woodland areas along the route. This species requires hollows for nesting.	
Swift Parrot	*Lathamus discolor*	E	E	This species inhabits areas with abundent winter flowering eucalpyts or lerp infestations. Habitat may exist along the proposed alignment.	

Common name	Species name	TSC Act status	EPBC Act status	Potential to occur within study area	Potential impact
Microchiropteran Bats					
Eastern Bentwing-bat	*Miniopterus schreibersii oceanis*	V		Foraging habitat for this species may occur in forested areas. This species roosts primarily wihtin caves but also in storm-water tunnels, buildings and other man-made structures.	A number of threatened microbats have the potential to forage and roost within the study area. Potential roosting habitat in the form of hollows and under decorticating bark would be impacted by the project. Suitable foraging habitat exists in a number of locations within the study area, notably along the watercourses and over open water bodies. These areas would not be directly impacted by the project. The lights from the established railway may affect bat foraging as the abundance of insects likely to be attracted to the lights may encourage bats to forage over the new rail corridor. Roosting sites may be a limiting factor within the study area due to low presence of stags and hollows and therefore the area is unlikely to support large populations of these species, however the importance of suitable habitats existing in the area therefore increases as necessary habitat for individuals that are present in the area. The project would not prevent migration or dispersal of any threatened microchiropteran bats and extensive areas of potential foraging and roosting habitat for these species occurs adjacent to the study area and throughout the locality. Therefore it is considered unlikely that the project would have a substantial impact on the lifecycle or habitat of any threatened bats. Furthermore, none are at the limits of their distribution.
Eastern Freetail-bat	*Mormopterus norfolkensis*	V		Foraging and roosting habitat may be present as this species occurs in woodland areas and roosts in tree hollows, under bark or in man-made structures.	
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V		Foraging habitat for this species may be present in woodland areas although it mostly flies along creek and river corridors. Roost sites include tree hollows and roofs of buildings.	
Large-footed Myotis	*Myotis adversus*	V		This species forages over streams and pools and roosts in a variety of locations including tree hollows, storm water channels, under bridges and in dense foliage. Sutaible habitat for this species may occur in the study area.	
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V		Foraging habitat for this species be present as it forages widely. Roost sites include tree hollows, mammal burrows and buildings.	
Megachiropteran Bats					
Grey-headed Flying Fox	*Hibbertia superans*			The Grey-headed Flying-fox may forage over the study area and may roost within the locality. However, no camps were recorded within the study area.	This species is known to forage widely, however habitat is patchy and restricted in the area therefore removal of canopy trees should be avoided where possible so as to maintain any suitable foraging habitat. This species is not at the limit of its distribution.

Common name	Species name	TSC Act status	EPBC Act status	Potential to occur within study area	Potential impact
Other Mammals					
Eastern Pygmy-possum	*Cercartetus nanus*	V		This species occurs in a range of habitats including woodland which occurs in the study area. This species feeds largely on nectar from flowering plants such as banksias, bottlebrushes and eucalypts as well as insects. Potential marginal habitat for this species may occur.	It is considered unlikely that the project would have a substantial impact on the lifecycle or habitat of the Eastern Pygmy-possum and this species is not at the limits of its distribution.
Invertebrates					
Cumberland Land Snail	*Meridolum corneovirens*	E		This species occupies Cumberland Plain Woodland which is present within the study area. This species was located at the northern end of the proposed alignment.	The Cumberland Land Snail is restricted to the endangered Cumberland Plain Woodland and therefore any clearance within suitable stands of this community may impact on this species.
Flora					
Bynoe's Wattle	*Acacia bynoeana*	E	V	This species occurs mainly in heath and dry sclerophyll forest, seeming to prefer open, sometimes slightly disturbed sites such as trail margins, road edges and in recently burnt open patches. Suitable habitat may therefore exist for this species.	There is the potential for direct impacts on potential habitat for some threatened flora species due to vegetation clearance such as displacement or disturbance, as well as indirect impacts including runoff, sedimentation, edge effects (opening up remnants to weed invasion), disruption to the pollination cycle (if clearing is undertaken during flowering periods), disturbance to dormancy periods and seed banks. The remnant vegetation communities that would normally potentially support suitable habitat for these threatened species are all of a modified or disturbed nature and at varying degrees of degradation. The remaining vegetation stands are also mostly isolated with the exception of the northern end of the proposed alignment where the vegetation connects with a larger woodland and riparian area around Second Ponds
Downy Wattle	*Acacia pubescens*	V	V	This species occurs in open woodland and forest, in a variety of plant communities, including Cumberland Plain Woodland. Suitable habitat may therefore exist for this species.	
Thick-lipped Spider-orchid	*Caladenia tessellata*	E	V	This species inhabits grassy sclerophyll woodland on clay loam or sandy soils. Suitable habitat may exist for this species.	
Netted Bottle Brush	*Callistemon linearifolius*	V		This species grows in dry sclerophyll forest therefore suitable habitat may exist for this species.	

Common name	Species name	TSC Act status	EPBC Act status	Potential to occur within study area	Potential impact
	Darwinia biflora	V	V	Occurs in Sydney only on the edges of weathered shale-capped ridges, where these intergrade with Hawkesbury Sandstone. Associated overstorey species include *Eucalyptus haemastoma, Corymbia gummifera* and/or *E. squamosa*. The vegetation structure is usually woodland, open forest or scrub-heath. Habitat for this species may occur.	Creek, which is outside the scope of this project. Therefore it is considered unlikely that the project would have a substantial impact on the lifecycle of any flora species.
	Dillwynia tenuifolia	V	V	This species is known from nearby areas and therefore may occur. However suitable scrubby / dry heath habitat is limited in the study area although suitable clay soil type and shale geology is present.	
	Eucalyptus spp. *cattai*	E		This species is known from the area within the proposed alignment and may occur in suitable habitat within the study area.	
Juniper-leaved Grevillea	*Grevillea juniperina* subsp. *juniperina*	V		This species grows on reddish clay to sandy soils derived from Wianamatta Shale and Tertiary alluvium (often with shale influence), typically containing lateritic gravels. Suitable habitat may exist within Cumberland Plain Woodland.	
	Grevillea parviflora subsp. *parviflora*	V	V	This species is known to occur in areas supporting heath, shrubby woodland and forests and often in disturbed areas such as on the fringes of tracks. Habitat may exist for this species.	
	Hibbertia superans	E		This species occurs on sandstone ridge tops often near the shale/sandstone boundary. It occurs both in open woodland and heathland, and appears to prefer open disturbed areas, such as track sides. Habitat for this species may exist.	

Common name	Species name	TSC Act status	EPBC Act status	Potential to occur within study area	Potential impact
	Leptospermum deanei	V	V	This species is found only in the Sydney area and occurs in woodland on lower hill slopes or near creeks in riparian scrub or woodland on sandy alluvial soil or sand over sandstone. Habitat for this species may exist within River Flat Eucalypt Forest.	
	Leucopogon fletcheri subsp. *fletcheri*	E		Occurs in dry eucalypt woodland or in shrubland on clayey lateritic soils, generally on flat to gently sloping terrain along ridges and spurs. Suitable habitat for this species may be present.	
	Micromyrtus minutiflora	E	V	Grows in Castlereagh Scribbly Gum Woodland, Ironbark Forest, Shale/Gravel Transition Forest, open forest on tertiary alluvium and consolidated river sediments. Suitable habitat may be present in woodland and forest areas.	
Spiked Rice-flower	*Pimelea spicata*	E	E	This species may occur as it grows on undulating topography of substrates derived from Wianamatta Shale, within Cumberland Plain Woodland.	
	Pultenaea parviflora	E	V	This species is endemic to the Cumberland Plain, occurring mostly from Windsor to Penrith and east to Dean Park and may be present in the area.	
	Tetratheca glandulosa	V	V	This species is known to inhabit heaths and scrubs, woodlands, open woodlands and forests associated with shale-sandstone transition habitat where shale-cappings occur over sandstone. Habitat for this species may be present.	
Endangered Ecological Communities					
Blue Gum High Forest		EEC	EEC	Adjacent to the Franklin Road Station proposed construction site.	This community would not be directly impacted and a buffer zone would be considered to avoid indirect impacts.

Common name	Species name	TSC Act status	EPBC Act status	Potential to occur within study area	Potential impact
Cumberland Plain Woodland		EEC	EEC	This community was patchy in its distribution with few isolated stands containing a native understorey and the majority containing only canopy species over cleared pasture / grazing land, as folllows: » North of Norwest Business park: private property that has retained the understorey, low level weed invasion with evidence of grazing by Rabbits; » Along Windsor Road at the northern extreme of the route: medium weed invasion with evidence of Rabbit grazing, and » Remnant canopy trees characteristic of this community remain scattered throughout properties over modified lands along the route north of Norwest Business Park.	Construction of the rail corridor along this section would require clearance of Cumberland Plain Woodland. The indicative 50 metres impact corridor would pass through areas of varying quality. 8.72 ha of scattered trees would be removed as a result of the corridor and 9.75 ha as a result of the Balmoral Road construction site. Additional clearance of scattered trees would be required for the Stabling yard, however the footprint for this site has not been finalised, therefore the clearance area cannot be determined. One small block of uncleared land contains species representative of this community other than canopy species. Clearance through this area for the construction of the cut and cover tunnel would result in the removal of the entire stand (1.58 ha). In addition to this stand, at the northern end of the proposed alignment, the existing remnant stand would be at the northern limit of the holding yard and would not be impacted upon.
Sydney Turpentine - Ironbark Forest		EEC		Two small stands of this community were present within the rail corridor: » Within the rail corridor on the western and eastern side between Cheltenham and Beecroft Stations: small stands with high disturbance; and » Along Cattai Creek near the proposed Hills centre Station: intact understorey with low weed invasion upslope of a weed dominated riverbed and edge.	Quadruplication would result in the clearance of the stands within the existing rail corridor, approximately 0.29 hectares. This stand, although modified with weed invasion and a high level of disturbance, contained representative canopy species as well as midstorey and groundcover species. Cut and cover through Cattai Creek would involve the clearance and disturbance of 50 m wide impact area across the creek and result in the clearance of approximately 0.31 ha. Due to high level of weed invasion along this creek measures for the control of runoff have been recommended as well as revegetation and ongoing weed management of the area.

Common name	Species name	TSC Act status	EPBC Act status	Potential to occur within study area	Potential impact
River-flat Eucalypt Forest on Coastal Floodplains		EEC		This community was present along the number of watercourses running adjacent to the proposed alignment and is likely to be directly impacted at the following locations: » Windsor Road within alignment: remnant canopy species over modified lands along a drainage line that meets Windsor Road; » Caddies Creek along viaduct alignment: high weed invasion in places with representative canopy trees; and » Caddies Creek at viaduct construction site: high weed invasion in places with representative canopy trees.	Clearance associated with the alignment along Windsor Road would remove approximately 0.10 ha. Construction of the viaduct would clear approximately 0.76 ha along its length and approximately 0.05 ha for the associated construction zone. Any construction in these area should minimse direct impacts by considering construction design and use the adjacent grasslands as well as ensuring the management of runoff into the community and associated creek line.

E = Endangered; V = Vulnerable; M = Migratory; EP = Endangered Population; EEC = Endangered Ecological Community; TSC Act = *Threatened Species Conservation Act 1995* (DEC 2006); EPBC Act = *Environment Protection and Conservation Ac 1999t* (DEH 2006)

Table 9.22 Estimated vegetation clearance

Vegetation community	Location / condition	Baulkham Hills LGA Extent[#] (ha)	Approximate clearance (ha)	% clearance	Total (% of total community
Cumberland Plain Woodland	North of Norwest Business Park: private property that has retained characteristic understorey and canopy, low level weed invasion with evidence of grazing by Rabbits.	386	1.6	0.41 %	0.41 %
	North of Norwest Business Park within Balmoral Road Construction Zone: remnant canopy trees scattered throughout properties with varied land use and modified understoreys.		9.8	N/A (as scattered trees not included in remaining extent)	
	Along alignment within indicative 50 m clearance zone: remnant canopy trees scattered throughout properties with varied land use and modified understoreys.		8.7		
	Stabling yard site: remnant canopy trees characteristic of this community remain scattered throughout properties over modified lands that would be used for the stabling yard and associated facilities.		Unknown		
Sydney Turpentine - Ironbark Forest	Within the rail corridor on the western and eastern side between Cheltenham and Beecroft Stations: small stands with characteristic understorey and canopy with high disturbance.	169	0.3	0.17 %	0.35 %
	Along Cattai Creek near the proposed Hills centre Station: intact understorey with low weed invasion upslope of a weed dominated riverbed and edge.		0.3	0.18 %	
River-flat Eucalypt Forest on Coastal Floodplains	Windsor Road within alignment: remnant canopy species over modified lands along a drainage line that meets Windsor Road.	561	0.1	0.02 %	0.16 %
	Caddies Creek along viaduct alignment: high weed invasion in places with representative canopy trees.		0.8	0.14 %	
	Caddies Creek at viaduct construction site: high weed invasion in places with representative canopy trees.		0.1	0.01 %	

[#] = based on 2003 aerials

9.4.3 Summary of results

The proposed alignment has been located to pass through previously developed and urbanised environments and avoid areas of significant vegetation wherever possible; and a significant portion is located in tunnel, thereby minimising disturbance to existing habitat.

A number of endangered ecological communities listed under the TSC Act and the Commonwealth EPBC Act have been identified along the proposed alignment and construction would result in the clearance of small areas within these communities:

» The endangered Sydney Turpentine-Ironbark Forest (TSC Act) was identified in two distinct locations along the proposed alignment. Approximately 0.6 hectares would be cleared which represents approximately 0.35 % of that remaining within the Baulkham Hills LGA;

» The endangered Cumberland Plain Woodland (TSC Act, EPBC Act) would be impacted at a number of locations along the proposed alignment. Approximately 1.6 hectares of intact community would be cleared, as well as 18.5 hectares of areas mapped as scattered remnant trees representative of this community. The clearance of intact community represents approximately 0.41 % of that remaining within the Baulkham Hills LGA; and

» The endangered River-flat Eucalypt Forest on Coastal Floodplains (listed by the TSC Act) occurs at a number of locations adjacent to the proposed alignment, and the project would directly impact on this community at three locations. Approximately 0.9 hectares (approximately 0.16 % of that remaining in the Baulkham Hills LGA) would be cleared.

A number of mitigation measures have been recommended (below) to minimise the direct and indirect impacts on these communities.

The Cumberland Land Snail (*Meridolum corneovirens*) is listed as endangered under the TSC Act. This species was identified during the current surveys in the Cumberland Plain Woodland just north of the termination of the alignment. This area is not to be impacted upon and mitigation measures would be required to avoid indirect impacts. Habitat also exists for this species within the intact stand that would be cleared within the Balmoral Road construction zone. This is an isolated stand however many of the known populations exist within small isolated stands (DEC 2006) and while little is known of the movements of this species it is possible that this stand provides sufficient habitat to support a population of this species, therefore clearance of this stand may impact on any present population of this species. The clearance and degradation of Cumberland Plain Woodland remnants is considered a threat to the survival of this species therefore any clearance may be considered a significant impact and habitat offsets may be required.

9.4.4 Recommended mitigation measures

Further investigations

Recommended further investigations include:

» In the event that the locations of construction facilities or permanent facilities change, additional surveys would be undertaken into potential impacts;

» Assessment of the location of structures associated with the tunnel such as air shafts and discharge/runoff outlets with respect to the potential application of SEPP 19; and

» Liaise with relevant agencies (including DEH and the Growth Centres Commission) to determine mitigation measures for biodiversity impacts arising from the project.

Recommended mitigation measures

Mitigation measures would be implemented to prevent direct and indirect impacts of the project on flora and fauna and their habitat within the study area and locality. Additional measures may be identified during detailed construction planning. Recommended measures would typically include:

» Retain or replace habitat features, such as fallen logs, that may be used by fauna;

» Avoid hollow-bearing trees and stags where possible. Where avoidance of a hollow-bearing tree is not possible, hollow branches and trunks should be carefully removed and checked by an onsite ecologist for any fauna and then placed within the adjacent woodland area to provide habitat for other fauna species. Any fauna found within removed hollows should be captured and released at nightfall;

» Design and position construction sites so as to minimise vegetation clearance and encroachment into remnant vegetation by using already available disturbed areas;

» Avoid the removal of canopy trees within the alignment clearance area outside of the working corridor;

» Consider necessary buffer zones around construction areas from adjacent vegetation and creek lines;

» Prepare a Revegetation Plan in order to consider the following:

  – Where natural regeneration is not expected, re-plant areas with local provenance plant species;

  – Control of noxious weeds;

  – Ensure that any planting in bushland areas is appropriate to the bushland community; and

  – Restoration of riparian zones following direct or indirect disturbance.

» Include winter flowering eucalypts in the re-planting to replace those lost during clearance so as to replace lost habitat for winter flowering dependent species;

» Refer to the Royal Botanical Gardens NSW Recommended Phytophthora cinnamomi protocols for the necessary management of Phytophthora cinnamomi;

» Consider low level shielded lighting;

» Fencing of proposed development areas to ensure construction works do not breach the boundaries and enter the adjacent areas of vegetation;

» Installation of sediment detention basins, or similar, prior to construction to prevent untreated runoff and sediment entering drainage lines and creeks within the study area;

» Placement of stockpiles away from vegetated areas;

- Piling of soil that may contain seed of exotic species away from adjacent vegetation or drainage lines where they could be spread during rainfall events;
- Monitoring and management of weed invasion along the proposed alignment to ensure regeneration of native species takes place;
- Replace removed soil as soon as possible after construction to avoid sedimentation runoff into adjacent drainage lines and creeks; and
- Replace removed soil as soon as possible after construction to avoid smothering of plants and new seedlings.

9.5 Spoil handling

This section summarises the results of the spoil management assessment undertaken by GHD. The full report is located in Appendix J.

9.5.1 Assessment methodology

The spoil management report assessed the volume and nature of the spoil generated; the associated truck movements; proposed reuse/disposal options; and provided comment on the potential haulage routes and methodology.

Spoil production rates and locations of spoil producing work sites identified in the spoil management report reflect the proposed approach to construction described in the Engineering and Infrastructure Technical Report (PB, 2006b).

9.5.2 Impact assessment

Sources of spoil

The majority of spoil would be generated from the excavation of tunnels and underground stations and would be removed from the construction site at Balmoral Road (and Hills Centre under the staged delivery scenario). Relatively smaller quantities generated by site preparation activities, excavation of vertical access shafts, dive structures, cut and cover tunnels and cut/fill activities for the surface railway component would be removed by truck directly from individual construction sites.

Spoil material

The majority of excavated spoil would be uncontaminated crushed sandstone and shale material. This is classified as 'virgin excavated natural material' (VENM) according to the DEC's current waste classification system. In general, this would consist of mixed size crushed rock, ranging from clay and sand to lumps of rock. Approximately 60% of the spoil material is expected to be sandstone, the remainder being shale.

The excavated spoil material has a bulked volume greater than its in situ volume. This is because the spoil in situ is in a naturally compacted state, and when excavated the same mass of spoil would take up a greater volume because it is loosened by the process of excavation. This is referred to as 'bulking' and hence, estimated spoil quantities are reported in bulked volume.

Excavation rates

The preferred excavation method for tunnels of sufficient length is by a tunnel boring machine (TBM). This is due to the fast rate of advance that can be achieved, though TBMs have an associated spoil production around five times the rate of road headers.

For planning purposes, the overall average travel rate is estimated at 175 metres per week or around 7,500 m^3 solid volume for each TBM. Based on this rate and a bulking factor after excavation of 1.6, this would convert to 12,000 m^3 per week of bulked material per TBM. The

maximum excavation rates could significantly exceed this average rate, and so temporary spoil stockpiling areas at the Balmoral Road work site would be required.

Cut and cover station excavation would be carried out using rock breakers, conventional excavators or a combination of methods depending on the site geology. The rate of spoil production from cut and cover excavation is estimated to be 2,800 m^3 per week of bulked material assuming two rock breakers or excavators are operating simultaneously.

Estimated spoil quantities

Table 9.23 provides a summary of the approximate spoil quantities estimated to be produced from the project. The project is expected to generate a total of approximately 5 million tonnes (or 4 million m^3 bulked volume) of spoil.

Table 9.23 Summary of spoil quantities and locations where produced

Source of spoil	Estimated spoil quantities	
	Mass (tonnes)	Bulked volume (m^3)
Cheltenham dive	49,300	39,400
Tunnels (underground)	2,293,300	1,834,600
Cross passages	2,300	1,840
Stations (underground)	1,024,000	819,200
Station ventilation and access shafts	184,200	147,360
Cut and cover sections	731,400	585,100
Stations (cut and cover)	415,000	332,000
Surface railway excess fill	264,000	211,250
Total	4,963,500	3,970,750

Location of spoil

The TBM conveyors would convey all the spoil from the TBM tunnel, cross passages and mined station sites to the Balmoral Road construction site (and the Hills Centre site under the staged delivery scenario). Excavated spoil from vertical access and ventilation shafts would be removed by truck directly from the respective ground level work sites.

Excavated excess spoil from cut and cover sections would be removed directly by truck from construction sites.

Excess excavated cut over fill for the surface railway construction would be removed by truck directly from the construction sites.

Options for spoil reuse/disposal from the project

Overall strategy

The strategy for reuse/disposal of spoil materials from the project would follow the conceptual hierarchy of spoil management options (refer to Figure 9.3):

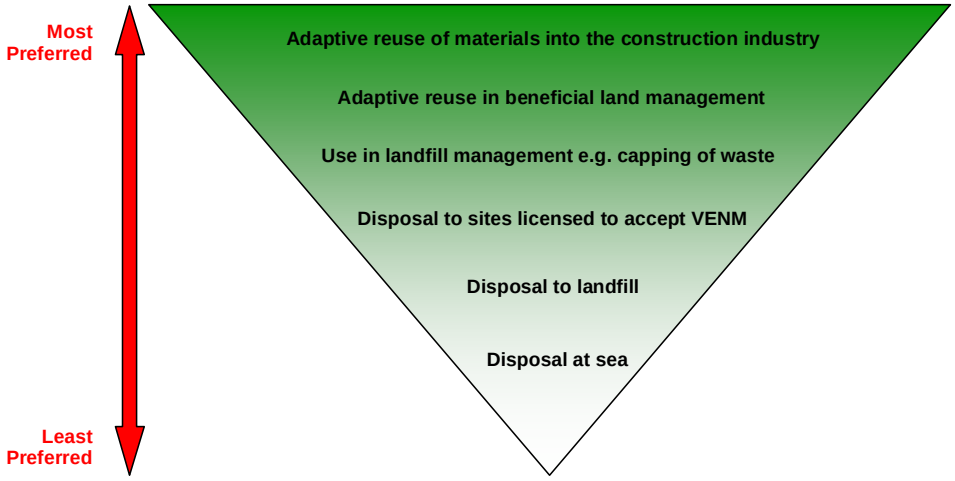

Figure 9.3 Spoil management hierarchy

Fill areas on site

There would be only limited opportunities for onsite reuse of spoil as the project has very limited on site requirements for fill and construction site space is also very limited. There would be opportunities to reuse better quality sandstone generated by the tunnelling operations for embankments (approximately 43,400 m^3 bulked volume) along the following sections:

» North of Burns Road to south abutment of viaduct at Samantha Riley Drive;

» North abutment of viaduct at Windsor Road at start of Rouse Hill Regional Centre cut and cover; and

» End of Rouse Hill Regional Centre cut and cover to the stabling facility.

There are also a number of locations along the at-grade section that might require levee banks for flood protection or noise mounds for sound attenuation purposes. A levee may be required at Second Ponds Creek and possibly at Elizabeth Macarthur Creek (near Burns Road Station).

Spoil material could be beneficially reused on site at any levee and noise mound locations. Quantities for such on site reuse opportunities would be determined during the detailed design phase of the project.

Off site beneficial reuse/VENM only disposal

When considering spoil reuse/disposal, the order of magnitude and timing are key to determining feasible options. Small quantities can be utilised on a large number of construction projects or accepted at other disposal sites (such as landfills or mining voids), but larger quantities often require special arrangements to be negotiated. Also, the possibility of such arrangements depends on the timing of other major construction projects that require fill coinciding with the period when spoil is being generated.

A number of organisations were contacted to determine spoil reuse options. Organisations that indicated possible acceptance of spoil over the period of construction of the project are shown in Table 9.24.

Table 9.24 Spoil reuse options

Company	Location	Spoil Reuse	Capacity
Rocla	Calga quarry	Calga quarry is located 40 km north of Hornsby via the F3 Freeway and 1 km along Peats Ridge Rd. The quarry has a very large capacity, Rocla indicated it would probably only accept good quality sandstone, no shale.	> 1 million m^3
Boral	Prospect recycling plant	Recycling of sandstone into building materials at the Prospect recycling plant. Currently process around 10,000 tonnes of sandstone per year, but are intending to increase capacity to approximately 60,000 to 70,000 tonnes per year over the next few years. Boral indicated it would probably only accept sandstone materials at the Prospect recycling plant.	60-70,000 tonnes / year
	Moorebank redevelop-ment site	Beneficial reuse at the Moorebank redevelopment site. Boral indicated that shale materials could also be accepted at this site.	Not specified
	Badgerys Creek Brick Plant	Boral has also indicated that there may be opportunities for reuse of particular types and qualities of shale by the Brick Division at its Badgerys Creek plant.	Not specified
Penrith Lakes Development Corporation	Penrith Lakes Scheme	Beneficial reuse as fill material in the Penrith Lakes scheme for both shale and sandstone materials. There would be a limiting lump size of approximately 150 mm.	> 3 million m^3
Sydney Ports Corporation	Port Botany Expansion	Possible reuse opportunity for sandstone as fill material in the construction of a new container terminal at Port Botany. Current plans are to obtain material from dredging but some material may need to be sourced as VENM from external projects.	Up to 7 million m^3
Hornsby Shire Council	Hornsby quarry	Hornsby quarry, owned by Hornsby Shire Council, has capacity for large quantities of VENM. There is a possibility that the void space would be available for placing materials from the project, pending decision from Council as to the final end-use for the disused quarry.	5 million m^3
Ecocycle / AWJ Civil	Wetherill Park	AWJ Civil, through Ecocycle can accept large quantities of VENM for beneficial reuse in their industrial projects as fill material.	> 2 million m^3
Holt Land Rehabilitation	Kurnell	VENM only receival site, for land rehabilitation of former sand mining areas.	Not specified

The locations of the above listed spoil reuse options are spread across the greater Sydney region. The actual spoil reuse sites for the project would need to be determined closer to the commencement of construction, as the availability of the sites to accept spoil materials from 2009 through to completion of excavation may change from the availabilities predicted at the current time.

Disposal at landfill

Table 9.25 lists typical landfill sites that receive VENM for use as daily cover or onsite engineering works.

Table 9.25 Typical landfills that receive VENM for onsite engineering

Facility	Location	Comments
Enviroguard	Erskine Park	VENM used as cover
Glenfield Waste Depot	Glenfield	VENM used as cover
Brandown	Thornleigh	VENM used as cover
WSN Environmental Solutions	Belrose, Eastern Creek, Lucas Heights, Jacks Gully	VENM used as cover
Penrith Waste	Penrith	Accepts contaminated soil

Table source: Arup (2005) North West Rail Link: 2004 Engineering Design Study report.

'Contaminated' spoil management

There are a number of solid waste landfills in Sydney, all located in Western Sydney. For example Penrith Waste at Mulgoa and the SITA landfill at Kemps Creek both receive contaminated soils. The SITA landfill is also licensed to receive some materials classified as Industrial Waste, but requires special landfilling techniques, and would therefore be relatively expensive.

Little or no contaminated spoil material is expected from the construction of the project.

Potential traffic from spoil transportation

Table 9.26 summarises the estimated standard truck movements associated with removal of spoil materials from various work sites (one truck arriving and departing from a worksite is equivalent to 2 truck movements). The standard truck sized used in the truck movement estimations is 19.5 m^3 bulked capacity.

It is anticipated that excavation of the bored tunnel sections would coincide with excavations of up to three of the underground stations as well as progressive excavation of cross passages. Therefore, average truck movements from removal of spoil from the Balmoral Road worksite would be in the order of 3,640 movements per week.

Table 9.26 Estimated spoil truck movements

Work site	Section/area to be excavated	Time to excavate (weeks)	Spoil generation rate (m^3/week)	Standard spoil truck movements per week
Cheltenham Dive	Cheltenham dive structure – piles	24	100	10
	Cheltenham dive structure – main dive	10	3,744	384
Balmoral Road	Bored tunnel from Cheltenham dive to Balmoral Road portal	126	8,600	882
	Franklin Road station excavation	23	8,960	919

Work site	Section/area to be excavated	Time to excavate (weeks)	Spoil generation rate (m^3/week)	Standard spoil truck movements per week
	Castle Hill station excavation	23	8,960	919
	Hills Centre station excavation	23	8,960	919
	Norwest station excavation	23	8,960	919
	Cross passages	126	15	1
Individual stations	Franklin Road ventilation/ access shafts	8	4,500	462
	Castle Hill ventilation/ access shafts	12	4,200	431
	Hills Centre ventilation/ access shafts	7	4,320	443
	Norwest ventilation/ access shafts	7	4,389	450
Cut & cover sections	Bored tunnel portal to north of Burns Road	40	6,141	630
	Rouse Hill Regional Centre	52	6,528	670
Cut & cover stations	Burns Road station excavation	16	4,375	449
	Rouse Hill station excavation	30	8,733	896
Surface railway cut/fill	North of Burns Road to south abutment of viaduct at Samantha Riley Drive	8	6,700	687
	North abutment of viaduct at Windsor Road at start of Rouse Hill Regional Centre cut and cover	16	5,609	575
	End of Rouse Hill Regional Centre cut and cover to stabling	16	4,244	435

Under staged delivery, the project between Epping and Hills Centre Station would be operational by 2015. Therefore, spoil removal for the tunnel up to this point (approximately 11 km in length) and two underground stations (Franklin Road and Castle Hill) would be from the Hills Centre site.

The spoil quantities and estimated truck movements at the Hills Centre site associated with the bored tunnel from Cheltenham dive to the Hills Centre site under this scenario (stage 1) would be less than, but similar to, the data shown in Table 9.26. During stage 2, spoil quantities and estimated truck movements at the Balmoral Road site associated with the bored tunnel from Hills Centre to Burns Road, would be reduced.

Spoil removal would also be required from the other work sites along the proposed alignment of the project. At Cheltenham, truck movements from removal of spoil from the excavation of the dive structure would be approximately 10 per week during piling, and then increase up to an average of around 384 movements during excavation of the main dive area.

Likely haulage method and routes

Method of haulage

Rail haulage for transport of spoil is generally more cost effective over longer distances (particularly, where transport distances exceed around 35 kilometres) than haulage by road. Rail transport also has less environmental impact. However, given the close proximity of and access to major motorways (M2 and Westlink M7 Motorways) to the spoil generating locations, as well as the factors that affect the practicality of rail haulage, haulage by road is the preferred option for transportation of spoil.

Spoil haulage trucks are anticipated to most likely be 'super dogs' (or semitrailers), with some transport by 'dogs' (or tray and trailers). The RTA has published B-Double mapping showing designated B-Double routes in Metropolitan Sydney and regional NSW. This mapping indicates routes, which can suitably accommodate certain types of B-Double type vehicles.

The key roads that are designated B-double routes providing access to and from all the sites are as follows:

» Beecroft Road;

» Castle Hill Road;

» Old Northern Road;

» Showground Road; and

» Windsor Road.

Haulage route - upgrade of the Main Northern Line between Epping and Beecroft

It is envisaged that work would be undertaken within the Main Northern Line rail corridor with the main access through the construction site proposed at the The Crescent, Beecroft. For spoil removal haulage trucks to access the M2 the route would be as follows:

» Right onto Beecroft Road;

» Left onto Pennant Hills Road; and then

» Both left and right movements onto the M2 can be obtained at the Pennant Hills Interchange.

Haulage route - Franklin Road Station work site

Options for haulage routes, including all B-Double assigned routes, to the M2 / Westlink M7 from the Franklin Road Station work site are shown in Table 9.27.

Table 9.27 Haulage route options from Franklin Road Station work site

East bound	West bound
» Left onto Castle Hill Road; » Right onto Pennant Hills Road; and then » Left onto the M2 at the Pennant Hills Interchange.	» Left onto Castle Hill Road; » Right onto Pennant Hills Road; and then » Right onto the M2 at the Pennant Hills Interchange.

Castle Hill Station work site

The following route options are provided for spoil haulage from the Castle Hill Station work site, including all B-Double assigned routes (Table 9.28).

Table 9.28 Haulage route options from Caste Hill Station work site

East bound	West bound
» Left onto Old Northern Road; » Left onto Windsor Road; and then » Left onto the M2 at the Windsor Road Interchange.	» Left onto Old Northern Road; » Right onto Showground Road; » Right onto Windsor Road; » Left onto Burns Road; » Straight through onto Sunnyholt Road; and then » Right onto the Westlink M7 at the Sunnyholt Road Interchange.

Hills Centre Station worksite

The following route options are provided for spoil haulage from the Hills Centre Station work site, including all B-Double assigned routes (Table 9.29). However, direct access to Showground Road would be established for spoil removal associated with the bored tunnel (staged delivery scenario).

Table 9.29 Haulage route options from Hill Centre Station work site

East bound	West bound
» Right onto Carrington Road; » Left onto Victoria Avenue; » Left onto Windsor Road; and then » Right onto the M2 at the Windsor Road Interchange.	» Right onto Carrington Road; » Right onto Victoria Avenue; » Left onto Showground Road; » Right onto Windsor Road; » Left onto Burns Road; » Straight through onto Sunnyholt Road; and then » Right onto the Westlink M7 at the Sunnyholt Road Interchange.

Norwest Station worksite

The following route options are provided for spoil haulage from the Norwest Station work site, including all B-Double assigned routes (Table 9.30).

Table 9.30 Haulage route options from Norwest Station work site

East bound	West bound
» Right onto Norwest Boulevard; and then » Straight through the signalised intersection at Old Windsor Road onto the new link to the Westlink M7.	» Right onto Norwest Boulevard; » Left onto Old Windsor Road; and then » Left onto the Westlink M7.

Norwest Boulevard is not identified on RTA mapping as being part of the designated B-Double routes around this area of Sydney. As a result, if the movement of material by B-Double vehicles is required, then permission should be sought from RTA and Baulkham Hills Council. Norwest Boulevard is designed to accommodate large trucks with wide traffic lanes and a divided solid median.

Balmoral Construction Site and Burns Road Station

Higher order roads are likely to be utilised for removal of spoil from the Balmoral Road work site. The following haulage routes provide access for heavy vehicles to and from the M7 Motorway:

» Old Windsor Road;

» Onto Sunnyholt Road; and then

» Right or Left onto the Westlink M7 at the Sunnyholt Road Interchange.

All routes except for the section of Old Windsor Road are designated B-Double Routes. Old Windsor Road was approved by the RTA as a construction route during the construction of the M7 and considered acceptable to provide the most direct access for construction vehicles from the Balmoral Road construction site and Burns Road Station site to the Westlink M7.

Rouse Hill Station work site

An option for a haulage route to the Westlink M7 from the Rouse Hill Station work site is as follows:

» Left onto Windsor Road;

» Straight onto Old Windsor Road;

» Right onto Sunnyholt Road; and then

» Right or Left onto the Westlink M7 at the Sunnyholt Road Interchange.

All routes except for a section of Old Windsor Road between Windsor Road and Sunnyholt Road are designated B-Double Routes. Old Windsor Road was approved by the RTA as a construction route during the construction of the M7 and considered acceptable to provide the most direct access for construction vehicles from the Rouse Hill Station site to the Westlink M7.

Rouse Hill stabling facility work site

The following haulage route to the Westlink M7 from the Rouse Hill work site is recommended:

» Right onto Windsor Road;

» Straight onto Old Windsor Road;

» Right onto Sunnyholt Road; and then

» Right or Left onto the Westlink M7 at the Sunnyholt Road Interchange.

All routes except for a section of Old Windsor Road between Windsor Road and Sunnyholt Road are designated B-Double Routes. Old Windsor Road was approved by the RTA as a construction route during the construction of the Westlink M7 and considered acceptable to

provide the most direct access for construction vehicles from the Rouse Hill stabling yards site to the Westlink M7.

9.5.3 Summary of results

The majority of spoil from construction of the project would be generated during excavation of tunnels and underground station sites. Spoil would be removed from the main construction work site at the Balmoral Road Release Area. Relatively smaller quantities generated by site preparation activities, excavation of vertical access shafts, dive structures, cut and cover tunnels and cut/fill activities for the surface railway component would be removed by truck directly from respective work sites.

The project is expected to generate a total of approximately 5 million tonnes (or 4 million m^3 bulked volume) of spoil. Most of this excavated spoil would be uncontaminated crushed sandstone and shale material, classified as 'virgin excavated natural material'.

A number of potential onsite and offsite spoil reuse/disposal sites were identified. However further investigation into possible locations for spoil reuse/disposal would need to be undertaken closer to the commencement of construction.

Haulage by road is the preferred option for transportation of spoil. A number of likely spoil haulage routes were identified, using key roads that are designated B-double routes, including Beecroft Road, Castle Hill Road, Old Northern Road, Showground Road and Old Windsor Road. It is expected that the highest number of average truck movements would be from removal of spoil from the Balmoral Road worksite (and the Hills Centre work site under the staged delivery scenario), which would be in the order of up to 3,640 movements per week.

9.5.4 Recommended mitigation measures

» Implementation of measures to reduce traffic impacts associated with spoil truck movements on the operation of the existing road network, including restricting hours of operation. Construction traffic impacts (including traffic from spoil trucks) and proposed mitigation measures are discussed in section 9.2.

» Implementation of the spoil management hierarchy as the overall strategy for the reuse or disposal of excess spoil materials. This includes:

  – onsite reuse of spoil material where possible;

  – where practicable, preferential reuse of excess spoil at sites that would use it for beneficial reuse in land rehabilitation or the construction industry, rather than disposal at landfill; and

  – further investigation of options for beneficial reuse for spoil offsite.

9.6 Indigenous heritage

This section summarises the results of the archaeological assessment of indigenous heritage undertaken by Jo McDonald Cultural Heritage Management Pty Ltd. The full report is located in Appendix G.

9.6.1 Assessment methodology

The Cumberland Plain has been extensively studied over the last two decades. Surveys associated with the Rouse Hill Infrastructure Project (JMcD CHM 1993, 2000, 2002) as well as the current excavation programs related to these surveys (McDonald and White 1993, JMcD CHM 2001, 2005); the Balmoral Road Release Area (JMcD CHM 2002); and the initial assessment of the 2002 alignment for the North West Rail Link (Mills 2003) are the most relevant to the project and were considered for this assessment.

Consultation was undertaken with Indigenous groups following the protocols developed by the Growth Centres Commission and the DEC. This included a briefing with DEC on 25 July 2006 and face-to-face meetings with each of the stakeholder groups during 25 and 26 July 2006 and participation in the field survey undertaken between 26 and 28 July. The indigenous heritage assessment was undertaken following the protocols and methodology developed for the North West and South West Growth Centres. The protocol and methodology ensure a consistent approach to the assessment of indigenous heritage and provide guidelines for Aboriginal stakeholder involvement in the assessment process. Upon advice from DEC, step 1 of the methodology and protocol was completed for the current concept plan stage. Initial field investigations (part of step 2) were also undertaken to inform the environmental assessment.

In 2003, Mills Archaeological and Heritage Services Pty Ltd undertook a field inspection along the entire length of the project. Since that time, modifications have been made to the proposed alignment, requiring field inspections to concentrate on the modifications between Burns Road Station and Hills Centre Station, and the stabling facility. Representatives from relevant Indigenous groups (Deerubbin Local Aboriginal Land Council, Darug Custodial Aboriginal Corporation, the Darug Tribal Aboriginal Corporation and Darug Aboriginal Cultural Heritage Assessments) participated in the field survey, which was undertaken between 26 and 28 July 2006.

In order to assess the significance and potential of Aboriginal sites and subsurface deposits within the study area, a land-use impact assessment was prepared, considering existing levels of disturbance within a corridor of 250m either side of the proposed alignment. This assessment was undertaken through a comparison of aerial photos, ortho-photomaps and an inspection of these locations during the current survey. This was restricted to those lands at the western end of the study area where there would be an impact on the current ground surface.

9.6.2 Impact assessment

The land-use impact mapping demonstrated the high level of disturbance along most of the proposed alignment. This is likely in part due to the fact that the project follows major roads for much of its (surface) length. Cumberland State Forest south of Castle Hill Road and large

properties on Balmoral Road are the only areas of significant size and low disturbance identified within the impact assessment corridor. The remaining areas of low disturbance are tributaries, creeks and highly vegetated lands immediately adjacent to these.

On the basis of land-use mapping, areas of archaeological sensitivity are identified (refer Figure 4 in Appendix G).

No areas of very high archaeological potential were identified in the study area, given the level of development along the proposed alignment. Areas of good archaeological potential have been identified. These areas have the least disturbance, though they may have been cleared of vegetation in the past, subject to a range of impacts and are not considered to be in pristine condition.

Previous investigations have identified a number of threatened landscapes (JMcD CHM 1999) based on the past impact of urban development on certain landscapes and topographic elements on the Cumberland Plain. These represent higher value landscapes in terms of local heritage conservation potential. The high value landscapes are:

» Shale hillslopes (Minchinbury and to a slightly lesser degree, Ashfield);

» First order tributary creeklines; and

» Shale ridges and low ridge tops (particularly Minchinbury).

The majority of the proposed alignment would have no impact on any potential archaeological deposit. The bored tunnel section of the route is proposed to be well below the depth of any deposit likely to contain archaeological material. The surface tracks and the cut and cover section of the tunnel would impact on any sub-surface deposits, as would the six stations along the project.

There are no areas of high archaeological potential that would be directly impacted by the project. There are a number of areas with moderate archaeological potential that would be impacted, in particular the stabling facility, Burns Road Station, the Hills Centre Station and Franklin Road Station.

Fourteen sites have been identified that could potentially be impacted by the project. A full description of each site is included in section 8.1 of Appendix G. A summary of these findings shows that:

» Three sites of moderate-high archaeological significance are located within the site proposed for the location of Burns Road Station and associated construction works. These sites would be impacted by the project.

» One site of moderate archaeological significance is located within Castle Hill industrial estate, where bored tunnelling has been proposed. The site is in close proximity to the Hills Centre Station and may be impacted by the project.

» Five sites of low-moderate archaeological potential are located between Burns Road Station and the stabling facility, where cut and cover construction has been proposed. These sites would be impacted by the project.

» Two sites of low-moderate archaeological potential and one site of moderate potential are located within 50 metres of the proposed alignment between Burns Road Station and Rouse

Hill Station. These sites are located on the western side of Windsor Road and may be impacted by the project.

» One site of low archaeological significance is located within the site proposed for Franklin Road Station and associated construction works. This site would be impacted by the project.

» One site of low archaeological significance is located at the eastern extent of the project, close to the quadruplication between Cheltenham and Epping Station. This site would be impacted by the project.

9.6.3 Summary of results

The project traverses a generally highly modified and disturbed landscape. Potential for intact archaeological deposits is low for most of the proposed alignment. No land was identified as being in pristine condition and the few areas of moderate to good archaeological potential are restricted to small parcels of land with at least some degree of previous land use impact.

Fourteen sites have been identified that could potentially be impacted by the project. Eleven of these sites are located between Burns Road Station and the stabling facility in Rouse Hill, where there is likely to be a high degree of previous disturbance. Two sites are located near proposed stations and could potentially be avoided during construction. One site is located in the vicinity of the quadruplication works, and this would be impacted by the project. Three of these sites are identified to have moderate-high archaeological potential.

9.6.4 Recommended mitigation measures

The following recommendations are made:

» Sites with low archaeological potential could be considered developable with no further archaeological work required, however Indigenous groups should be given the opportunity to monitor work.

» If the three sites identified to have moderate to high archaeological potential cannot be avoided (to be confirmed during further design development), they should be subject to salvage excavation prior to any sub-surface impact on the deposit. Advertising for interested parties would need to be undertaken prior to any sub-surface investigation, in accordance with DEC requirements.

» The protocol and methodology developed for the Growth Centres should continue to be applied as the project progresses.

» All staff contracted to work on the project would be made aware of their responsibilities under the *National Parks and Wildlife Act 1974*.

» An indigenous heritage management sub-plan would be prepared as part of the construction environmental management plan; in consultation with DEC, the Deerubbin Local Aboriginal Land Council, Metropolitan Local Aboriginal Land Council, Darug Tribal Aboriginal Corporation, and Darug Custodians Aboriginal Corporation; detailing:

  – Procedures for monitoring of areas of potential archaeological sensitivity identified in the environmental assessment during initial clearing and construction activities;

– Procedures and protocols to be implemented during the construction phase to ensure that there are no direct or indirect impacts on any other Aboriginal sites in the vicinity of the construction area; and
– Measures for the management of any previously unidentified items/areas of potential indigenous archaeological significance identified during construction works.

9.7 Non-indigenous heritage

This section summarises the results of the heritage review undertaken by Casey & Lowe Pty Ltd. The full report is located in Appendix H.

9.7.1 Assessment methodology

The assessment involved the following tasks:

» Site visits on 21 June and 18 July 2006;

» Review of previous assessments;

» Consultation with Council planners (Blacktown City, Baulkham Hills Shire and Hornsby Shire);

» Review and updating the lists of heritage items identified previously (Mills 2002);

» Review of 1947 and 1951 aerial photographs covering the route; and

» Sites previously identified along Old Windsor Road and Windsor Road[1] (now within work compounds as part of works associated with the North West Transitway) were inspected and discussions held with the RTA.

9.7.2 Impact assessment

Section 3.2.8 provides a description of the existing environment in relation to non-Indigenous heritage. Potential impacts of the project are described below.

Quadruplication

The project would remove vegetation listed as a heritage item by the Hornsby LEP within the rail corridor between Carlingford Road and Kandy Avenue.

Cheltenham dive site

The Beecroft Village Green (item #22) is located in the vicinity of the Cheltenham dive site. The listing for the Village Green mentions the 'stand of indigenous remnant forest trees'. At this stage of design it is envisaged that some temporary work during construction, such as an access road, staff/worker accommodation and the storage of plant, may encroach outside the rail corridor into the road corridor of The Crescent and/or into Beecroft Village Green. The extent of this possible encroachment would be clarified during future design work and would be planned to protect access along The Crescent and protect the Tennis Courts. The project would involve removal of some of the remnant indigenous forest trees to construct a shaft for the tunnel boring machines.

Franklin Road station

In the vicinity of the proposed Franklin Station, the tunnel would go under listed building (item #49), while listed building (item #54) is situated on the other side of Castle Hill Road.

[1] Sites inventoried in Casey & Lowe 1993.

Two house sites (items #123 and #124) are located in the general works area associated with the station construction. These sites are potential archaeological sites and not standing buildings, and are not currently listed. Further research needs to be undertaken to establish their date and level of heritage significance.

Castle Hill Station

No potential impacts identified.

Hills Centre Station

No listed items would be directly impacted by the project. The sites of two buildings shown on a 1920s plan may be impacted (items #125 and #126). Further investigations would be required to establish their date and level of heritage significance.

Norwest Station

There are no known non-indigenous heritage items or archaeological sites in the vicinity of the station.

Bella Visa homestead, listed on the State Heritage Register, is located approximately 1.5 km to the southwest of the proposed station area. The cultural values (including its curtilage and vistas of surrounding farmlands) have been impacted by development in the surrounding area. It is considered that the construction of Norwest Station, within an area subject to development of the Norwest Business Centre and associated land uses, would be unlikely to impact on the remaining cultural values of the homestead and its vistas.

Burns Road Station

There are no identified items in the vicinity of Burns Road Station.

Between Burns Road Station and Windsor Road

In this section, the only known heritage site potentially affected by the project is an unlisted archaeological site located south of Samantha Riley Drive (item #74). The proposed alignment goes directly over this site. The site has been subject to impacts associated with the construction of service roads in the vicinity of the North West Transitway.

The original alignment of Old Windsor Road would not be impacted.

Between Windsor Road and Rouse Hill Station

An archaeological site (the site of Swan Inn item #79) listed on the RTA's section 170 register would be directly impacted by the project, which would go through a portion of the site. The 1885 survey shows only the location of the front of the main building – it is not known how extensive this building was or where and how many outbuildings were associated with it. The construction of the North West Transitway is likely to have impacted on the front of the site.

The project would be located between Mungerie House (item #82) and Windsor Road. This item is listed on the Baulkham Hills LEP. It is unlikely that there were any structures in the area between the house and Windsor Road. The main potential impact would be on vistas.

The Mean Fiddler Hotel (Royal Oak, item #86) fronts onto Windsor Road. At this point, the project would travel under Windsor Road to the south of Commercial Road and would continue

parallel to the road in a cutting. Trains should not be visible from the hotel, which now fronts a four-lane roadway.

Stabling facility

There are no listed heritage items or known archaeological sites in the immediate vicinity of the stabling facility.

The main heritage constraint in this area would be the potential impact of the stabling facility on vistas to and from the Rouse Hill Estate. The stabling facility may be visible from Rouse Hill House (item #128 listed on the State Heritage Register) and visible from the Rouse Hill Estate generally (the proposed stabling facility is approximately one kilometre from the estate). The house is regarded as one of the most substantial and complete houses from the Macquarie period (1810-1822), while the estate is generally regarded as being possibly unique in its chain of occupancy, extent of its colonial garden, collection of outbuildings and relationship to the landscape.

9.7.3 Summary of results

The potential impacts on heritage items are summarised in Table 9.31.

Table 9.31 Summary of heritage impact assessment

Location (proposed alignment section)	Item and listing	Potential impact
Quadruplication	Listed vegetation (Hornsby LEP)	Potential direct impact.
Cheltenham dive site	Beecroft village green (Hornsby LEP)	Potential for encroachment during construction would be clarified during future design work.
Franklin Road Station	House sites (no heritage listing)	Potential direct impact. Further investigations needed to establish heritage significance.
Hills Centre Station	House sites (no heritage listing)	Potential direct impact. Further investigations needed to establish heritage significance.
Between Burns Road Station and Windsor Road	Archaeological site (no heritage listing)	Potential direct impact.
Between Windsor Road and Rouse Hill Station	Archaeological site (s170 register)	Potential direct impact.
	Mungerie house (Baulkham Hills LEP)	Potential impact on vistas.
Vicinity of the stabling facility	Rouse Hill house (State Heritage Register)	Potential impact on vistas.

9.7.4 Recommended mitigation measures

Further investigations

» Additional research to determine the history and heritage significance of the four house sites identified in Castle Hill - sites off Franklin Road (items #123 and #124) and Carrington Road (items #125 and #126). If the sites are determined to be significant, site-specific archaeological assessments should be undertaken.

» Site-specific archaeological assessments should be undertaken for the archaeological sites identified along Old Windsor Road (item #74) and Windsor Road (item #79).

» A view analysis should be undertaken to and from Rouse Hill House and its estate (item #128). If required, the analysis should identify appropriate mitigation measures.

Recommended mitigation measures

» Prepare a non-Indigenous heritage management plan as part of the construction environmental management plan prior to construction, outlining appropriate management and mitigation measures of non-Indigenous heritage items.

» The preliminary noise and vibration assessment has indicated that vibration levels generated during construction and operation of the tunnel section would be below building damage criteria. However, as a precautionary measure, property condition surveys of heritage structures above the proposed alignment would be undertaken prior to construction.

9.8 Geology and groundwater

This section summarises the results of the geology, geotechnical and groundwater assessment undertaken by GHD. The full report is located in Appendix F.

9.8.1 Assessment methodology

The assessment involved a desktop study of available geotechnical and hydrogeological information relating to the project. The desktop study included a review of previous investigations conducted for the project, in combination with information from GHD's in-house database and publicly available resources such as soil landscape maps, topographic maps and geological plans. Information was also gathered from relevant site specific reporting previously undertaken for the project.

In addition, a site inspection was conducted along the proposed alignment, focusing on the location of construction depots, future rail stations, and the geomorphology in the vicinity of the project.

9.8.2 Impact assessment

Geology and geotechnical

Only minimal geotechnical information has been defined along the proposed alignment to date. A more detailed description of the geological and geotechnical description of the proposed alignment has been provided in Chapter 4 of Appendix F.

Hydrogeology

Alluvial sediments

Alluvial sediments are at risk of contamination from track spills and wastes carried along drainage lines by stormwater discharge. They may also give rise to nuisance inflows to bridge foundations and other excavations during construction on the floodplains. The deposits are shallow, limited laterally, and they are not significant sources of groundwater. Notwithstanding, they must be protected from contamination.

Igneous dykes

Dykes can have two possible effects on the groundwater system. Firstly, where weathered to clay they can act as groundwater dams, holding water back on the up-gradient side. In the Sydney Basin dykes are typically weathered to depths of 10-30m, but greater depths of weathering are known. Secondly, fresh dyke rock (generally basalt) at greater depths can be fractured and saturated, causing it to function as a vertical aquifer. Groundwater flows in the order of 10 litres per second may occur, being greater than normal inflows from the sandstone.

Ashfield Shale

The uppermost weathering profile can degrade to reactive clays capping the surface and restricting infiltration of precipitation or movement of groundwater. The lower portion of the weathering profile can include rock that is fractured. The variability within the weathered shale

profile can lead to a localised perched water table forming lenses of low permeability and low storage capacity. This is indicated by lines of seeps, which appear along the fresh/weathered bedrock interface in road cuttings after heavy rains. The shale is also responsible for the ephemeral nature of existing waterways within the vicinity of the rail corridor. A high degree of run off due to the low hydraulic conductivity of weathered and unweathered shale, can impede recharge to underlying sandstone where it is present.

The groundwater within a weathered shale aquifer is of fairly low salinity; 500-1000 mg/L total dissolved salts. Most of the water temporarily stored in the weathering profile following rain is later lost as base flow in minor watercourses or by trees through evapo-transpiration. During normal rainfall little or no water penetrates below the root zone, probably less than 1% of total precipitation.

Hawkesbury Sandstone

Inherent permeability is relatively low due to the cemented nature of the sandstone. Hydraulic conductivity within the sandstone is dominated by secondary structural features such as bedding plane seams and joint sets. As such, inflow rates are likely to vary as construction proceeds and various structures are intersected.

Seepage

The tunnels are to be excavated within the upper strata of the Hawkesbury Sandstone, the Mittagong Formation and the Ashfield Shale. It is expected that some inflows would occur at locations where permeable bedding plane seams, joint plane defects, dykes or faults are intersected.

Experience gained from tunnelling within the Sydney Basin in recent years within geological terrains similar to that likely to be encountered during construction of the project suggests that groundwater seepage within the tunnel is not likely to cause a significant problem for operational use. It seems reasonable to assume that conditions experienced during construction and operation would be similar to those previously experienced in other tunnel infrastructure projects.

The yield of seepage within the tunnel when operational is provisionally expected to be within expected design limits of 0.1 to 1 litres per second per kilometre, which translates to a range of approximately 2.5 – 25 litres per second for the entire tunnel length. Higher intermittent rates could be expected when these structures are encountered during construction. Where the tunnels are driven beneath valleys (Devlins Creek) or shallow cover areas, groundwater inflows are anticipated to be more prevalent with the possibility of higher rates of inflow.

Estimation of seepage volumes is difficult given the limited aquifer testing carried out along the route to date and is in part based on experience gained from other tunneling projects constructed in the Sydney Basin. Groundwater seepage into the tunnel during operation is provisionally expected to be similar to allowances made in other tunneling projects with flow rates possibly an order of magnitude higher than estimated operational seepage rates. High flow rates experienced when structures are intersected should be limited to relatively short periods of time as available groundwater head is removed. Intensity and time for increased seepage rates to dissipate would be dependent on interconnectivity of joint and fracture structures and the head, which is available. However, it would generally be expected that high

inflow rates should dissipate by around 50% within days and to operational levels within weeks or months.

Groundwater levels

Further field investigations are required to accurately assess the risk from relatively high groundwater pressures within the Hawkesbury Sandstone or perched systems within the Ashfield Shale. Seasonal variations in groundwater levels will occur in response to rainfall and may also affect seepage rates. Variations of levels in the order of 10 metres within the Hawkesbury Sandstone may occur.

The regional water table within the Hawkesbury Sandstone 'outcrops' in the beds of low-lying permanently flowing streams in the Beecroft-Castle Hill area. The water table rises away from these watercourses, following the topography but in a more subdued fashion - deep between ridges, shallow close to streams. Its level may fluctuate by several metres between wet and dry seasons, especially beneath ridges. Recharging water is believed to enter the system along the upper, non-perennial tributaries of these streams, and to ultimately discharge at sea level.

Working Paper No 4 (SKM, 2003) identified that the main groundwater issue affecting feasibility of the project is the possibility that inflows to the tunnel would eventually lower the regional water table, causing some creeks to cease flowing, and some wetlands to dry out. The long-term extent of the problem would depend on the relationship between the tunnel invert and the height of the water table, and the type of lining adopted.

Other groundwater-related issues that could arise during construction and operation include:

» Disposal of turbid, saline or contaminated water collected within the tunnel;

» Contaminants leaking to the water table where the tunnel is above the water table;

» The water table could rise several metres during unusually wet years and flood previously dry sections of the tunnel invert;

» Land subsidence could result from under drainage of shallow aquifers, especially unconsolidated alluvial aquifers;

» The lowering of the water table could result in loss of output from wells in the vicinity of the rail line;

» Leakage into a deep cutting and into the Rouse Hill Regional Centre station excavation.

In addition, two site specific issues were identified, one south of Castle Hill Road relating to soil stability; and one in the vicinity of Second Ponds Creek relating to land salinisation.

Impact of seepage on groundwater levels

Seepage may cause localised drawdown within a narrow corridor in which the tunnel is centred. The extent of possible impacts would vary and depend on the interconnectivity of fractures within the rock mass. When tunnel headings are located within the Ashfield Shale, low intrinsic formation permeability would generally restrict lateral migration of a drawdown cone.

With the localised extent of drawdown dependent on hydraulic parameters of the surrounding rock masses, long-term local groundwater levels can expect to fall to levels governed by the level of drainage infrastructure.

Groundwater quality

The water quality in the receiving waters that may be impacted by the project is generally poor to fair. It can therefore be anticipated that, in the short to medium term, the quality of water discharged to these waterways from the project would need to be of a high standard to ensure that the receiving water quality does not worsen the receiving water. Quality standards for water to be discharged to the environment would need to be considered carefully and is likely to be licensed by the DEC.

There are several options for water treatment, depending on what contaminants are being treated. It is likely that treatment plant(s) would be required to treat groundwater inflowing to the tunnel and deep open cut sections of the rail line. The provision of a single plant would require the transfer of water over considerable distances within the tunnel.

Discharges

Seepages could be expected to occur locally throughout most of the tunnel route depending on groundwater conditions and as such, discharge to the surface would be required.

Potential water retention areas within the excavated tunnel can be located at low point tunnel inflections and therefore subject to possible gravity drainage within the tunnel during operation. Possible groundwater collection areas are situated at the following locations:

» Below Devlins Creek (Cheltenham Dive);

» Near Hills Centre Station; and

» Near Burns Road Portal.

Availability of suitable areas for a small treatment plant may be difficult to acquire, particularly at locations where a high density of development which has already been established. Design considerations may enable total discharge to be removed by way of both the Cheltenham Dive structure and the portal near Burns Road. Pumping between sumps over short distances may be required to cross over inflections in vertical alignment, which are located at stations.

9.8.3 Summary of results

Only minimal geotechnical information has been gathered along the proposed alignment to date, as such, a number of project-specific geotechnical requirements need to be addressed as part of the further design phase. This would involve geotechnical site investigations at specific locations.

Two site specific issues were identified, one south of Castle Hill Road relating to soil stability, and one in the vicinity of Second Ponds Creek relating to potential salinity.

Experience gained from tunneling within the Sydney Basin in recent years within geological terrains similar to that likely to be encountered during construction of the project, suggests that groundwater seepage within the tunnel is not likely to cause a significant problem during operation.

Potential groundwater-related issues which could arise during construction and operation were identified. The potential for these impacts would be managed through implementation of recommended mitigation measures during the design, construction and operation phases.

9.8.4 Recommended mitigation measures

Further investigations

The proposed alignment requires further investigation to confirm the design and construction requirements imposed by the Ashfield Shale, Mittagong Formation and Hawkesbury Sandstone strata that would be encountered.

Geotechnical

Geotechnical site investigations would need to be carried out at specific locations and would include:

» The new rail bridge over the M2, and other sites as necessary along the quadruplication section;

» The proposed station sites;

» Locations to be identified along the tunnel sections;

» Locations to be identified along the surface sections; and

» Other infrastructure sites to be identified along the route.

Site investigations would be planned and would include subsurface drilling, vertical and inclined core sample recovery, core orientation, borehole permeability testing, piezometer installations, borehole instrumentation, detailed logging and laboratory testing of rock cores.

The reporting and review phases discussed above, would establish chains of communication and procedures, whereby it is accepted that ongoing geotechnical monitoring and verification are integral components of the project. Monitoring would commence with piezometers and borehole instrumentation installed at the site investigation phase, and continue through construction inspections and assessments. The progressive collection and review of geotechnical data would enable geotechnical models to be refined and critical design assumptions to be verified.

Groundwater

» Further studies and investigations would need to be designed to address all the issues identified to date.

» Investigate the need for single or multiple treatment plants to treat groundwater inflowing to the tunnel and deep open cut sections of the project.

» Investigate the use of chemicals and disposal of sludges as part of further design development.

» Additional and more detailed information is required on the regional geology of the area, and the hydrogeological setting along the route of the proposed rail line.

» A study needs to be carried out to determine the present and future environmental values for the waterways in the area and water quality criteria required to meet these values. The water quality objectives would be governed by receiving water discharge areas.

» Studies/investigations need to be carried out to evaluate the potential for inflow to the tunnel and deep open cut areas, and the likely pollutants in these waters. The investigations would include drilling and inflow measurements along the proposed alignment of the rail line.

» Samples of water would need to be gathered and subjected to testing to determine the most suitable treatment processes to meet the required water quality standards.

» The above studies would provide a database for the tunnel designers. Interaction is required between the tunnel and station cavern designers and the groundwater specialists to identify lining options and outcomes (eg reduced inflows), identify a site for the treatment plant(s), and sites for the disposal of treated water. Transfer systems within the tunnel would need to be taken into account, as well as the disposal of water from fire hydrants.

Recommended mitigation measures

» At the completion of the further investigations recommended above, the potential impacts and methods of mitigation would need to be tabulated. If a high impact activity is identified during the design development stage them it is normal practice to mitigate this impact by design. At the completion of the design development stage, all impacts would be appropriately mitigated.

» A water and soil management sub-plan would be developed as part of the construction and operation environmental management plans, which would incorporate the outcomes of a detailed geotechnical and geochemical investigation undertaken as part of the design development of the project. This plan would include information on surface water and groundwater monitoring programs.

9.9 Surface water and flooding

This section summarises the results of the flooding and surface water management assessment undertaken by GHD. The full report is located in Appendix E.

9.9.1 Assessment methodology

The assessment included a review of previous reports and other information. Most of this information was prepared for the previous 2002 alignment, however given the nature of alignment modifications, the data was considered adequate for the present assessment.

Working Paper No 3, Hydrology and Hydraulics Assessment, SKM, April 2003 provided an assessment of the 2002 alignment. The modifications incorporated in the current project respond to some of the issues raised in this report. Because the project is similar to the previous 2002 alignment for parts of the aboveground sections, this Working Paper was used as a key background document to this assessment.

The review of available information was supported by field visits to key sites.

9.9.2 Impact assessment

General

Potential impacts associated with the project in terms of surface water and flooding include:

- Raised flood levels due to obstructions to the flood discharges in the form of insufficient waterway openings, or constriction due to facilities and buildings being located in the flood way. This could lead to increased flood risk;
- Reduced floodplain storage at the location of rail embankments or associated facilities in the floodplain;
- Impact on local drainage, due to facilities interfering with the conveyance of local runoff;
- Increased runoff due to increased impervious areas;
- Stormwater quality impacts associated with the construction phase and operational phase, such as dewatering of underground facilities, for example tunnels and stations;
- Flood water entering the tunnel through the dive structures, portals and associated structures; and
- General construction phase impacts.

Further information is provided below.

Flood levels and conveyance

Elizabeth Macarthur Creek (southeast of Burns Road Station)

The project is located adjacent to Elizabeth Macarthur Creek in a cut and cover tunnel. No impacts are expected during the operational phase provided the topography is reinstated.

During the construction phase it is proposed to locate a construction work site within the Elizabeth Macarthur Creek flood plain. Careful management of surface water would be required to divert flows around the works areas to prevent construction related pollution from discharging to the creek. In addition, a buffer (preferably 40m or more) should be provided between the works area and Elizabeth Macarthur Creek.

The cut and cover operation is located on the edge of the floodplain and it would be necessary to ensure that flood waters are adequately managed during the construction phase, to prevent inundation of the works areas. This could be achieved by the provision of bunding to an appropriate flood level, which should be determined through a risk assessment.

Caddies Creek Confluence

At this location the project would be located on a viaduct. The viaduct would be located above the 1% annual exceedence probability (AEP) event, however may be subject to the probable maximum flood (PMF). The PMF information at this location is presently not available. Design of the viaduct would need to minimise flood level impacts to the residential area located east of Elizabeth Macarthur Creek and throughout the area of the Caddies Creek Confluence.

Potential impacts associated with the viaduct include loss of floodplain storage and disruption to the flow associated with piers and abutments. It would also be important to determine the PMF flood levels to ensure the viaduct does not impact such rare events.

A further impact is the potential for raised flow velocities associated with conveyance through the constriction and around piers of the proposed viaduct. This may lead to erosion and local scour and as a result the piers would need to be carefully designed.

Tributary 4

As the project at Tributary 4 is located in a cut and cover tunnel, no major impact is expected during the operational phase. During the construction phase the cut and cover operation is proposed across the creek line. It would be necessary to ensure that, during the construction phase, the creek and potential floodwaters are adequately managed to prevent inundation of the works.

Temporary works to manage Tributary 4 would need to minimise the flood level impact to surrounding lands as this could raise the flood risk to existing dwellings.

Tributary 3

At Tributary 3 the project is located in a cut and cover tunnel. No impact is expected during the operational phase. During the construction phase the cut and cover operation is proposed to cross the creek line. It would be necessary to ensure that the creek and potential floodwaters are adequately managed during the construction phase, to prevent inundation of the works.

Temporary works to manage Tributary 3 would need to minimise the flood level impact to surrounding lands as this could raise the flood risk to dwellings.

It would be necessary to ensure that Rouse Hill Station is outside or above the 1% AEP and PMF flood extents of Tributary 3, to prevent the risk of floodwater ingress to the station.

Second Ponds Creek

At Second Ponds Creek the proposed alignment and stabling facility would be located in a cutting, emerging from the cut and cover tunnel. During the construction phase it is proposed to locate work site areas within the PMF and 1% AEP event flood plains. The works in these areas would need to minimise the flood level impact to surrounding lands as this could raise the flood risk to existing dwellings.

For the operational phase, the cutting is located on the edge of the floodplain, and it would be necessary to ensure that flood waters do not overflow to the cutting, and potentially enter the cut and cover tunnel.

Quadruplication of Northern Line

At creek crossings associated with the quadruplication of the Northern Line there is the risk that, without mitigation, extension of culverts and fill embankments could affect conveyance through existing structures and increase local flood risk. In addition, where culverts may be replaced, the risk exists that flood conveyance through the structure may be altered reducing upstream flooding, with the transfer of flood risk downstream of the proposed alignment.

Scour

The potential for raised flow velocities as flood flow passes through the constriction of any proposed waterway opening, leading to scour at the inlets and outlets, would need to be managed and designed for. In addition where piers and abutments are located within the flow path, the risk of erosion and scour impacts needs to be managed.

Floodplain storage

No information is available on potential impacts associated with floodplain storage loss. While loss of floodplain storage may be an issue for all the proposed crossings, the key areas where the impact may be significant include:

» Second Ponds Creek; and

» Caddies Creek Confluence.

During further design development, additional studies should be undertaken to define flood peaks and levels for a full range of events. These should rely on two-dimensional modelling where potential floodplain storage impacts need to be defined.

Local stormwater management and drainage

On-site stormwater runoff peak flow rates and volumes could be increased due to the increased impermeable surfaces associated with the works, particularly in areas such as the stabling facilities or at the location of stations. During moderate rainfall events the resultant discharges can be highly erosive to stream bed banks and the receiving environment, thereby causing downstream degradation (for example of the aquatic habitat).

Increased peaks could raise on-site and off-site flood risk if not adequately managed. This could raise the flood risk (to life and property), compromise downstream infrastructure capacity and impact downstream environments leading to increased erosion and sedimentation.

Flood risk at the sites could also be impacted by local drainage channels that bisect or are located in close proximity to the proposed alignment, and that convey runoff from larger

upstream catchment areas either through or past the works. In areas of cuttings, local berms may be required to divert surface waters. Floodwaters captured within cuttings would need to be managed and disposed.

Stormwater quality

Operational phase water quality impacts are expected to be associated mainly with dewatering of the underground infrastructure, and management of local aboveground stormwater. Water intercepted through sub-surface drainage would need to be pumped to the surface, treated and disposed of to local creeks, meeting relevant water quality standards.

Construction phase impacts

During the construction phase, clearing and earthmoving activities have the potential to impact on surface water quality in the vicinity of the sites, especially during high rainfall events. The activities and aspects of the works that have potential to lead to erosion, sediment transport, siltation and contamination of natural waters include:

» Earthworks undertaken immediately prior to rainfall periods;

» Work areas that have not been stabilised, and clearing of land in advance of construction works;

» Stripping of topsoil, particularly in advance of construction works;

» Bulk earthworks and construction of pavements;

» Washing of construction machinery;

» Works within drainage paths, including depressions;

» Stockpiling of excavated materials;

» Storage and transfer of oils, fuels, fertilisers and chemicals;

» Maintenance of plant and equipment; and

» Management of tunnel construction water.

9.9.3 Summary of results

Potential impacts associated with the project upon surface water and flooding during the construction and operational phases include:

» Obstructions to flood discharges from insufficient waterway openings or constriction from facilities and buildings located in the floodplain;

» Increased surface water runoff from an increase in impervious areas;

» Stormwater quality impacts; and

» Flood waters entering the tunnel.

The potential for these impacts would be managed through implementation of recommended mitigation measures during the design, construction and operational phases.

9.9.4 Recommended mitigation measures

Further investigations

Flood conveyance and levels

Undertake detailed investigation of the hydrology and hydraulics at each site, using two-dimensional modelling as appropriate.

Caddies Creek confluence

A two dimensional model should be used during the design stage to facilitate:

» A better understanding of the discharges at the confluence of the creeks;

» The advantages of replacing part of the viaduct with a bridge section at the confluence of Caddies Creek and Elizabeth Macarthur Creek and Tributary 5 and Caddies Creek;

» Definition of the PMF flood passage and assessment of the likely impacts;

» Better definition of flood plain storage loss impacts; and

» Optimising the design of the viaduct structures.

Floodplain storage

It would be important to further define the floodplain storage impacts as part of design development, potentially through the use of two-dimensional modelling.

Recommended mitigation measures

Flood conveyance and levels

At Elizabeth Macarthur Creek (southeast of Burns Road Station), Caddies Creek Confluence, Tributary 4 and 3, Second Ponds Creek and the quadruplication section, the objective would be to minimise increases in flood levels upstream of the structure and maintain or reduce the existing flood risk.

Elizabeth Macarthur Creek (southeast of Burns Road Station)

At Elizabeth Macarthur Creek, investigate locating the works areas outside the creek and associated floodplain.

During the construction phase of the cut and cover tunnel it would be necessary to ensure floodwaters do not overflow to the works areas. This may require local creek diversions with local bunding, with consideration given to local flood risk impacts.

Bunding should occur to an appropriate flood level, which should be determined through a risk assessment. A buffer (preferably 40m or more) should be provided between the works area and Elizabeth Macarthur Creek.

Tributaries

Should temporary diversion of the creek together with bunding of the works areas be required, such work should make provision for flood events to prevent overflow to the cut and cover operation and minimise upstream flood risk.

It would be necessary to locate Rouse Hill Station outside or above the Tributary 3 flood plain or make provision through local bunding to prevent floodwaters from entering the station for events up to the PMF.

Second Ponds Creek

At this site it would be preferable to locate the works areas outside the creek and associated floodplain during the construction phase.

For the operational phase, it would be important to prevent ingress of flood waters to the siding area and potentially the cut and cover tunnel. This could be achieved by locating the western extent of the siding outside the floodplain or providing local bunding in this area.

For the area within the cutting, local surface water would need to be managed, such that discharges are diverted away from the cutting. Furthermore, runoff entering the cutting area would need provision of adequate drainage including pump stations together with water quality treatment before discharge to the environment.

Quadruplication

At creek crossings associated with the quadruplication section, care should be taken to maintain the existing local flood risk.

If culvert extensions are required, these should be designed not to increase upstream flooding. Should existing culverts be replaced, flood risk should not be transferred downstream of the proposed alignment by providing increased conveyance.

Scour

Erosion and scour should be managed by careful design of transitions at structure inlets and outlets, and provision of erosion protection. This would require adequate land upstream and downstream of structures to locate transitions. Erosion protection using 'soft' engineered solutions should be used in preference to hard engineered structures.

Local stormwater management and drainage

Changes in local stormwater runoff, such as runoff volume and runoff peak magnitude and response can best be managed using on-site detention facilities and Water Sensitive Urban Design strategies, according to local Council requirements.

Stormwater quality

Water quality associated with dewatering operations can be treated above ground, using package or other treatment facilities before disposal to local creeks. Other above ground water quality impacts can be managed using appropriate Water Sensitive Urban Design strategies, which could include structural solutions (for example gross pollution traps).

Recommended environmental management measures

Construction phase impacts could be managed by implementation of a construction phase soil and water management plan as part of the construction environmental management plan detailing stormwater management strategies in accordance with the guideline 'Soils and Construction, Managing Urban Stormwater' (Landcom, 2004). These would include amongst others:

- General site practices and responsibilities;
- Material management practices;
- Stockpile practices;
- Water treatment plant for tunnel construction water;
- Topsoil practices; and
- Erosion control practices.

9.10 Visual and urban design

This section summarises the results of the urban design and visual impact assessment undertaken by Hassell. The full report is located in Appendix I.

9.10.1 Assessment methodology

The urban design and visual impact assessment involved evaluating the visual and urban design impacts of the project in the context of the surrounding land uses. Urban design and visual impacts were considered in terms of:

» Impacts on urban design and visual effects, including:
  – General impacts
  – Effect on built form;
  – Amenity;
  – Landscape impacts; and
  – Access and connectivity;
» Identification of significant local impacts.

9.10.2 Impact assessment

Impacts on urban design and visual effects

General impacts

Potential visual and urban design impacts associated with the project include:

» Visual impacts associated with construction sites, including the use of machinery, construction activities and materials;
» The loss of vegetation that currently provides shade, screening and visual landscape amenity;
» A new visual element in the landscape where the project involves above ground structures;
» Potential amenity impacts during construction;
» Changes to urban form at the interface between stations and the existing urban environment; and
» New stations that are accessible and comprise modern design standards.

Effect on built form

As the majority of the project involves underground construction, the potential for impact on built form is minimised. In the vicinity of the stations, the project has the potential to result in an intensification of land uses, thereby affecting built form.

It is important that existing statutory provisions and strategic plans integrate future built form with the project. This would require relevant statutory authorities to continue liaison with the proponent during the design development.

Localised impacts could be expected during the construction and operational phase of the project. Initial impacts would include property acquisitions and the resulting change in visual and urban form.

Mitigation measures would be implemented to minimise potential visual and urban design impacts on built form. In particular, in areas where heavy engineering requirements are necessary (such as general construction sites, surface tracks, retaining walls, tunnel dive structures, viaducts, bridges and stations etc) careful selection of finishing materials, final presentation and urban design is necessary.

Urban design guidelines would be developed to guide the urban design of the project. This would focus on creating an urban environment that is both visually pleasing, encourages rail patronage and results in a cohesive built form with the buildings around it.

Amenity

Potential construction and operational visual impacts associated with amenity are likely to be more significant in areas where a loss of vegetation is expected, where the project would involve significant above ground works (such as the Balmoral Road construction site) and underground / surface interfaces. However amenity impacts would be reduced in areas where construction was taking place at the same time as surrounding urban development

Landscape impacts

Potential landscape impacts are likely to focus on the loss of vegetation in areas where surface works are proposed and through the introduction of new infrastructure to the landscape. Existing vegetation provides for a number of uses, including shade along footpaths, screening and a representation of nature within an increasingly urban environment. The loss of vegetation along the surface sections of the project (e.g quadruplication section, viaduct and construction sites) would affect the current landscape values associated with existing vegetation. Potential ecological impacts are considered in section 9.4.

The project would also introduce a new landscape character to the environment. In particular the application of above ground structures (such as embankments, retaining walls, viaducts and noise walls) would permanently alter the landscape. The potential impacts of these new features are that existing visual views are altered.

The urban design guidelines for the project would include landscape design principles to minimise the impacts of vegetation removal and changes to the landscape.

Access and connectivity

Once operational, there is potential for urban design improvements in directing and managing pedestrian and traffic movement. Potential access impacts are considered in section 9.2.

Potential construction impacts would include possible movement of pedestrian traffic away from existing footpaths and access ways. In addition, temporary footpaths and access ways may be required to compensate for the loss of existing access ways.

Connectivity with surrounding land uses would need to be considered during the construction and design development of the project. Connectivity should be based on the efficient movement of pedestrian and vehicle traffic. During the operational phase, connectivity should also optimise viewing vistas and create links with key land uses, including connectivity between land uses either side of the rail line and surrounding development.

Connectivity with surrounding land uses is necessary in order for the project to capture the benefits of attracting pedestrian and vehicular traffic and ensuring its success.

The urban design guidelines for the project would need to consider safe connections across above ground sections of the project.

Potential local impacts

Epping to Beecroft

Potential built form impacts would include retaining walls, additional bridges over the M2 and Devlins Creek. The most significant potential for visual impacts would be in areas where there are retaining walls.

Vegetation would be removed as part of the project on the rail reserve edges between Epping and Beecroft, resulting in exposure of the railway. To reduce this impact, dense low-level plantings are recommended to screen railway cuttings and railway embankments. In addition, remnant vegetation could be enhanced with plantings of appropriate species to provide screening of rail structures.

The surrounding residential landscape in Cheltenham affords filtered views to the existing rail line. The project would not dramatically alter the rail horizon, which does not rise above the current landform levels but maintains the existing rail grade. Residents who have downward viewing angles (on the west side of Cheltenham) would experience some loss of vegetation in their view. Residents who have upward viewing angles in Epping and on the east side of Cheltenham would be most affected by the project. The potential for noise walls exist along the rail corridor and would need to be sympathetically treated.

Implementation of landscape mitigation measures and urban design principles would ensure these impacts are minimised.

Franklin Road Station

The surface interface would substantially alter the character of the existing environment.

The main visual impacts in the locality are on adjacent residents, the Inala and Tangara Schools to the northeast and motorists on Castle Hill Road. While there are few local residents, the visual catchment of this area is broad, and the proposed removal of existing trees in this area would affect the natural ridgeline when viewed from a distance.

A balance between sensitive urban design of the station structures and ancillary facilities, ie, car parking areas, and retention of trees where practicable should mitigate and reduce the visual impact.

Castle Hill Station

The civic design of the station surrounds has the potential to improve the area and the adjacent commercial zones. There would be a low level of visual impact, provided disturbance to the existing established trees within Arthur Whitling Park is minimised through avoidance or implementation of landscape mitigation measures.

Hills Centre Station

The sub-surface station reduces adverse visual effect within the landscape setting, with only the station entrances emerging above ground level. Short-term construction activities would impact on amenity of the locality. The ultimate station structure would have minimum visual impact. Ancillary facilities such as car parking areas need to be designed to reduce visual impact.

Norwest Station

The proposed sub-surface station with access structures at-grade would provide a low level of visual disturbance within the locality. Locally, the station abuts the Ice Skating Rink, Norwest Marketown and Hillsong Church, all of which are of considerable scale and affirm a strong built form to the commercial area.

The civic design of the station based on sound urban design principles has the potential to improve the area and the adjacent commercial zones.

Norwest Station to Burns Road Station

The visual sensitivity of the area is low due to the scattered nature of existing residences, however further urban development projects in the vicinity would increase the number of impacted residences, thus increasing the visual sensitivity of the area although also creating opportunities to integrate development. The visual impact of the cut and cover section is limited as the project would involve rehabilitation of the existing landscape.

Burns Road Station

The proposed station includes commuter carpark facilities and a town centre, linked with the facilities provided at the North West Transitway interchange. Notwithstanding the alterations to the landscape by the introduction of the town centre, the scale of new built form and roads is less significant than the expanse of the Old Windsor Road and the expansion of the North West Transitway.

A permanent new station facility would contrast with the existing landscape character but would be in keeping with the expanse of transport infrastructure already adjacent to this site and the future transit oriented development. Consideration would need to be given toward facilitating connectivity with areas to the west. As the development of the Balmoral Road Release Area is yet to commence, there are opportunities to ensure that the station is integrated with the design and development of this area.

Burns Road to Rouse Hill Station

The project would involve a new built form, which includes a viaduct structure adjacent and parallel to Old Windsor Road. This would be a highly visible element. In addition noise barriers and embankments may be required.

The proposed alignment runs parallel to Old Windsor Road/Windsor Road and remains consistent with the strong arterial transport character of the area. Potential impacts upon the wetland/riparian communities along Caddies Creek and the construction process increase the visual effect of the project.

The viaduct has the potential to be a simple and elegant feature in a landscape of roads and bridges and residential housing. However there would be a change in character from a rural residential floodplain to a more complex transport corridor.

An indicative photomontage is provided in Figure 9.4.

Figure 9.4 Indicative photomontage of a potential viaduct across Elizabeth Macarthur Creek floodplain and crossing Windsor Road

Source: Cox/TIDC

Rouse Hill Station

The station would require urban design and visual integration with the Rouse Hill Regional Centre development. Potential impacts can be avoided if the design principles are implemented as the Rouse Hill Regional Centre develops.

Amenity and visual issues are unlikely to materialise as the station is not located near sensitive receivers, would not contrast with the transport character of Windsor Road and little vegetation would be lost.

Rouse Hill stabling facility

The rail approach to the stabling facility would be via a deep cutting of up to 10 metres beneath Windsor Road, which extends to Second Ponds Creek floodplain area. The rail cutting carves through the flat floodplain landscape that is already impacted upon by the Old Windsor Road widening.

The stabling facility covers a moderate area in a deep cutting, creating a discrete element in the landscape that is mostly disguised from the existing semi-rural character and in keeping with the adjoining road corridor.

As the stabling facility would be seen in the context of an expanded Old Windsor Road and the new urban release areas of Area 20 and Kellyville Ridge, the impact on the viewshed and urban design is likely to be minimised. However this would require integrated land use planning so that new residential areas, particularly within Area 20, are located a suitable distance from the stabling yard.

Views from Rouse Hill Regional Park would be screened by the trees along Second Ponds Creek, which would minimise the visual impact of the stabling yard area for park users. However, as noted in section 9.7, a view analysis should be undertaken to and from Rouse Hill House and its estate to identify the potential for any impacts on the viewshed of this heritage listed property.

9.10.3 Summary of results

Potential visual and urban design impacts during the construction phase would be focussed around surface construction areas where sensitive viewing receptors exist within the visual catchment.

During operation, the six new stations would act as catalysts to change in the visual and urban design elements surrounding the station precincts, enhance connectivity and encourage use of the project.

Surface elements of the project, such as the viaduct, provide an opportunity to introduce urban design features into a newly emerging urban landscape.

The introduction of the quadruplication and the associated dive structures would result in a visual change to the existing environment.

Project urban design guidelines would be prepared, including urban design principles to guide the further design of the project. This would ensure a high level of urban design for the project, thus minimising the potential for visual impacts and ensuring that the project is effectively integrated with the surrounding built form.

9.10.4 Recommended mitigation measures

Further investigations

Project urban design guidelines would be prepared, including urban design principles to guide the design development of the project. The following urban design principles would be used to guide the design of the new stations, the Cheltenham Station upgrade and/or the stabling facility concepts:

» Each railway station is to reinforce the role of its surrounding neighbourhood as a principal transport, commercial and community centre within the locality.

» Each railway station and the stabling facility is to be designed in the context of the scale, character and image of the surrounding area (desired or existing) and enhance the presentation of the area to visitors and travellers.

» Railway station access is to maintain or improve the cross-railway line connections or links to surrounding areas and activities. Where a connection between adjacent areas is desirable, pedestrian bridges or underpasses would be considered.

» Easy access facilities and links are to be incorporated into the station designs and surrounding interchanges.

» Railway station design should maintain visibility and protect and enhance built or natural features.

» Urban design should create a civic presence for the railway station as befits its role as a focus of human activity.

» Movement networks should improve existing, or establish new comfortable and inviting pedestrian environments, including disability access within the railway station and adjoining areas. There should be emphasis on the application of 'crime prevention through environmental design' principles.

» Public transport and other non-car based travel should be given priority connection to the railway station and its adjoining areas.

» Station precinct design should facilitate new development that reflects the highest standards and quality of architectural design, taking into account the existing built context and values.

Further visual assessment of the project would be undertaken as part of future design development. This would consider any urban design changes and opportunities for improvement. Additional assessments would include proposed bridging structures; cutting and embankment treatments; landscape treatment projects; detailed design of the stations and stabling facility; proposed acoustic treatments; and the final width and location of any visual buffer areas.

Mitigation measures

General measures to mitigate visual impacts would include:

» Where noise walls are proposed, potential visual impacts would be minimised by implementation of urban design measures, to be developed in consultation with adjacent

property owners (mitigation measures might include plantings and high quality facings near residential areas) as far as possible.

- Earth mounding would be considered where space allows and where vegetation would not be lost.
- A co-ordinated design theme would be established for bridges and flyovers to link the overall rail design together. The design would ensure that the structures are simple, integrated with the surrounding area and finished to a high quality. Fencing and any railing on the bridges would also be integrated with the overall design.
- The design of any underpasses would adopt safer by design principles, including the need for unobstructed views into and outside of the underpass, effective drainage and ventilation, wide corridors and good lighting.
- Light spill from construction and operation would be minimised as much as possible to reduce impacts on surrounding existing and future residents.
- Lighting around stations and car parking areas would also be specifically designed to reduce light spill to nearby residents, whilst still meeting public safety requirements.

9.11 Social impacts

This section summarises the results of the social impact assessment undertaken by B Cubed Sustainability. The full report is located in Appendix K.

9.11.1 Assessment methodology

The social impact assessment was undertaken mainly as a desktop study. Reviews of existing literature and reports have been undertaken. Materials reviewed include maps, photographs and other relevant sources. Site inspections were undertaken on 21 July and 7 August 2006.

9.11.2 Key socio-economic characteristics

Key characteristics include the following:

Population and income

In 2001 (Australian Bureau of Statistics Census) the total population of suburbs in the vicinity of the project was 163,433. This total comprised 4.1% of Sydney's total population. The suburbs of Baulkham Hills and Castle Hill had the highest population of the total at 20.6% and 19.4% respectively.

Every suburb's median weekly family income was higher than the Sydney average of $1,000-$1,199, apart from Parklea where the median weekly family income was half that of the Sydney average.

Relative socio-economic advantage/disadvantage information was gathered from the ABS's socio-economic indexes for areas database. It is noted that no values were available for Parklea. All suburbs within the subject area are classed as 'advantaged' as their index values are over 1,000.

Journey to work and car reliance

The total journey to work using public transport reliance (bus or train) totalled 6,164. Of this 3,889 (63.1%) relied on train and 2,275 (36.9%) on bus. As a total of trips within these suburbs, bus and train travel comprised 9.6% of total journeys. This is lower than Sydney's average of 16.3%.

As a total of trips within the selected suburbs, car use comprised 86%. This is higher than Sydney's average of 74.2%. As a percentage of the total car trips within these suburbs, Glenhaven (94.1%) and Kellyville (92.3%) were the highest and Epping (72%) and Pennant Hills (70.9%) were the lowest.

9.11.3 Impact assessment

General impacts

Potential social impacts that may result from the construction and operation of significant transport infrastructure such as the project include:

» Increased employment during construction and operation;

» Benefits to local businesses in the vicinity of new railway stations;

» Achieving the aims, with resultant social and economic benefits, of planning strategies such as the Metropolitan Strategy;

» Economic and social benefits achieved through reduced vehicle usage;

» Improved connectivity between communities which can reduce social severance, but also impact on community identities;

» Severance of existing communities by the addition of a physical barrier;

» Improved access to educational and employment opportunities;

» Improved transport choice and reduced car dependency;

» Improved health outcomes associated with improved air quality and reduced travel times/car dependency;

» Altered journey to work characteristics (and the possibility for impacts to spread well beyond the project area); and

» Amenity impacts (built form, noise and vibration, air quality etc).

Potential impacts at the metropolitan level

The construction of the project would have positive social impacts at the metropolitan level, including:

» Employment opportunities (refer section 9.12);

» Reduced public transport journey times and car dependency – this has the potential to result in air quality improvements and positive health benefits;

» Improvements in access to, from and within North West Sydney; and

» Assist with the implementation of Metropolitan Strategy initiatives relating to strengthening the role of centres, development of corridors and access to employment and services.

Potential impacts at the local level

At a local level, both positive and negative impacts could be experienced. The construction phase would be associated with a higher potential for negative impacts, particularly as a result of disruption and impacts on local amenity. The project has the potential for significant positive impacts at a local level, particularly as a result of improvements to access and services.

Potential social impacts at the local level include:

» Community identity and interaction;

» Amenity impacts;

» Access and transport, particularly for people with special needs; and

» Acquisition and dislocation.

These are discussed below.

Community identity and interaction

Potential issues and impacts include:

» Severance – this relates to the extent which the project or related activities (such as construction activities) have the potential to physically divide a community. Construction of rail infrastructure can create physical barriers interrupting established social linkages, connections and travel patterns. However, this potential impact is likely to be minimal for the project. In established urban areas, the project would be located in a tunnel. There would be some surface sections In the newer development areas to the north west, however these would be located in the vicinity of existing regional road infrastructure and at the edges of newer development areas.

» Community identity - infrastructure (such as a railway station) can promote community identity, as it can be a meeting place and a focal point for activity. However, it can also have negative impacts on identity as the character of the place changes due to differences in community structures and behaviours.

» Social interaction - social interaction refers generally to the extent to which individual or group actions promote a high level of interaction. The presence of a community focal point such as a railway station and associated infrastructure has the potential to increase social interaction.

» Community assets - related to the above elements is the role of community assets in promoting cohesion and interaction among community members. Positive impacts in relation to community assets include improvements to access. Negative impacts could occur as the result of disruption to the use of these assets, either temporarily during construction, or permanently if acquisition is required. Key community assets in the study area include:

  – Cheltenham railway station and commuter car park;

  – Beecroft Scout hall, tennis courts and Village Green;

  – The Hills Centre and Baulkham Hills Shire Council administration centre;

  – Open space and recreation reserves such as Arthur Whitling Park at Castle Hill and the Castle Hill Showground;

» Uncertainty - In relation to the project, uncertainty may be experienced particularly during the conceptual phase where a number of variables exist. This can increase levels of stress in the community.

Amenity impacts

The construction and operation of the project has the potential to create amenity impacts such as:

» Noise and vibration - noise and vibration during the construction and operation phases may impact on residential amenity unless appropriate design and mitigation measures are adopted.

» Changes to traffic and parking – potential issues and impacts include:

  – Impacts experienced as a result of construction traffic;

  – Reduction in vehicular traffic, especially during the peak periods;

  - Reductions in 'rat-running' through neighbourhood streets in some areas and increases in other areas;
  - Some increased congestion of local roads around new stations with park and ride facilities; and
  - Changes to commuter parking arrangements.

Potential traffic and transport impacts are discussed in section 9.2.

» Visual impacts including:
  - Impacts to vegetation – vegetation and trees can contribute significantly to residential amenity, and any loss of vegetation can have a negative impact. This potential impact would be minimal for the project, as the majority is located in a tunnel and/or in areas that have already been disturbed for urban development. There would however be some clearing required of small stands of remnant vegetation, mainly in the vicinity of the quadruplication and between Burns Road and Rouse Hill Stations. Potential ecological impacts are discussed in section 9.4.
  - Changes to the visual quality of the landscape, both during construction (landscape disturbance and the presence of construction worksites) and operation (presence of new structures). Potential visual impacts are discussed in section 9.10.
» Air quality impacts – the main potential for negative impacts would be as a result of dust generation during construction. Positive air quality impacts may occur if car use decreases.

The potential for negative amenity impacts would be significantly reduced by the implementation of appropriate design features (such as noise mitigation) and stringent environmental management controls guided by the construction and operation environmental management plans.

Access and transport

The project has the potential to provide significant social benefits in terms of improvements to access, particularly for groups with special needs or impaired mobility. This could include people with a disability, young people and the aged. As noted in chapter 5, the project would provide people from North West Sydney with improved access to employment, education, shopping and community facilities. There would also be improvements to access to major shopping centres located at Castle Hill, Macquarie Park, Chatswood and the Sydney CBD, and future facilities planned at Rouse Hill. Major health facilities, such as the Royal North Shore Hospital, would be more accessible to patients, staff, and visitors alike. There would also be easy connections to the centres of Strathfield, Burwood and Hornsby via one change of train at Epping.

Acquisition

As noted in section 9.1, the project would require acquisition of land along the route, with approximately 105 private properties needing to be totally or partially acquired. Potential issues that can arise as a result of property acquisitions are outlined in Table 9.32.

Table 9.32 Potential social impacts associated with acquisition

Residential	Commercial/ employment	Rural	Industrial
» Anxiety » Amenity » Financial distress » Isolation » Severance from community	» Financial concerns » Relocation costs » Locating suitable alternative accommodation » Staff anxiety » Operational difficulties » Market impacts	» Loss of agricultural land and production » Relocation costs » Locating suitable alternative accommodation	» Financial concerns » Relocation costs » Locating suitable alternative accommodation » Staff anxiety » Operational difficulties » Market impacts

All acquisitions would be undertaken in consultation with landowners, in accordance with the terms of the *Land Acquisition (Just Terms Compensation) Act 1991*. Section 55 of the act allows for the following matters to be considered in determining the amount of compensation to which a person in entitled:

> '(a) the market value of the land on the date of its acquisition,
>
> (b) any special value of the land to the person on the date of its acquisition,
>
> (c) any loss attributable to severance,
>
> (d) any loss attributable to disturbance,
>
> (e) solatium,
>
> (f) any increase or decrease in the value of any other land of the person at the date of acquisition which adjoins or is severed from the acquired land by reason of the carrying out of, or the project to carry out, the public purpose for which the land was acquired.'

Potential impacts for localities - construction

Given the conceptual nature of the project at this stage, the social impact assessment focussed on identifying the main potential impacts. This would allow these to be addressed during the ongoing/future design processes. Further information on specific impacts for individual localities would be available following the input from the community as a result of further consultation being undertaken for the project, and more detailed investigations undertaken in association with design work. Where specific potential impacts for individual localities have been noted, these are listed below.

Quadruplication section

» Social interaction may reduce during the construction phase as a result of the scale of works and site disturbances including the reconstruction of the Cheltenham Road Bridge.

» Potential impacts on community assets including the commuter car park at Cheltenham Station.

» Potential for amenity impacts.

Tunnel portal – dive site

» Potential impacts on community assets including the Scout Hall and Beecroft Village Green.

» Potential for amenity impacts.

Castle Hill Station

» Some impacts on traffic and parking arrangements within the centre could be anticipated during the construction phase, including haulage down Old Northern and Showground Roads.

» Potential impacts on community assets – particularly Arthur Whitling Park, under which the station is proposed to be located.

Hills Centre Station

» Potential impacts on community assets - works would be required adjacent to the Castle Hill Showground for the station entrance and access ways and tunnel spoil construction site under the staged delivery scenario.

Balmoral Road Construction site

» Amenity impacts.

Viaduct section between Balmoral Road and Rouse Hill

» Potential for physical severance as the linear nature of the construction works may create a barrier between those communities living on either side of the viaduct.

» Social interaction may reduce during the construction phase as a result of the scale of works and site disturbances.

Potential impacts for localities - operation

Further information on specific impacts for individual localities would be available following the input from the community as a result of further consultation being undertaken for the project, and more detailed investigations undertaken in association with design work. Where specific potential impacts for individual localities have been noted, these are listed below.

Quadruplication section

» Improvements to access - Cheltenham Railway Station would become an 'easy-access' station, which would allow improved access for the aged and those who have a physical disability.

» Improvements to amenity:

  – Local streets around the station experience high levels of parking during the week as a result of commuter use of these stations from suburbs in North West Sydney. There is potential for the level of parking in the local streets to reduce, as people would no longer need to drive to Cheltenham (and other stations). Apart from local benefits, this would also benefit communities located along the rail corridor due to reduced peak hour traffic flows in these areas.

Franklin Road Station

» There is the potential for the area around Franklin Road Station to develop its own identity and sense of place with the introduction of the railway station.

» Impacts on amenity - it is anticipated that much of the train patronage would comprise people living in the Cherrybrook, Dural and Glenorie areas and that these people would use the Franklin Road Station as a 'park and ride' facility, which has the potential to cause congestion on local roads during peak periods.

Castle Hill Station

» Improved community identity as the station has the potential to form a focal point and meeting place for the community and improve access to the centre.

» Improved social interaction as a result of increased activity around the centre.

» A new community asset in the form of a new railway station and associated facilities.

» Impacts to Arthur Whiting Park – an area of this park would be required for permanent works at the station including entrance, egress, service shafts and ventilation buildings.

Hills Centre Station

» The new station has the potential to impact on the level and type of interaction within the community. This locality already has its own strong community identity and sense of place. This could be increased by the introduction of the railway station.

Norwest Station

» There is the potential for the area around Norwest Station to develop a stronger community identity and sense of place with the introduction of the railway station. The identity of the area is currently dominated by the presence of the Hillsong Church facilities and the location of corporate operations/businesses. The new station has the potential to reinforce and strengthen the existing identity of the area.

Viaduct section between Balmoral Road and Rouse Hill

» The potential for physical severance as a result of the surface sections would need to be considered as part of the design development. The cut and cover and viaduct sections of the existing design allow for ease of access. Those sections on the surface may require additional crossings to be considered as part of the further design stage.

Rouse Hill Station

» The station has the potential to provide a strong focus for the built form of the Rouse Hill Regional Centre. The presence of a railway station, major centre and associated transport infrastructure would assist the area develop into a dynamic place where people interact. Over time, this would generate increased social capital in the area, as people interact with other community members on a regular basis.

Rouse Hill Stabling

» Potential for amenity impacts.

9.11.4 Summary of impacts

The main potential social impact associated with the project would be the potential for disruption during construction. Overall, the project seeks to deliver positive benefits at the local, regional and metropolitan level, mainly through improvements to accessibility.

The project would have positive social impacts at the metropolitan level, including:

» Employment opportunities.

» Reduced public transport journey times and car dependency – this has the potential to result in air quality improvements and positive health benefits.

» Improvements in access to, from and within North West Sydney.

» Assist with the implementation of Metropolitan Strategy initiatives relating to strengthening the role of centres, development of corridors and access to employment and services.

Potential social impacts at the local level include:

» Community identity and interaction:

  – Potential severance impacts are likely to be minimal for the project.

  – The presence of a community focal point such as a railway station and associated infrastructure has the potential to increase social interaction and promote identity.

  – Positive impacts in relation to community assets include improvements to access. Negative impacts could occur as the result of disruption to the use of these assets, either temporarily during construction, or permanently if acquisition is required.

» Amenity impacts – The construction and operation of the project has the potential to create amenity impacts such as noise and vibration; changes to traffic and parking; visual impacts; and air quality (dust) impacts.

» Access and transport, particularly for people with special needs - the project has the potential to provide significant social benefits in terms of improvements to access, particularly for groups with special needs or impaired mobility.

9.11.5 Recommended mitigation measures

Further investigations

» Undertake additional social and demographic analysis once results of the 2006 ABS census have been released and project details have been refined. This should include the identification of measures to protect community assets and enhance community services and facilities.

Recommended mitigation measures

» Work closely with local councils to develop urban planning solutions around the stations, which meet the needs of the project and maximise potential social benefits.

» Undertake consultation with the community throughout the project planning and construction phases to ensure that community members have adequate information about the project and the timing and scope of activities in their local area.

- Design stations and interchanges to promote community interaction.
- Implementation of measures to minimise the potential for construction and operation impacts on amenity. This would include measures recommended in other sections of the environmental assessment and the development and implementation of construction and operation environmental management plans.
- Integrating community development programs into the project delivery phase to build community ownership and understanding of its key elements and broader aims and objectives.
- Undertake property acquisitions in accordance with the terms of the *Land Acquisition (Just Terms Compensation) Act 1991.*

9.12 Economic impacts

9.12.1 Overview

This section summarises the relevant results of the social impact assessment undertaken by B Cubed Sustainability. The complete report is contained in Appendix J. Other sources of information include the Norwest Business Park Land Use Overview Report (B Cubed Sustainability: 2006).

9.12.2 Impact assessment

Potential impacts are described in the following section. Specific impacts would need to be determined at a locality by locality level once the design has been refined and construction details are finalised.

Increase in business activity

Potential positive impacts may occur as a result of increased demand for food and services by the construction workforce during the construction period, and as a result in increased visitation to areas in the vicinity of stations by commuters (during operation). This includes potential increase in business activities and growth, and opportunities to establish integrated transit oriented developments in the vicinity of:

» Franklin Road Station;

» Castle Hill centre;

» Hills Centre Station;

» Norwest Business Park;

» Burns Road Station; and

» Rouse Hill Regional Centre.

In particular, it is considered that the presence of a rail station would support the growth of Castle Hill as a major centre. Growth in this centre and the larger role it could play in the metropolitan area would result in positive economic conditions for local businesses and the community.

Improved access to local businesses

The large number of employers in centres such as Castle Hill and Norwest may find it easier to attract and to retain quality employees as a result of improved access to the metropolitan rail network.

Increase in employment opportunities

At the metropolitan level, the construction of the project would have a significant positive impact in terms of the provision of direct jobs in the construction and related industries and numerous other jobs in support industries.

The potential for increase in business activity noted above may also lead to an increase in employment.

Business acquisitions

The project would require full or partial acquisition of approximately 40 commercial/employment properties.

Disruptions during construction

If not managed effectively, there is the potential for impacts on the operation of businesses in the vicinity of construction activities. Potential impacts could include:

» Alterations to access arrangements during construction and operation - any changes to the existing access arrangements, making it difficult to stop or directly access businesses in the area, may result in negative impacts; and

» Potential for a downturn in trade during the construction period if the number of visitors reduce (as a result of any disruptions to access, reduction in the general amenity of the area and/or any reduction in car parking spaces).

The provision of adequate long-term access to these businesses, as well as maintaining access throughout the construction period, would assist in minimising the significance of these impacts.

During construction, impacts created by traffic/parking and noise/vibration would need to be managed to ensure that potential impacts experienced by businesses in the locality are minimised.

Potential for impacts to businesses with specialised needs

The potential for impacts to businesses with particular needs and requirements has also been noted. This could include businesses in Norwest Business Park with high technology equipment that may be affected by noise and vibration interference.

Major landholders at the Norwest Business Park include:

» ARV Food Services
» Alltech Associates Aus
» Belle Banne Flexco
» Bullivant's Health Prod
» Cathay Pac. / IBMGSA
» Demcy International
» Di Lorenzo Ceramics
» Interfab Holdings
» Le Rêve Cosmetics
» Modern Group
» Nutricia Australia
» Optus Singtel
» Otto Bock
» PMA Solutions
» ResMed
» Schneider Electric
» Sigma Pharmaceuticals
» Undercover Wear
» Woolworths Limited
» Wyeth Australia

A number of these occupants may have high technology equipment on site with the potential to be affected by noise and vibration if this is not adequately managed during construction and operation.

However not all of them:

» Are adjacent to the proposed alignment; or

» Are likely to have operations/activities which could potentially be affected by construction or rail related noise and vibration.

The potential for noise and vibration impacts, together with appropriate mitigation measures, are considered in section 9.3.

9.12.3 Summary of impacts

Potential impacts include the following.

» Increase in business activity;

» Improved access to local businesses;

» Increase in employment opportunities;

» Business acquisitions; and

» Disruptions during construction - If not managed effectively, there is the potential for impacts on the operation of businesses in the vicinity of construction activities.

Specific impacts would need to be determined at a locality-by-locality level once the design has been refined and construction details are finalised.

9.12.4 Recommended mitigation measures

Further investigations

» A detailed assessment should be undertaken of potential local business impacts in the vicinity of construction sites. This assessment would need to be integrated into the design development phase to ensure negative impacts are minimised while potential benefits are maximised. The assessment would include consideration of:

  – Businesses that may be affected by the works;

  – Short term construction related impacts and how these can be managed; and

  – Long term benefits of increased activity around station precincts.

Mitigation and management measures

The following measures are recommended to minimise the potential for construction related impacts to local businesses:

» Careful placement of construction worksites to minimise the potential for disruption of access to businesses;

» Minimising loss of carparking during construction periods;

» Ensuring early consultation and appropriate timing of works to minimise disruption to businesses;

» Ensuring consultation with owners and tenants of land to be acquired, and negotiation in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*;

- Maximising the use of arterial roads for construction access, and placing controls over the use of local roads and commercial centre parking for construction vehicles; and
- Implementation of measures to minimise the potential for construction and operation impacts on amenity. This would include measures recommended in other sections of the environmental assessment and the development and implementation of construction and operation environmental management plans.