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Transport Infrastructure Development Corporation

North West Rail Link Environmental Assessment

Spoil Management

October 2006

INFRASTRUCTURE | MINING & INDUSTRY | DEFENCE | PROPERTY & BUILDINGS | ENVIRONMENT

Contents

Table Index

Figure Index

Appendices

1. Introduction

This report has been prepared as part of the environmental assessment of the proposed North West Rail Link (the proposal). The Transport Infrastructure Development Corporation (TIDC) is the proponent of the proposal, and the environmental assessment is being prepared by GHD, in accordance with the requirements of Part 3A of the *Environmental Planning and Assessment Act 1979*.

This report assesses the management of spoil generated by the proposal. It focuses on the volume and nature of the spoil generated, the associated truck movements, proposed reuse/disposal options, and makes comment on the likely haulage routes and method. It has been prepared to meet the Department of Planning Director General's Requirements for the environmental assessment.

Spoil production rates and locations of spoil producing work sites identified in this report reflect the proposed approach to construction described in the Parsons Brinkerhoff (2006) *Engineering and Infrastructure Technical Report*. While it is possible that elements of the construction plan may vary as a result of detailed project design and construction planning, the general spoil management strategies and principles outlined in this report can still be applied.

1.1 Project outline

The proposed North West Rail Link would be the principal trunk public transport line in Sydney's North West. It would connect with the Northern Line between Beecroft and Cheltenham Stations and terminate at Rouse Hill Town Centre. The rail link would be twin track, approximately 23 kilometres in length and would include:

- A 2.5 km surface quadruplication of the Northern Line between north of Epping Station and Beecroft Station (including works at Cheltenham Station);
- A 16 km section in tunnel from the Northern Line to north of Norwest Business Park, including four underground stations (Franklin Road Station, Castle Hill Station, Hills Centre Station and Norwest Station);
- A 4 km surface section from north of Norwest Business Park to Rouse Hill, including two underground stations (Burns Road Station and Rouse Hill Station)
- An interim train stabling facility at Rouse Hill;
- Ancillary tunnel support facilities such as tunnel ventilation, transformers and a water treatment plant(s); and
- Construction work sites, including a large site within the Balmoral Road Release Area.

In addition, a number of construction sites would be established. The main work site is likely to be in the Balmoral Road release area. Smaller sites would also be required at the stations and in close proximity to the tunnelling operations.

The location of the proposal is shown in Figure 1-1.

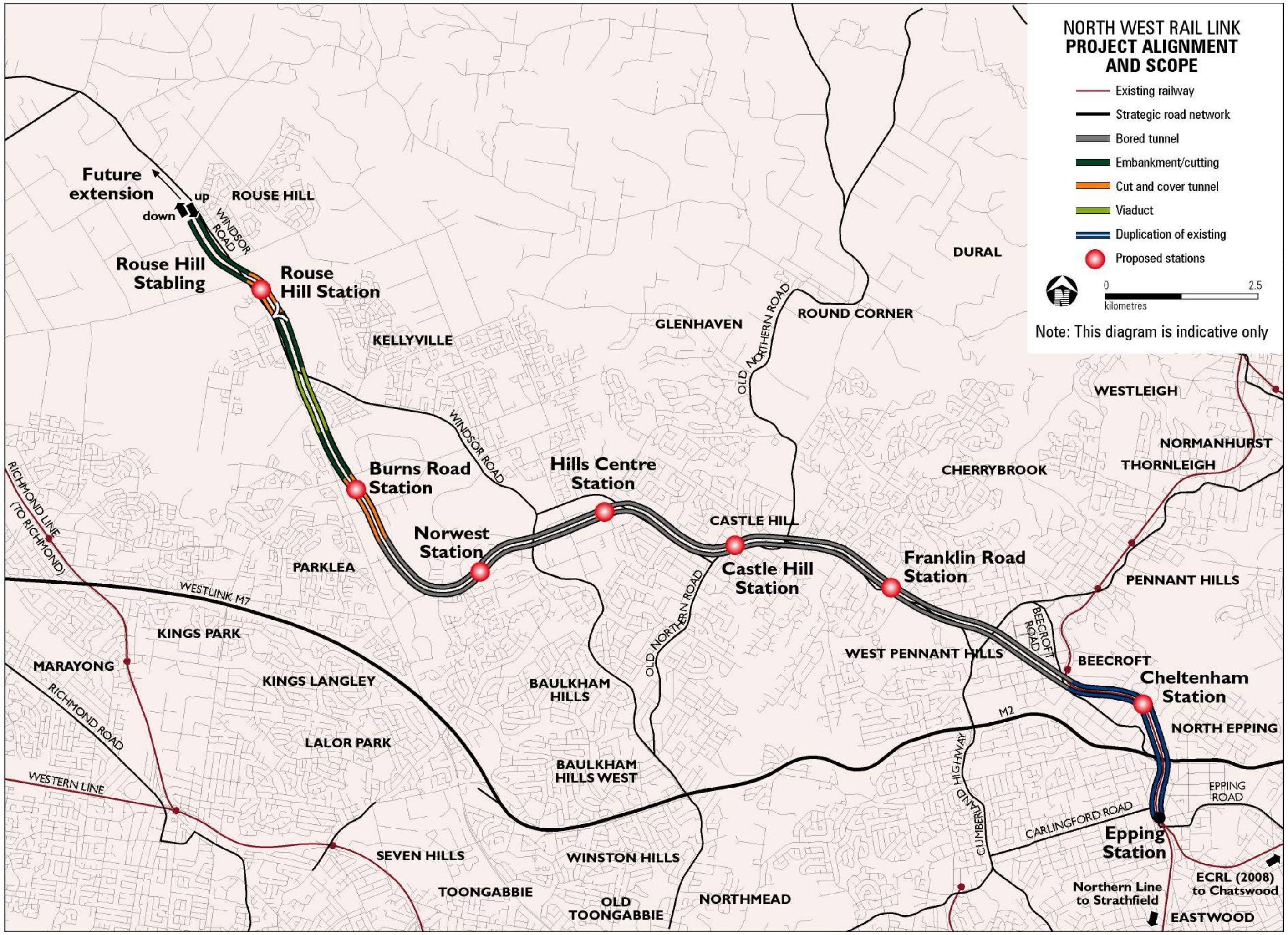

Figure 1-1 Location of the proposal

2. Spoil Management

2.1 Assumptions for Estimates

The quantities of spoil expected to be generated, and estimated in this report are based on information provided in the Parsons Brinkerhoff (May 2006) and Evans & Peck (May 2006) reports in the North West Rail Link Project Review Report and supported by information in the Arup (2005) *2004 Engineering Design Study*. General assumptions used in estimating spoil quantities are as follows:

- Tunnels are of 7.4 m excavated diameter;
- Bulking factor (volume increase during excavation) for sandstone / shale is 1.6; and
- Density of fill (sandstone / shale spoil) is 2 t/m^3.

2.2 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 New South Wales Department of Environment and Conservation (DEC) 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.

Excavated sandstone is generally characterised by a mixture of rock and sand, and the rock fragments are recognisable by individual grains that are visible to the naked eye. The quantity of larger rock fragments (or gravel through to boulder size) depends on how the material is excavated and the strength of the rock. Generally, ripping will produce a mixture of gravel / boulder sizes, while slow excavation with tunnel boring machine (TBM) may reduce the material to sand with some fines.

Shale, when excavated, is usually a mixture of broken rock and clay, and the individual particle grains in the rock fragments are not visible to the naked eye. In general, the higher the proportion of clay in the material, the less useful it would be as a fill material. However, some shales can be crushed, ground and processed to produce clay for vitrified products including tiles, pipes and bricks.

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 will take up a greater volume because it is loosened by the process of excavation. This is referred to as 'bulking' and hence, in this report the estimated spoil quantities are reported in bulked volume. Bulked volume is calculated by applying a bulking factor to the in situ volume (section 2.1).

2.3 Excavation Rates

The preferred excavation method for tunnels of sufficient length is by 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. Road headers are another commonly used method for underground excavation, particularly through sandstone and shale. Road headers would be required for other construction activities such as at station sites, or for TBM access shafts and starter tunnels. Table 2-1 lists the tunnel excavation and hence spoil production rates for various excavation techniques in both sandstone and shale.

Table 2-1 Tunnel excavation rates

Equipment	Geology	Tunnel Diameter (m)	Average Rate (m/wk)	Peak Rate (m/wk)	Duration (h/d/wk)	Average (t/wk)
TBM	Sandstone	7.4	200	400	24 h, 6 d	17,200
TBM	Shale	7.4	120	240	24 h, 6 d	10,320
Road header	Sandstone / shale	7.4	30	60	24 h, 6 d	2,580
Rock breakers & excavators	Sandstone / shale	stations (80,000 m^3 to 120,000 m^3)			10 h, 6 d	3,500*

Note: * assumes two rock breakers / excavators working per station

Source: Arup (2005) *North West Rail Link: 2004 Engineering Design Study*, p.62

For planning purposes, the overall average travel rate is estimated at 175 m 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.

For a single large diameter tunnel excavated by road header, the average excavation rate would be approximately 30 m per week for a tunnel heading face area of around 43 m^2. Therefore, the average solid excavation volume per week would be approximately 1,290 m^3, creating a bulked average volume of approximately 2,060 m^3 per week per tunnel heading.

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.

2.4 Sources of Spoil

The North West Rail Link project would produce spoil from the following:

» Excavation of tunnels and tunnel dive structures;

» Mining of underground station box structures;

» Excavation of station access and ventilation shafts;

» Construction of surface railway in cut or fill; and

» Construction of cut and cover sections of railway.

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

The following sections outline the estimated spoil quantities that would be produced at various locations along the alignment of the NWRL.

2.4.1 Cheltenham Dive

Spoil produced

Two dive structures would be constructed branching off the Northern Line between Cheltenham Station and Beecroft Station to connect with the twin-bored tunnels. These dive structures incorporate the tunnel portals, and each is anticipated to be approximately 300 m in length. An estimated 39,400 m^3 bulked volume of spoil would result from excavations for the Cheltenham Dive.

Location of spoil

The spoil from excavation of the dives at Cheltenham would be removed by truck from the work site at the location of the dives.

2.4.2 Bored Tunnels and Underground Stations

Spoil produced

The bored tunnel section in the Reference Scheme includes two rail tunnels, one for the Up main and one for the Down main. Two TBMs would simultaneously travel the full length of each tunnel from the west to east, from the portal at Balmoral Road to the Cheltenham Dive adjacent to the junction with the Northern Line. This 13.3 km tunnel would generate approximately 2.29 million tonnes (1.83 million m^3 bulked volume) of spoil.

A further 1,150 m^3 bulked volume of spoil would be generated from excavation of cross passages. Table 2-2 shows the minimum number of required cross passages for each tunnel section and the corresponding estimated spoil produced for each section.

Table 2-2 Estimated spoil generated from excavated cross passages

Start	Finish	Distance (km)	Minimum number cross passages	Bulked volume spoil generated (m^3)
Cheltenham dive	Franklin Road Station	3.90	13	580
Franklin Road Station	Castle Hill Station	2.32	7	300
Castle Hill Station	Hills Centre Station	2.14	6	270
Hills Centre Station	Norwest Station	2.03	5	240
Norwest Station	Burns Road Station	2.90	9	450
TOTAL		*13.29*	*40*	*1,840*

Note: assumes that small cross passages require 2 m excavated diameter and are 6 m in length. Larger sized cross passages of 4 m excavated diameter may also be required.

Four underground stations (Franklin Road, Castle Hill, Hills Centre and Norwest stations) would be mined from below ground. Each of these underground station boxes is expected to generate approximately 204,800 m^3 bulked volume of spoil. As there are four underground stations to be mined, this equates to a total of approximately 819,200 m^3 bulked volume of spoil from underground station excavations.

At each of the underground stations, ventilation and access shafts would also need to be constructed. No intermediate shafts are proposed between stations so that access is from the stations and all ventilation and control equipment is centralised. The excavation of these shafts is expected to occur top down. The estimated spoil produced from the excavation of ventilation and access shafts is shown in Table 2-3. A total of approximately 147,360 m^3 bulked volume of spoil would be produced from the top down excavation of ventilation and access shafts for the four underground stations.

Table 2-3 Estimated spoil quantities from excavation of underground station ventilation & access shaft

Ventilation / access shafts location	Bulked volume spoil generated (m^3)	Key assumptions in calculations
Franklin Road Station	36,000	1 access shaft and 1 ventilation shaft, both 15 x 30m in area, depth of shaft 25m
Castle Hill Station	50,400	1 access shaft and 1 ventilation shaft, both 15 x 30m in area, depth of shaft 35m
Hills Centre Station	30,240	1 access shaft and 1 ventilation shaft, both 15 x 30m in area, depth of shaft 21m
Norwest Station	30,720	1 access shaft and 1 ventilation shaft, both 15 x 30m in area, depth of shaft 32m
TOTAL	*147,360*	

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 portal main construction work site. Excavated spoil from vertical access and ventilation shafts would be removed by truck directly from the respective ground level work sites.

2.4.3 Cut and Cover Tunnels and Stations

Spoil produced

The tunnel between the bored tunnel portal at Balmoral Road to north of Burns Road as well as the tunnel passing below the Rouse Hill Regional Centre would be constructed by cut and cover. Earthwork volumes for these sections of work (that is, excluding sections of permanent cut and fill and excluding bored tunnel sections) are shown in Table 2-4. A total of 585,100 m^3 bulked volume of excess spoil material would be generated that cannot be reused as fill.

Table 2-4 Earthworks bulked volumes for cut and cover sections

Section	Cut (m^3)	Fill (m^3)	Excess Cut / Fill (m^3)
Bored tunnel portal to north of Burns Road	455,650	210,000	245,650
Rouse Hill Regional Centre	636,950	297,500	339,450
TOTAL	*1,092,600*	*507,500*	*585,100*

Note: The earthworks volumes are based on typical rail cross sections in cut and fill as set out in Appendix C of the Arup *2004 Engineering Design Study*, and assume a rate of 175 m^3/m reuse of spoil to fill the cut and cover excavation.

Source: adapted from Arup (2005) *North West Rail Link: 2004 Engineering Design Study*

In addition to the cut and cover quantities listed above, there would also be spoil generated from the excavation of cut and cover stations at Burns Road and Rouse Hill. Burns Road Station is in partial cut and cover, and currently proposed to be aligned approximately 14 to 8 m below the present ground level. The estimated quantity of spoil from excavation of Burns Road Station is in the order of 70,000 m^3 bulked volume.

Rouse Hill Station would be constructed to a depth of approximately 12 to 14 m below present ground level. The estimated spoil quantity from excavation of the station box structure and associated plant and service room area is 262,000 m^3 bulked volume.

GHD

Table 2-5 Estimated bulked volumes of spoil for cut and cover stations

Section	Bulked volume spoil generated (m^3)	Assumptions
Burns Road Station	70,000	Based on average depth of excavation of 11 m, width of station box of 22 m and length of station box of 180 m.
Rouse Hill Station	262,000	Based on average depth of excavation of 13 m, width of station box of 60 m and length of station box of 210 m.
TOTAL	*332,000*	

Location of spoil

Excavated excess spoil from cut and cover section would be removed directly from work sites along the alignment of the rail line. Spoil from cut and cover stations would be removed by truck directly from the respective station work sites.

2.4.4 Surface Railway Embankment / Cutting Construction

Spoil produced

Cuttings for the surface railway sections would be carried out using conventional earthmoving equipment. The cuttings are expected to be contained within the Ashfield Shale Formation which lies closest to the surface. Some excavation may also be required down into the Mittagong Shale Formation in the vicinity of the Rouse Hill Station.

Table 2-6 shows the earthworks volumes for the sections of surface railway in cut or fill (that is, excluding excavations from the bored tunnel and from cut and cover sections). A total of 254,650 m^3 bulked volume of shale would be cut for the construction of surface railway, with approximately 43,300 m^3 bulked volume of fill being required for fill embankment.

Table 2-6 Earthworks bulked volumes for railway in cut or fill

Section	Cut (m^3)	Fill (m^3)	Excess of cut over fill (m^3)
North of Burns Road to south abutment of viaduct at Samantha Riley Drive	59,700	6,100	53,600
North abutment of viaduct at Windsor Road at start of Rouse Hill Regional Centre cut and cover	127,000	37,250	89 750
End of Rouse Hill Regional Centre cut and cover to stabling	67,950	50	67,900
TOTAL	*254,650*	*43,400*	*211,250*

Source: adapted from Arup (2005) *North West Rail Link: 2004 Engineering Design Study*

The above table shows that the volume of excavation in shale material could easily supply the fill material volume requirements. While excavated shale materials are predicted to have medium to high durability and be generally suitable for placement in fill embankments, treatment of the upper layer is likely to be required to provide an adequate track bed (Arup 2005). An alternative would be to source the required 43,400 m^3 of material for fill embankments from the tunnel excavations in the Hawkesbury Sandstone. The sandstone would be preferable to shale for a number of engineering and geotechnical reasons.

Location of spoil

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

2.4.5 Summary of Spoil Quantities

Table 2-7 provides a summary of the approximate spoil quantities estimated to be produced from the proposal. The proposal is expected to generate a total of approximately 5 million tonnes (or 4 million m^3 bulked volume) of spoil.

Table 2-7 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*

2.5 Potential Traffic From Spoil Transportation

Table 2-8 summarise the estimated standard truck movements associated with removal of spoil materials from various work sites. The standard truck sized used in the truck movement estimations is 19.5 m^3 bulked capacity.

Table 2-8 Estimated spoil truck movements[1]

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
	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
	Caste 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 Town 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

[1] One truck arriving and departing from site = 2 truck movements

Over the construction period, it is expected that spoil generation would occur along various sections of the proposed alignment concurrently. The actual cumulative effects in terms of spoil generation and associated truck movements would be determined once detailed construction scheduling and detailed designs are finalised.

However, it is anticipated that excavation of the bored tunnel sections would coincide with excavations of up to three of the underground station boxes 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. This is equivalent to an average of approximately 22 truck movements per hour (where one truck arriving and departing the site is equivalent to 2 truck movements), assuming spoil removal occurs 24 hours per day.

Spoil removal would also be required from the other work sites along the alignment of the NWRL. 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 per week during excavation of the main dive area.

3. Potential Spoil Reuse / Disposal Options

3.1 Overall Strategy for Spoil Reuse / Disposal

As discussed in section 2.4, a total of approximately 4 million m^3 of bulked spoil material would be generated from excavation works for the proposal. The strategy for reuse / disposal of spoil materials from the proposal would follow the following conceptual hierarchy of spoil management options (Figure 3-1):

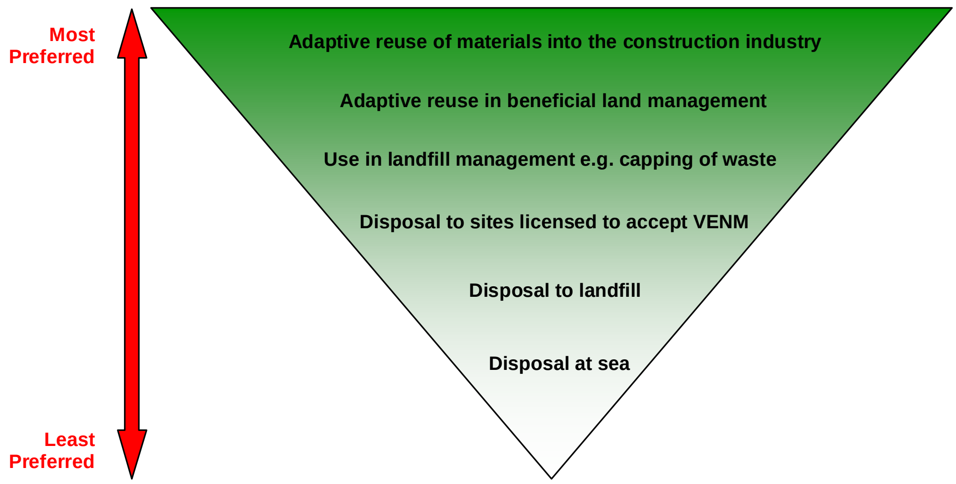

Figure 3-1 Spoil management hierarchy

3.1.1 Adaptive reuse into the construction industry

VENM can be accepted and re-used on other construction sites with minimum effort and minimal cost. VENM does not normally require chemical testing prior to re-use, as it is a natural material by definition, However is some circumstances, for VENM to be received at another project site, some representative samples may have to be tested for contamination, but once certified as not contaminated, it can be freely used. Alternatively, the material can be further processed by an external party for use in the building or construction industry.

There are a number of applications for shale and sandstones found in the Sydney region. The technique used to extract the material, or the degree of processing, largely determines the materials likely reuse application. Hawkesbury sandstone can be used to produce coarse concrete sand (with processing), but it is likely that its greatest application would be as a select earth fill material in an unprocessed form. Other potential applications for sandstone include as a lower level pavement material or low grade road base. Some shale types can be used as fill for building sub-base road pavements others are suited to crushing, grinding and processing to produce clay for vitrified products, including tiles, pipes and bricks. Low clay content shales are more suited to use as fill, while high clay content shales are more suited to use in brick making.

The VENM or processed VENM material must meet certain standards in order for it to be suitable for use in the building or construction industries. Table 3-1 lists the important parameters for each building or construction material type.

Table 3-1 Standards for specific building or construction applications

Material	Standard	Fundamental Specifications
Construction sand	AS 2870	Grain size distribution (< 5% fines)
	AS 3798	Absence of organic material and out-size grains
Masonry sand	AS 1316	Grain size distribution (no fines)
	AS 3700	Absence of organic material and out-size grains
Drainage aggregate	AS 2758.1	Absence of fines and clays; and
	AS 2758.2	Uniformity in grain-size distribution
Compacted fill	AS 3798	The absence of: » Organic material; » Leachable or dissolvable components; » Collapsing, dispersive or reactive materials; » Chemical contamination; » Silts or silt-like particles; and » Physical contamination, such as wood, metal, plastic and boulders
Ripped sandstone	Department of Housing 1989	Grading, absence of deleterious material, shrinkage less than 5%

3.1.2 Adaptive reuse in beneficial land management

VENM can also be used in beneficial land management. For example, shale materials can be suitable as cover for contaminated land reclamation projects. The opportunities for reuse of spoil materials in beneficial land management can sometimes be limited, as appropriate land management projects may not be underway in the vicinity of the VENM generating activities.

3.1.3 Use in landfill management

VENM can be used for operational purposes at landfill sites, such as application as daily cover or for general site engineering works. In which case, any amount of VENM can also be accepted at the landfill site without incurring the Section 88 waste levy. However, landfill operators / owners are restricted to the amount of VENM that they are able to claim a Section 88 rebate on to twenty percent of the total amount of waste received and landfilled at the site.

Furthermore, often sufficient material is delivered to the landfill sites by smaller companies (such as landscapers and builders), or is excavated from the site itself. Therefore, landfill operators / owners are not usually seeking large quantities of VENM.

3.1.4 VENM only receival sites

VENM can also be received at VENM only facilities, such as extractive industry voids, without incurring the Section 88 waste levy. This means that disposal (gate) fees at VENM only sites are significantly lower compared to other landfills. While there are a number of extractive industry voids in the Sydney region, not all are potential VENM filling sites and only a few are currently operating as VENM only receival sites (such as at the Holt Land Rehabilitation site at Kurnell).

3.1.5 Disposal at landfill

If the excavated materials (spoil) are classified as inert waste (i.e. their characteristics do not allow them to be classified as VENM), they can be disposed of to an appropriately licensed landfill. However disposal of the material to landfill incurs a waste levy.

Disposal of 'clean' material at landfill is not a preferred reuse option, but can occasionally be required where necessary to maintain construction progress.

3.1.6 Disposal at sea

Disposal by dumping at sea is least preferred in terms of the overall conceptual spoil management hierarchy for the project (Figure 3-1). Furthermore, there would be more viable (logistically and economically) spoil management options available higher in the hierarchy.

3.1.7 'Contaminated' spoil

If it cannot be treated on site and re-used, relocated or reburied on site, contaminated soil generally needs to be disposed of to either an inert waste landfill, or a licensed Solid Waste Class 2 landfill. If the spoil does not meet the criteria for disposal at a Solid Waste Class 2 landfill, it would be classified as either industrial or hazardous waste.

If classified as either industrial or hazardous waste, the material generally requires chemical stabilisation (if heavy metals are involved), or bioremediation (if hydrocarbon are involved) to enable it to be safely disposed of to a solid waste landfill.

3.2 Options for Spoil Reuse / Disposal From the Proposal

3.2.1 Fill areas on site

There would be only limited opportunities for onsite reuse of spoil as the proposal has very limited on site requirements for fill and work site space is also very limited. Beyond the western portal, the rail alignment is either on embankment, viaduct or in open cut. Construction of this section of the rail link would be by conventional civil construction techniques involving earthworks cut and fill. There is potential 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 Town Centre cut and cover; and
» End of Rouse Hill Town Centre cut and cover to stabling.

There are also a number of locations along the at-grade portion that might require levee banks for flooding 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.

3.2.2 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 proposal are shown in Table 3-2. Spoil is expected to be generated over an approximate 2.5 to 3 year period.

To enable some flexibility in delivery of spoil to off site options, some amount of spoil will need to be stockpiled at each worksite. The volume of spoil that can be stockpiled at each worksite will be limited by the space available. At the Balmoral Road worksite, the space available will governed by a number of construction method decisions. For example, there is a requirement that the TBM tunnels be lined. The proposed method for lining is by segmental concrete placed during the TMB operation (Evans & Peck May 2006). Therefore if the concrete tunnel segments are manufactured at the Balmoral Road worksite, this would require significant land area (in the order of 5 ha). This land requirement would be much lower if the segments were to be manufactured off-site and trucked in.

Based on the average spoil generation rates, the spoil stockpile size required (approximately 3 days of spoil) at the Balmoral Road worksite appears to be in the order of 15,500 m^3. This equates to a spoil stockpile footprint area of around 0.35 ha (35 m x 90 m x 10 m high).

Table 3-2 Spoil reuse options

Company	Location	Spoil Reuse	Capacity	Map ID
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	1
Boral	Prospect recycling plant	Recycling of sandstone into building materials at the Prospect recycling plant. Currently process around 10,000 t of sandstone per year, but are intending on increasing capacity to approximately 60 to 70,000 t per year over the next few years. Boral indicated it would probably only accept sandstone materials at the Prospect recycling plant.	60-70,000 t / year	2
	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	3
	Badgery's 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 it's Badgery's Creek plant.	Not specified	4
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	5
Sydney Ports	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	6
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 proposal, pending decision from Council as to the final end-use for the disused quarry.	5 million m^3	7
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	8
Holt Land Rehabilitation	Kurnell	VENM only receival site, for land rehabilitation of former sand mining areas.	Not specified	9

The locations of the above listed spoil reuse options are spread across the greater Sydney region, as shown on Figure 3-2. The actual spoil reuse sites for the proposal 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 excavations may change from the availabilities predicted at the current time.

Further to this, actual spoil haulage routes would also be determined once actual spoil reuse / disposal sites have been selected and arrangements confirmed. Probable haulage routes are discussed in section 4.

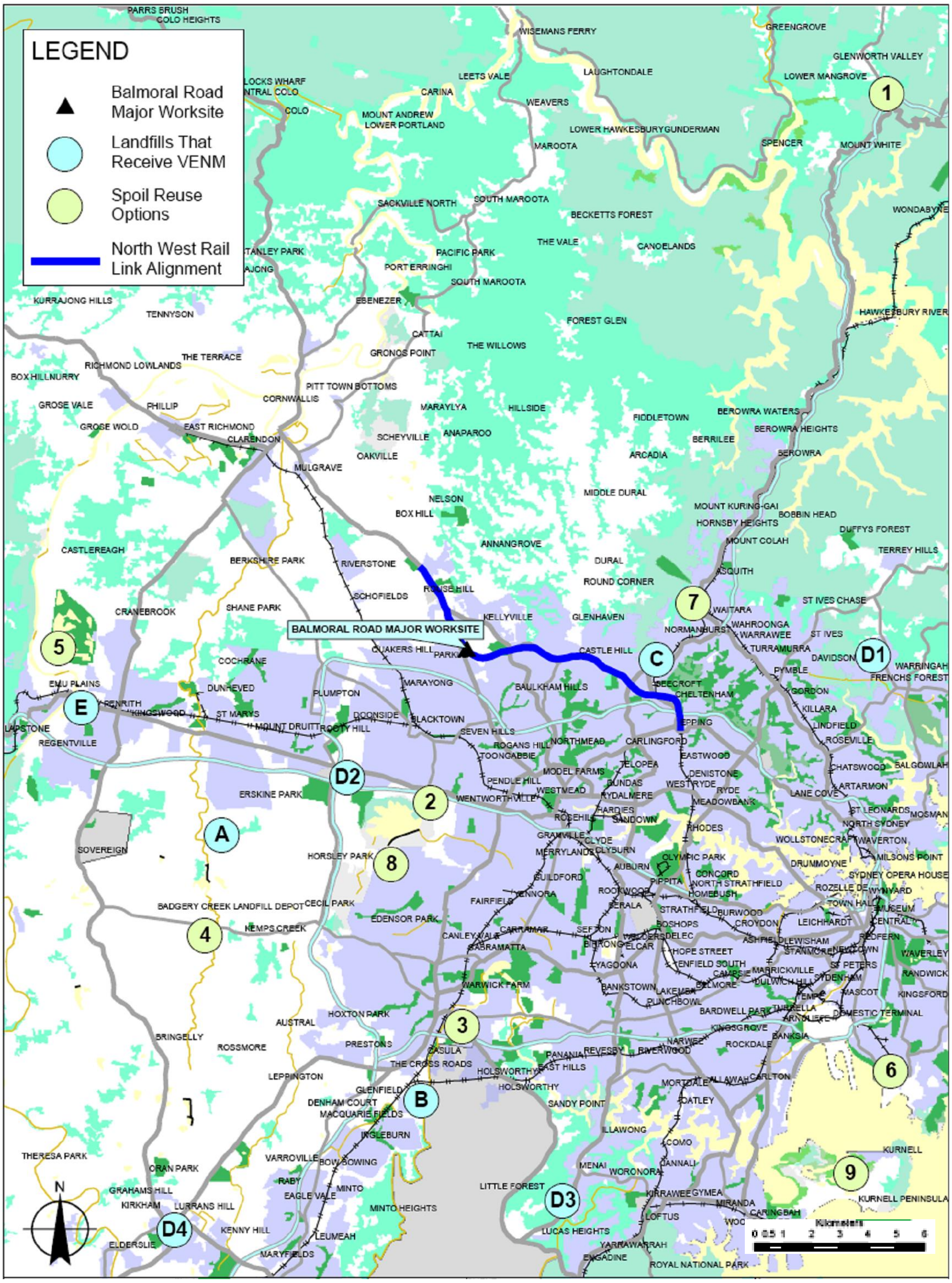

Figure 3-2 Spoil reuse options and landfill sites that receive VENM

3.2.3 Disposal at landfill

Table 3-3 lists typical landfill sites that receive VENM for use as daily cover or onsite engineering works. The locations of these typical landfill sites within the greater Sydney region are shown on Figure 3-2.

Table 3-3 Typical landfills that receive VENM for onsite engineering

Facility	Location	Comments	Map ID
Enviroguard	Erskine Park	VENM used as cover	A
Glenfield Waste Depot	Glenfield	VENM used as cover	B
Brandown	Thornleigh	VENM used as cover	C
WSN Environmental Solutions	(D1) Belrose, (D2) Eastern Creek, (D3) Lucas Heights, (D4) Jacks Gully	VENM used as cover	D
Penrith Waste	Penrith	Accepts contaminated soil	E

Dial A Dump recently purchased the former Fitzpatrick hard rock quarry at Eastern Creek, which has an estimated capacity of 11-12 million cubic metres. Dial A Dump plans to use the site for a class 2 solid waste landfill, with a recycling centre also planned. The quarry is currently zoned for landfill and EPA licences and approval from Blacktown Council are currently being sought for the landfilling operation. Approvals for the waste operations may take up to two years, however it is likely that this site may be available and suitable for disposal of spoil materials during the NWRL construction period. However, disposal at this facility (except for the purposes of onsite engineering) would incur the Section 88 waste levy as the site would not be classified as 'VENM only'.

In addition to the spoil disposal options listed, various disposal sites were contacted or investigated during the 2001 Rail Infrastructure Study investigations, initially based on the table provided in the Environmental Impact State (EIS) of the Parramatta Rail Link (PRL). This table has been reproduced in Appendix A as it appears in the Arup (2005) *North West Rail Link: 2004 Engineering Design Study* report.

3.2.4 '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 to be generated from the construction of the proposal.

4. Likely Haulage Routes and Method

4.1 Method of Haulage

Excess spoil that cannot be reused on site for construction of rail embankments, levee banks or noise attenuation would be removed for reuse at external sites or for disposal at a landfill that is licensed to accept the material. The 2001 Rail Infrastructure Study, and the 2004 Engineering Design Study (Arup 2005) identified two possible options for spoil removal: trucks and rail. The key findings from these studies and the Evans & Peck (May 2006) constructability report are discussed below.

The previous studies have found that there were two possible sites where rail haulage has the potential to be utilised. These were identified as:

1. Cheltenham dive structure and tunnel portal; and
2. An intermediate spoil stockpile located adjacent to the Richmond Line.

Handling spoil disposal at the Cheltenham Dive by rail would require the construction of a new siding line, which would severely disrupt the programme of other rail works required at the junction with the Northern Line and delay the Reference Scheme construction programme. Furthermore, land area is limited in this area and the grading of the Northern Line at between 1 in 40 to 1 in 50 at this location is not conducive to stabling of spoil trains.

The other potential opportunity for transport of spoil by rail haulage was identified as having an intermediate spoil stockpile located adjacent to the Richmond Line. This would need to be located relatively close to the Balmoral Road major worksite (for example at the south end of the Schofields Airfield), but even so would still require truck haulage to the site and then transferral to rail. In addition, the feasibility of allowing truck haulage routes from the Balmoral Road major worksite to the spoil stockpile location is not certain as approval of the haulage route would need to be given by the local Council.

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 environment impact. However, given the close proximity of and access to major motorways (e.g. M2) to the spoil generating locations, as well as the factors discussed above, haulage by road is the preferred option for transportation of spoil.

4.2 Haulage Trucks

Spoil haulage trucks are anticipated to most likely be ‘super dogs’ (or semitrailers), with some transport by ‘dogs’ (or tray and trailers).

The ‘standard truck’ used in calculations to estimate the number of spoil trucks (section 2.5) is that defined in the Arup (2001) Rail Infrastructure Study, as shown in Table 4-1. The standard truck is based on the assumption that 90 percent of spoil haulage would be by ‘dogs’ and 10 percent by ‘super dogs’.

Table 4-1 Truck type and haulage capacities

Type	Bulked volume (m^3)	Tonnage (tonnes)
Single tray	9	11
Tray and trailer (dogs)	19	24
Semi (super dogs)	24	30
Standard truck	19.5	24.6

4.3 Likely Haulage Routes

4.3.1 B-Double Routes

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. Roads that are relevant to the construction of the proposal are shown in Figure 4-1.

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.

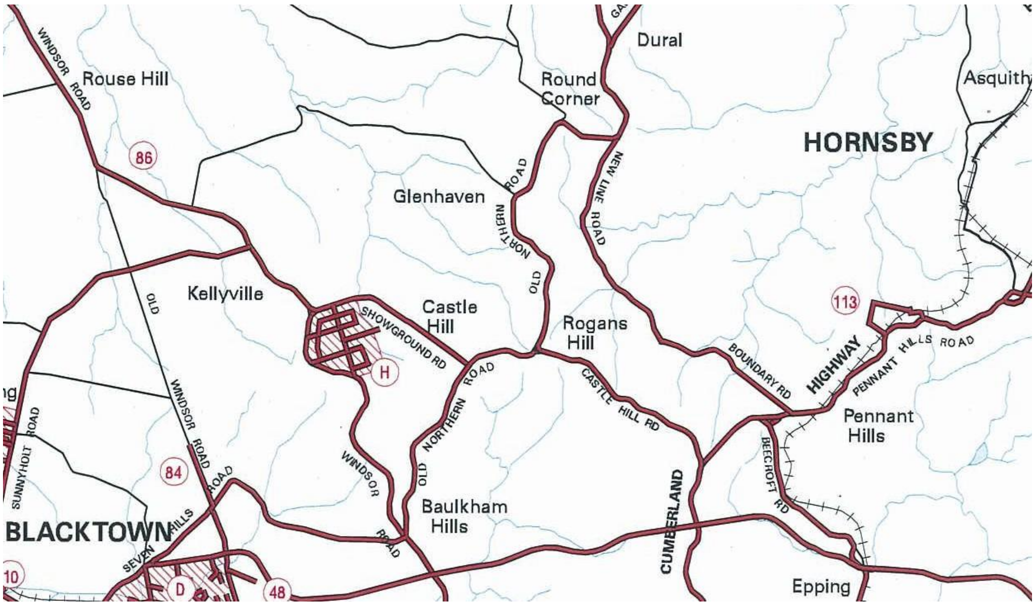

Figure 4-1 RTA B-Double Routes[2]

4.3.2 Upgrade of the Main Northern Line between Epping and Beecroft

It is envisaged that work would be undertaken within the rail corridor with the main access through the construction site proposed at the Beecroft Village Green and tennis club. 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.

4.3.3 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 4-2. Note that according to the GHD (2006) traffic, transport, parking and access study, further investigation is required to determine the preferred site access location. The two options are as follows:

- Access to site from west side of Franklin Road. This will impact on existing residential properties and two schools; or
- Provide direct signalised access from Castle Hill Road into the site, potentially at the intersection with Glenhope Road.

[2] Source: RTA Website (http://www.rta.nsw.gov.au)

Table 4-2 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 » Right onto the M2 at the Pennant Hills Interchange.

4.3.4 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 4-3).

Table 4-3 Haulage route options from Caste Hill Station work site

East bound	West bound
» Left onto Old Northern Road; » Left onto Windsor Road; and then » Right 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.

4.3.5 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 4-4).

Table 4-4 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.

4.3.6 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 4-5).

Table 4-5 Haulage route options from Hill Centre 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.

4.3.7 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 Westlink M7:

- » 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 Westlink 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.

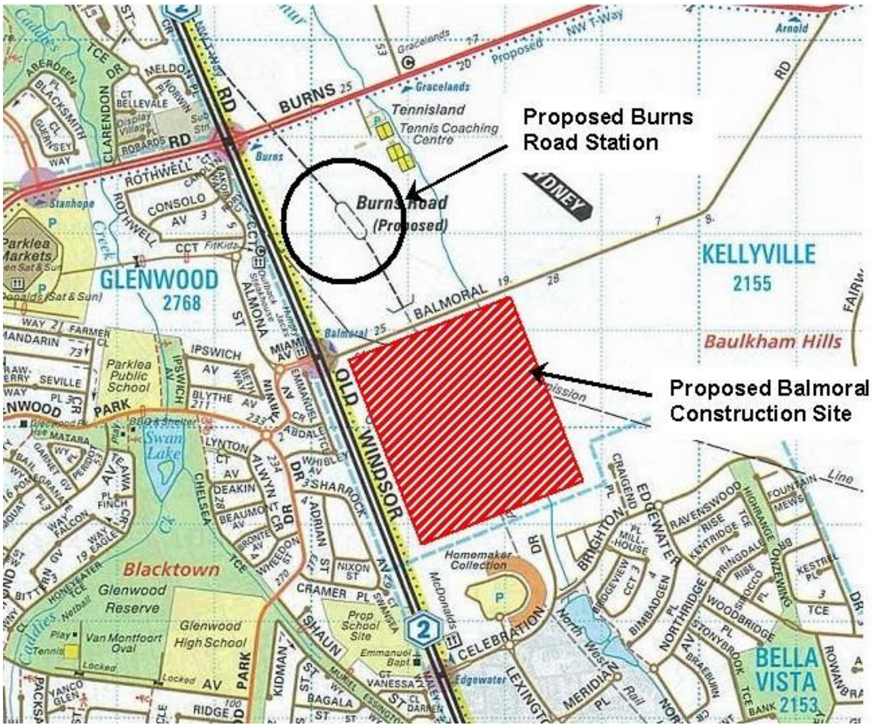

Figure 4-2 Balmoral Construction Site and Burns Road Station

4.3.8 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 Westlink M7 and considered acceptable to provide the most direct access for construction vehicles from the Rouse Hill Station site to the Westlink M7.

4.3.9 Rouse Hill stabling yards work site

The following haulage route to the Westlink M7 from the Rouse Hill Station 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.

5. Mitigation Measures

The following mitigation measures are recommended to minimise the impact of spoil generation and associated spoil truck movements from the proposal. These mitigation measures would be reviewed as the design, planning and consultation for the proposal progress:

- 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 will 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.
- 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 assessed in detail in the GHD (2006) traffic, transport, parking and access assessment for the NWRL.

The amount of spoil that will be able to be beneficially reused depends strongly on the timing of other major construction projects or void space that require fill coinciding with the period when spoil is being generated. It will also be affected by other projects that may be generating large quantities of spoil during the same period. Furthermore, large quantities of spoil often require special arrangements to be negotiated.

Hence, having broad objectives rather than specific targets for reuse is more practicable in this situation.

6. References

Arup (2001) *North West Rail Link: Rail Infrastructure Study*, for Rail Infrastructure Corporation, Arup

Arup (2005) *North West Rail Link: 2004 Engineering Design Study,* for RailCorp, Arup

ERM (1999) *Parramatta Rail Link: Environmental Impact Statement*, ERM

Evans & Peck (May 2006) *North West Rail Link Project Review Report: Constructability and Programme Review*, Draft, for Transport Infrastructure Development Corporation, Evans & Peck

GHD (2006) *North West Rail Link Environmental Assessment: Traffic, Transport, Parking and Access Assessment*, prepared for Transport Infrastructure Development Corporation

Parsons Brinkerhoff (May 2006) *North West Rail Link Project Review Report: Engineering and Infrastructure Technical Report*, Draft, for Transport Infrastructure Development Corporation, Parsons Brinkerhoff

Appendix A

Spoil Reuse Table from Arup (2005)

A Spoil reuse (from Parramatta Rail Link EIS)

Company	Spoil Reuse	Capacity	Proximity to Rail
Austral Bricks	Fill storage for future use by the company located at Horsley Park requiring shale and sandstone	300,000 m^3	
Benedict Sand and Gravel	Register of interest. Reuse of sandstone and shale	Not indicated	
Brentwood Services Pty Ltd	Acting on behalf of a joint venture company with interest related to the consumption of products in the building industry	Not indicated	
CSR Construction Materials	Potential opportunity to use Hornsby Quarry for spoil disposal	5 million m^3	Yes
Dixon Sand & Soil Pty Ltd	Register of interest. Two possible sites, Agnes Banks (Richmond/Penrith Road) sand quarry (200 acres) and Maroota (Wisemans Ferry)	20,000 tonnes (16,000 m^3)	
Dunmore Sand and Soil Pty Ltd	Register of interest. Reuse of spoil to fill dredge pond	0.5 to 1 million tonnes (400,000 to 800,000 m^3)	
Hornsby Rural Fire Service	Register of interest. Reuse of crushed sandstone for over 100 km of fire trails	Not indicated	
Huntley Heritage Environmental Management	Currently rehabilitating the Huntly and Avondale Collieries in the Illawarra region, south of Sydney	Approximately 5.5 million tonnes (4.4 million m^3)	
Lucas & Tait (Sales) Pty Ltd	Potential opportunity for spoil reuse at Campbelltown	Approximately 100,000 m^3	
National Parks and Wildlife Service	Pathways along Lower Prospect Canal Lands	Approximately 150,000 m^3	
Port Kembla Port Authority	Inner and outer harbour restoration	Approximately 5 million tonnes (4 million m^3	
Pyrmont Raw Materials	St Marys Sandstone Recycling Project (used previously on the Northside Storage Tunnel)	1.5 million tonnes/year* (1.2 million m^3/year)	Yes
Sydney Ports	Developments in Port Botany over the next 5 to 10 years	Up to 2.1 million m^3	Yes

Note: * advice provided June 2001
Source: Arup (2005) *North West Rail Link: 2004 Engineering Design Study*

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