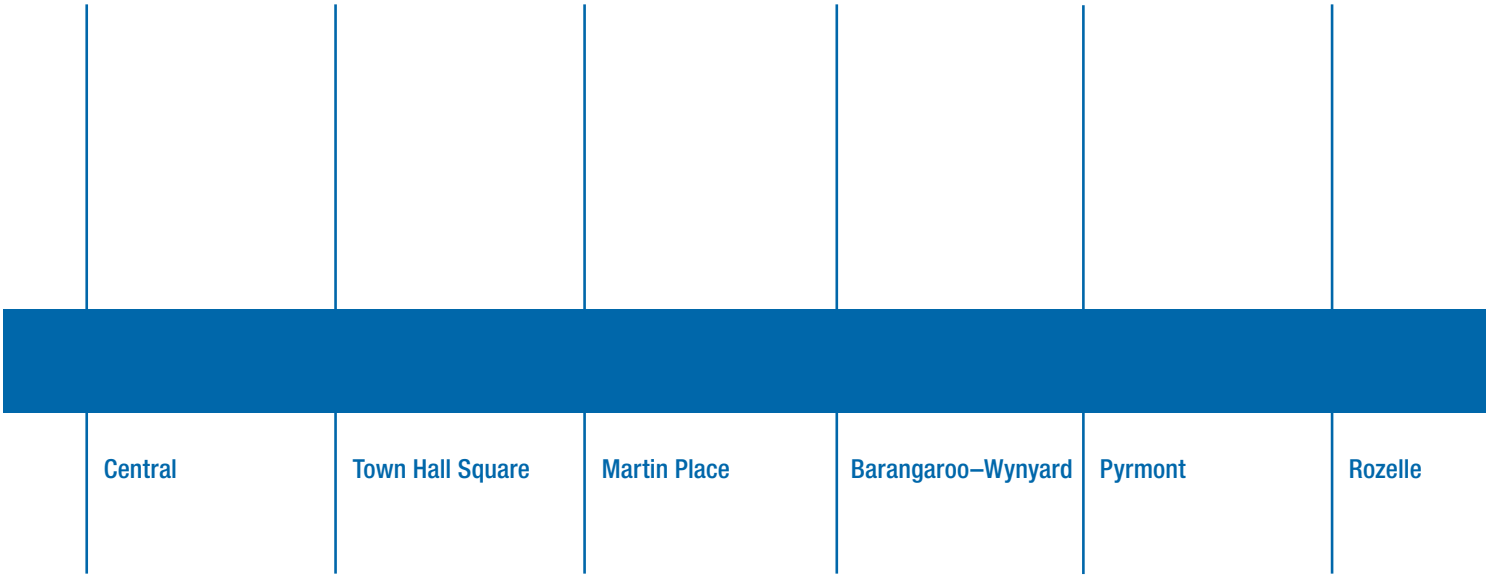
SydneyMetro

Technical Paper 2

Spoil management



CBD Metro

Environmental Assessment

Technical Paper 2 – Spoil Management

Date: June 2009
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SydneyMetro

Contents

This report is to be read in conjunction with the Environmental Assessment for the Sydney Metro Network Stage 1 (CBD Metro) project dated September 2009.

The project as described within the Environmental Assessment will prevail in the event of any inconsistency with the project as described in the following document.

1 Introduction

This report has been prepared to support the assessment of the proposed CBD Metro and forms a technical paper as part of the Environmental Assessment (EA) prepared for the project.

The CBD Metro project comprises a seven kilometre long metro railway from Central to Rozelle, primarily within underground twin tunnels, with new stations at Central, Town Hall Square, Martin Place, Barangaroo-Wynyard, Pyrmont and Rozelle, and provision for a future station at White Bay. A stabling and maintenance depot and an operations control centre (OCC) are proposed at Rozelle within the former Rozelle Marshalling Yard site.

It is anticipated that the project would generate up to about 1,273,000 cubic metres (solid) of spoil. The main spoil generating activities would involve the boring of the twin tunnels between Central Station and the proposed metro station at Rozelle. Spoil would also be generated from tunnel connections to the proposed stabling and maintenance depot at Rozelle and station excavations at Central, Town Hall Square, Martin Place, Barangaroo-Wynyard (including a pedestrian tunnel), Pyrmont, Rozelle and White Bay.

This report outlines the spoil management strategy for the proposed CBD Metro project. Requirements for the content of the Environmental Assessment have been issued by the Director-General of Planning and those regarding spoil management request:

- An indication of expected spoil generated from the project (at each relevant spoil management location).
- The potential for contaminated spoil to be encountered during construction.
- An appropriate level of assessment of the contamination in accordance with *Managing Contaminated Land: Planning Guidelines.*
- A strategy for stockpiling and handling of spoil to minimise the potential for dust and contaminated runoff.
- identification of potential spoil reuse, disposal and treatment sites (as appropriate)
- A key focus on the beneficial reuse of spoil, in preference to its disposal.
- A considered approach to route identification and scheduling of construction transport movements, having regard to alternatives to road transport.

2 Spoil composition

2.1 Classification

The total expected volume of spoil generated by this project is about 1.27 million cubic metres (all volumes are quoted as solid not bulked), with about 0.5 million cubic metres extracted via the White Bay construction site. Much of the spoil material would be derived from sandstone and shales excavated from below the sub-surface and would be unlikely to be contaminated. Over 80 per cent of the excavated material (generally sandstone rock or shale) can be classified as Virgin Excavated Natural Material (VENM). VENM is clean, natural material, which is uncontaminated with other waste materials or manufactured chemicals.

The *Protection of the Environment Operations Act 1997* (POEO Act) defines VENM as 'natural material (such as clay, gravel, soil or rock fines):

- That has been excavated or quarried from areas that are not contaminated with manufactured chemicals or process residues, as a result of industrial, commercial, mining or agricultural activities; and
- That does not contain any sulfidic ores or soils or any other waste.'

Where an excavated material cannot be classified as VENM, it would need to be disposed of to an appropriately classified land fill, although it may be eligible for reuse. It is anticipated that the majority (greater than 15%) of the remaining 20 per cent of material that would not be classified as VENM (under DECC guidelines) would have minimal to no contamination.

2.2 Potential for contamination

Some spoil generated from surface activities, especially excavation in former industrial areas such as White Bay and the former Rozelle Marshalling Yard, has potential for contamination. The potential volumes of contaminated spoil in comparison with the total spoil volume generated is very small and would be expected to be less than one percent of the total excavated volume.

An assessment was undertaken to determine the potential for contamination to be present at proposed construction sites within the CBD Metro project. This assessment is presented as Appendix A and comprised:

- A review of the NSW DECC Contaminated Sites Register to assess the potential for identified contaminated sites to be present along the route of the proposed CBD Metro.
- A review of historical and current land use to determine if potential sites exist or existed along, or adjacent to, the route of the proposed CBD Metro, which may have impacted on soils or groundwater at proposed construction sites.
- A review of existing environmental investigation reports for the former Rozelle Marshalling Yard site and the White Bay Power Station site to identify areas of contamination and assess the impact of any contamination upon the proposed works at the two sites. These reviews comprised assessment of whether:
  - The investigations undertaken to date meet the requirements of the *"Managing Contaminated Land: Planning Guidelines (SEPP-55)"*.

- Potentially contaminated areas identified within the reports impact upon proposed CBD Metro construction sites.

- The investigations undertaken to date provide sufficient information to clearly identify potential constraints for soils and groundwater within CBD Metro construction sites, or whether additional investigations are required to fill these data gaps.

A drilling program to monitor groundwater for contaminants in the Gordon Street area of the former Rozelle Marshalling Yard has been established and will be reported on as the project advances.

The findings were summarised to outline potential constraints to site development (in terms of contaminated spoil management and as a matter of environmental and public health) at each of the proposed CBD Metro construction sites and to identify potential management strategies for contaminated spoil management.

There are two areas of shallow soil contamination within the White Bay construction site that pose a potential risk to human health and constraint on the proposed works. Shallow polycyclic aromatic hydrocarbon (PAH) contamination present along the northern boundary of the CBD Metro construction site is currently capped by a bitumen hard stand, preventing access to the underlying fill material and contaminants contained within. The second area of lead contamination is located to the south-west of the actual location of the White Bay Station, although the state of groundcover in this location is unclear. Therefore, where the concrete and bitumen ground cover remains intact, the risk posed to human health is considered to be low. In addition, the impermeable ground cover would prevent precipitation infiltration and potential leaching of the contaminants to groundwater and into Rozelle Bay.

At the former Rozelle Marshalling Yard there are a number of areas impacted upon by contamination. Of these, one area poses a particular constraint to the CBD Metro project as it would affect the construction of some buildings associated with the stabling and maintenance depot. The other area, although heavily contaminated, only affect the proposed rail tracks leading into the site.

A review of all other construction sites for the project through data searches and aerial photography did not identify any additional areas of environmental concern that have not previously been identified by the DECC records review. The development of the majority of the CBD Metro project corridor as Sydney CBD or mixed commercial and residential land use appears to have resulted in the remediation of any industrial legacies associated with the historical land use.

The Millers Point Gas Works site is located approximately 300 metres to the north of the proposed Barangaroo-Wynyard Station and the presence of potentially contaminated groundwater raises the possibility that any dewatering activities undertaken as part of the construction of the Barangaroo-Wynyard Station may draw contaminants towards the construction site. A drilling program to monitor groundwater for contaminants has been established.

The Millers Point Gasworks, White Bay Power Station and the former Rozelle Marshalling Yard appear to represent the only significant areas of environmental concern along or close to the proposed corridor that would require management / remediation.

Section 4.5 describes in detail the management strategy for this material.

2.3 Potential for Yellow Block sandstone

Historically, Sydney has sought the high strength light yellow class 1 sandstone (Yellow Block) from the Pyrmont region. The Pyrmont Station shaft or cavern may have Yellow Block present and the project has a commitment to cut any accessible Yellow Block sandstone to assist other agencies in the preservation of Sydney's heritage structures.

3 Spoil production

3.1 Construction methods

Construction sites would be established at each of the proposed station sites and excavation of spoil would be undertaken from within these sites. Each station would have a major site and one or more minor sites for excavation.

Running tunnels would most likely be constructed using two Earth Pressure Balance (EPB) Tunnel Boring Machines (TBMs) which would be launched from the White Bay construction site and run to Central. The TBMs would cross two waterways where clay and sandstone materials overlaying sandstone would be encountered. At these locations an average production rate of 200 metres per month would be achieved. In other parts of the alignment, the EPB TBM may achieve a rate of more than 400 metres per month in sections of uniform sandstone on straight alignment and down to 250 metres per month through sections of tight radius curves. An average of 300 metres per month was used for programming purposes and all TBM generated spoil would be removed through the White Bay construction site.

Roadheaders would most likely be used for the short tunnel runs from White Bay to Rozelle and at the junctions with the Rozelle stabling and maintenance depot structures. The construction of running tunnels with roadheaders would typically operate at a rate of about 200 metres per month. The comparatively smaller ventilation, emergency egress and Barangaroo Pedestrian Link (BPL) tunnels would be excavated with small road headers. A portion of the BPL will be ‘cut and cover’ across Kent Street.

Roadheaders and excavators with rock breakers, line drilling and milling heads would be required to construct the ancillary underground spaces, including caverns for diamond crossovers and mined turnback tunnels at Central and Rozelle, underground crossovers, turnouts and stabling and maintenance depot connection tunnels at White Bay and the cross passages. The roadheader excavation works would generally be undertaken prior to TBM excavation, with the exception of the cross passages, where road header excavation works would follow the TBM excavation.

The stations would generally be mined from shafts, with surface structure portions constructed by cut and cover. At Town Hall, Martin Place, Barangaroo-Wynyard, Pyrmont and Rozelle, the shafts would be sunk to rail level and the cavern cut to form the space at platform level and for the upper concourse. At Central, the station would be part mined cavern with access from the surface through the mid section open cut. Roadheaders would be the primary mining equipment with specific detailed excavation by excavators with rock breakers, milling heads, and line drilling to be used. Where sensitive receivers are affected by equipment vibration, it is likely that controlled blasting would be used. Spoil would be brought to the surface by various means, although the majority would be likely to be moved using vertical conveyors.

All of the station sites would produce rock spoil, apart from near the surface, where there is ‘other than rock’ (fill, clay, extremely to highly weather sandstone) overburden material that may extend for a few metres below the surface (in the case of the future White Bay Station, the depth to rock would be approximately 12 – 14 metres).

Where Yellow Block sandstone is accessible, most likely at Pyrmont, the material would be removed in blocks sized between 2 and 5 tonnes.

3.2 Excavation volumes

Table 3.1 summarises the volume of spoil produced at each spoil management location.

Table 3.1 Spoil volumes generated from each work site

Spoil management site	Total volume (m^3) (approximate)[1]	Source of spoil	Material and percentage
Central Station	214,900	Entrances, shafts, station cavern and mined tunnels	Sandstone and Shale Rock 70% Soft 30%
Town Hall Square Station	80,300	Entrances, shafts, station cavern and mined tunnels	Sandstone Rock 85% Soft 15%
Martin Place Station	113,600	Shafts, station cavern and mined tunnels	Sandstone Rock 88% Soft 12%
Barangaroo-Wynyard Station	148,000	Shafts, station cavern and mined tunnels, pedestrian link	Sandstone Rock 75% Soft 25%
Pyrmont Station	90,900	Shafts, station cavern and mined tunnels Station	Sandstone Rock 95% Soft 5%
White Bay Station Rozelle stabling and maintenance depot site	400,100 86,200	Future station box, running tunnels from White Bay to Rozelle, White Bay to Central and White Bay to depot Surface material	Sandstone Rock 77% Soft 23%
Rozelle Station	139,000	Entrance shafts, station cavern and mined tunnels	Sandstone Rock 95% Soft 5%
Total Volume	**1,273,000**		

[1] Note that the volumes are likely to be reduced by as much as 10% with further design refinements.

3.3 Overview of spoil handling and management

3.3.1 Construction site areas

The construction site areas and the processes for handling and management of spoil at these sites are described in detail below. In general all sites except White Bay would provide for construction of shafts and subsequent underground station chamber excavations. At White Bay, the station site would be constructed by cut and cover.

A typical construction site would contain a temporary spoil storage bin and drive-through access for trucks so that they can be loaded with excavated shaft and station spoil within the boundary of the construction site. This is discussed further in section 3.4.

The spoil bins could potentially be vertical hoppers that feed spoil in turn into trucks beneath, or be a three sided vertical walled bin where a front end loader shovels the spoil up into each truck as it arrives in turn at the construction site. At Town Hall, Martin Place, Pyrmont and part of Barangaroo-Wynyard the construction sites are relatively limited in size and queuing on-site by trucks would not be possible.

The vertical transport of spoil from shaft excavation and the subsequent underground station cavern excavation could be selected from a variety of lifting methods. A skip bucket either lifted by a mobile, gantry or tower crane would be used with the spoil being tipped directly into the on-site storage bin or directly into a truck.

3.3.2 Air quality management

Dust impacts from spoil handling and transportation would be minimised at each construction site location by a variety of methods, including:

- Providing facilities at each construction site to allow for the wash down of all vehicles. These facilities would include a water trough and grate plus automated water jet sprays for hosing down each vehicle. Additionally, manual hosing down of individual vehicles would also be possible.
- Spoil trucks leaving the construction sites would have the spoil covered by mandatory tarpaulins and a street sweeper would be provided when required to remove wind-blown material from the road surface.
- Preventing dust generation from the transfer of spoil from skips to the storage bins by depositing spoil within the confines of the vertical enclosures of the bin or hoppers and the use of fine water jet sprays for dry spoil.

Within the confines of the shafts and larger vertical sided openings during excavation, there are a variety of excavation methods that would potentially generate dust. Typical construction plant such as hydraulic rock breakers, hydraulic bucket excavators, hydraulic rock trimmers, bulldozer blades and rippers and rock drilling would be expected to be used. Some dust generation would be anticipated, particularly during the excavation of hard sandstone rock.

Dust suppression would be undertaken using fine water jets and hoses as close to the source as is safely practical. Dust generated during shaft excavation can be confined to the shaft using a combination of a shaft decking enclosure, if required, and air extraction from the base of the shaft via temporary air ducts with the extracted air moved by fans to the surface where it would be filtered. The source of dust would be from the shafts or the use of roadheaders in the rock chambers below. The dust would be collected into bags or small steel containers by the air filtration plant and would be removed off-site by road transport.

Roadheaders would generate dust at the tunnel face. The roadheaders would be fitted with water sprays at the cutter head. Water sprays would be in continuous operation during the rock cutting process.

An air extraction system would be used during the excavation of the station chambers. Air would be extracted close to the excavated face via ducting and ducted extraction fans and transferred along the station chamber and up the shaft to the air filtration plant.

Each construction site would be surrounded by a hoarding that would help to confine any dust generated within the construction site. In addition, the use of noise abatement sheds at particular construction sites would also help to contain dust.

3.3.3 Water quality management

Sediment laden water would be generated at the surface, in the shafts and during the excavation of the station caverns. Sediment may accumulate underground when it has not been pumped to the surface. The sediment would be collected by manual labour and/or front end loaders. This would be disposed of along with the general spoil transported out of the excavated station chambers.

For excavation in sandstone rock and shale, the volume of water that would be generated is expected to be small. The source of water would be predominately groundwater, although uncovered open excavations would also collect rainwater that would need to be pumped back to the surface. This water would contain sediments as a result of mechanical breakdown of rock to fine particles and highly weathered sandstone and shale. Due to the sediments and particles from track and tyre wear from the plant and other construction equipment operating in the shafts and station chambers, the water would be transformed into a slurry.

Under and in the base of shafts, sediment sumps would be used at pump locations. Some sediment would collect in these sumps and be cleaned out periodically. The sediment would be collected and transported off- site.

Other water transported sediment would need to comply with the requirements of the POEO Act and any licence conditions before water could be pumped into the stormwater drainage network. A performance based approached would be adopted to manage water discharge from the construction sites, with a maximum suspended solids discharge concentration of 50mg/L.

Sediment laden water would be pumped to the surface and treated to encourage flocculation and slow settling prior to the excess water being pumped into the stormwater drainage system. Settlement tanks, which would be automatically operated and monitored, would be provided on the surface. Chemicals would be added to the sediment to encourage settlement, as appropriate, to facilitate mechanical extraction of the sediment for periodic transport off-site. The remaining water, once in compliance with the allowable discharge concentration, can then be pumped off into the stormwater drainage network. If the water does not comply with the allowable concentrations, it would be transported off-site by appropriate enclosed tanker trucks.

Sediment pollution could also be generated by other sources at the surface construction sites including concrete waste, dewatering of trenches and stockpiles of materials (including spoil). Surface generated sediment would be contained by drainage channels, straw bales, sumps and/or pumping and either treated on-site or transported off-site as necessary.

3.4 Detailed construction site spoil management

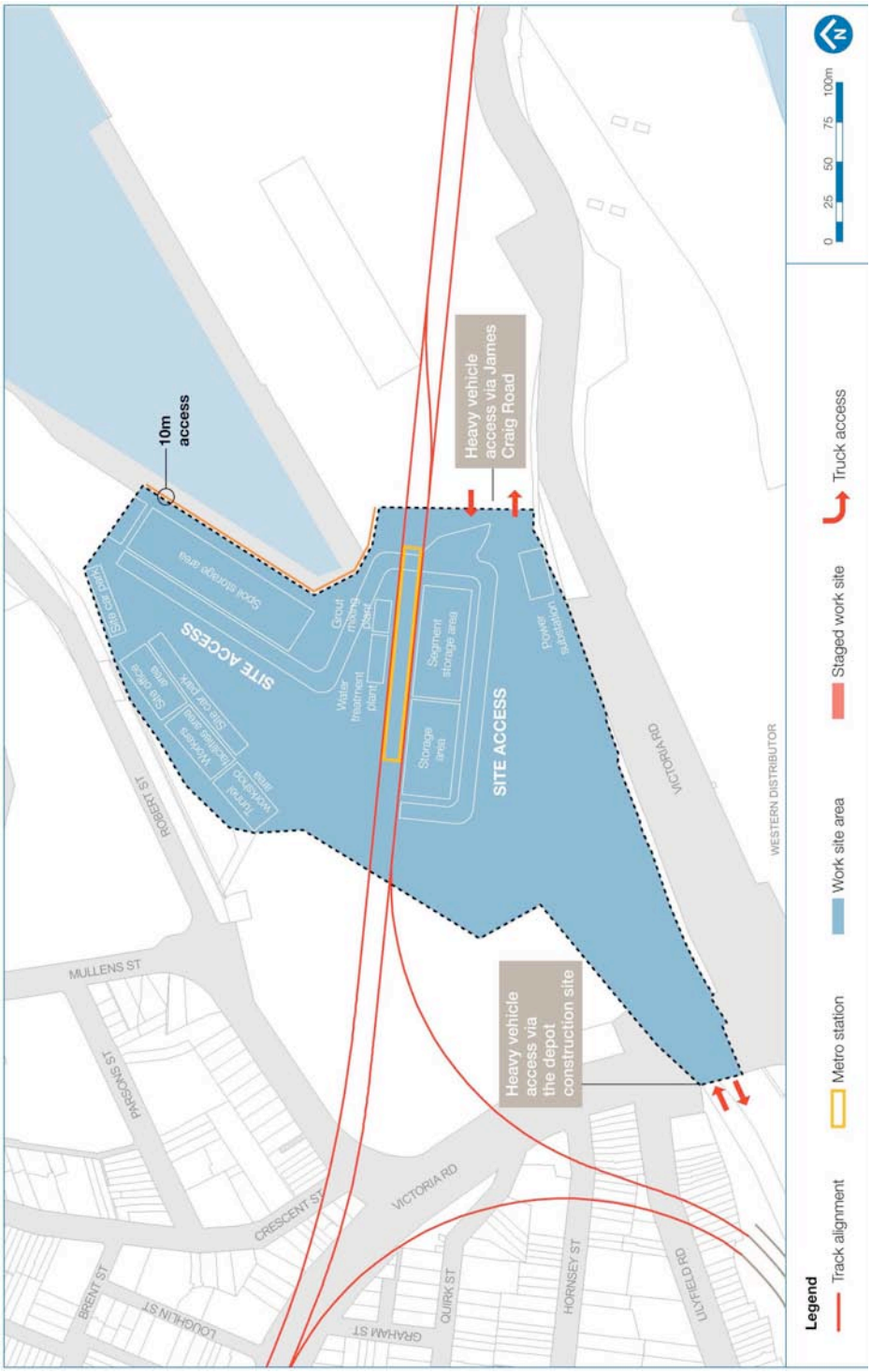
Each construction site would require development of the site layout, spoil extraction processes, spoil storage areas, water treatment systems, dust control systems, noise barriers or structures to control noise (acoustic sheds), truck access locations and loading mechanisms to place spoil in the truck. This section provides detail for White Bay and the Rozelle Stabling and Maintenance Depot, which would be the largest construction sites for the CBD Metro project. White Bay is the location where the TBMs would be launched, and the depot site is where approximately 150,000 m^3 of fill would be required. This would be partly sourced from the depot access tunnel excavation.

Other construction sites would have similar elements such as temporary storage, air treatment processes and water treatment plants, as well as loading mechanisms appropriate for the site.

3.4.1 White Bay

The White Bay construction site, shown in Figure 3.1, is the largest construction site for the CBD Metro project.

Figure 3.1 White Bay construction site location and feasible layout



The spoil would be temporarily stored and transported off-site from White Bay by truck, barge or rail. These options are discussed in detail in Chapter 5.

The main sources of spoil generated at this site would be as follows:

- the open excavation for future White Bay Station
- the TBM driven tunnels to Central Station
- the road header excavated tunnels to Rozelle Station.

The site may also act as a possible transit spoil storage location for spoil from all other project sites.

The spoil storage area at this construction site would most likely be located on the wharf at the top end of White Bay. The spoil storage plan area would be approximately 120 metres long, 30 metres wide and five metres high, with a capacity of about 10,000 cubic metres. There would be separate spoil holding bins or areas to allow the different spoil types to be stored separately. The storage capacity would be sufficient for about 1 week of high productivity from two TBMs.

The storage bins could consist of vertically walled bins or hoppers or a combination of both.

As the opportunity exists for barging spoil from the White Bay site rather than the use of truck transport alone, a dedicated wharf facility may need to be constructed for this purpose, or the adjacent existing Sydney Port Corporation wharf used, and a means of transport such as conveyor or truck used to carry spoil to the wharf utilised. Similarly, a rail freight transportation may also be feasible, subject to access through the Rozelle Stabling and Maintenance Depot being available, as well as availability of train paths and logistics. In both cases, suitable disposal locations are necessary to accommodate spoil receival and management.

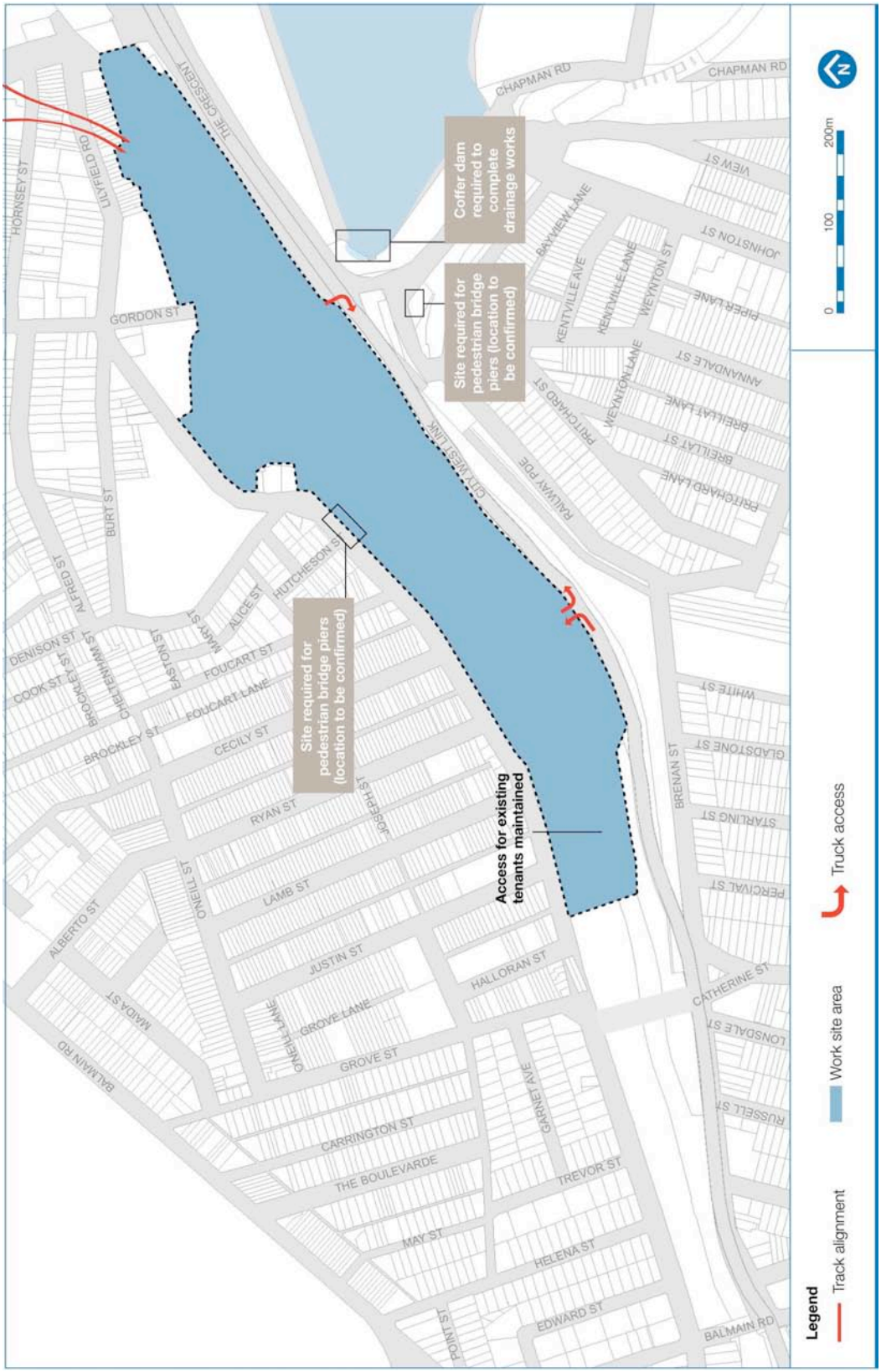
The future White Bay Station box would be excavated in reclaimed landfill material, with an excavation depth of approximately 12-14 metres to rock level. The perimeter of the excavation would be supported by contiguous secant piles or a diaphragm wall. These wall types would minimise the inflow of ground water into the excavation.

Spoil from the open excavation could be removed by a variety of methods, including by gantry crane, tower crane and/or trucked out of the excavation on ramps to the spoil storage area. A conveyor belt or rail haulage may be used to transfer spoil from the TBM driven tunnels to the future White Bay Station construction site. If a conveyor is used, the in-tunnel spoil could be transferred at the White Bay open excavation to a vertical conveyor belt or a series of inclined conveyors. If rail spoil haulage is used in the tunnels, the muck wagons could transfer the spoil to either spoil buckets that can be lifted by crane, a vertical conveyor belt or a series of inclined conveyor belts.

3.4.2 Rozelle Stabling and Maintenance Depot

A flood study has established that nominally a 1 in 100 year peak event required that the levels throughout the existing site be raised. It is estimated that 150,000 m^3 is required to achieve this. The construction area is shown in Figure 3.2.

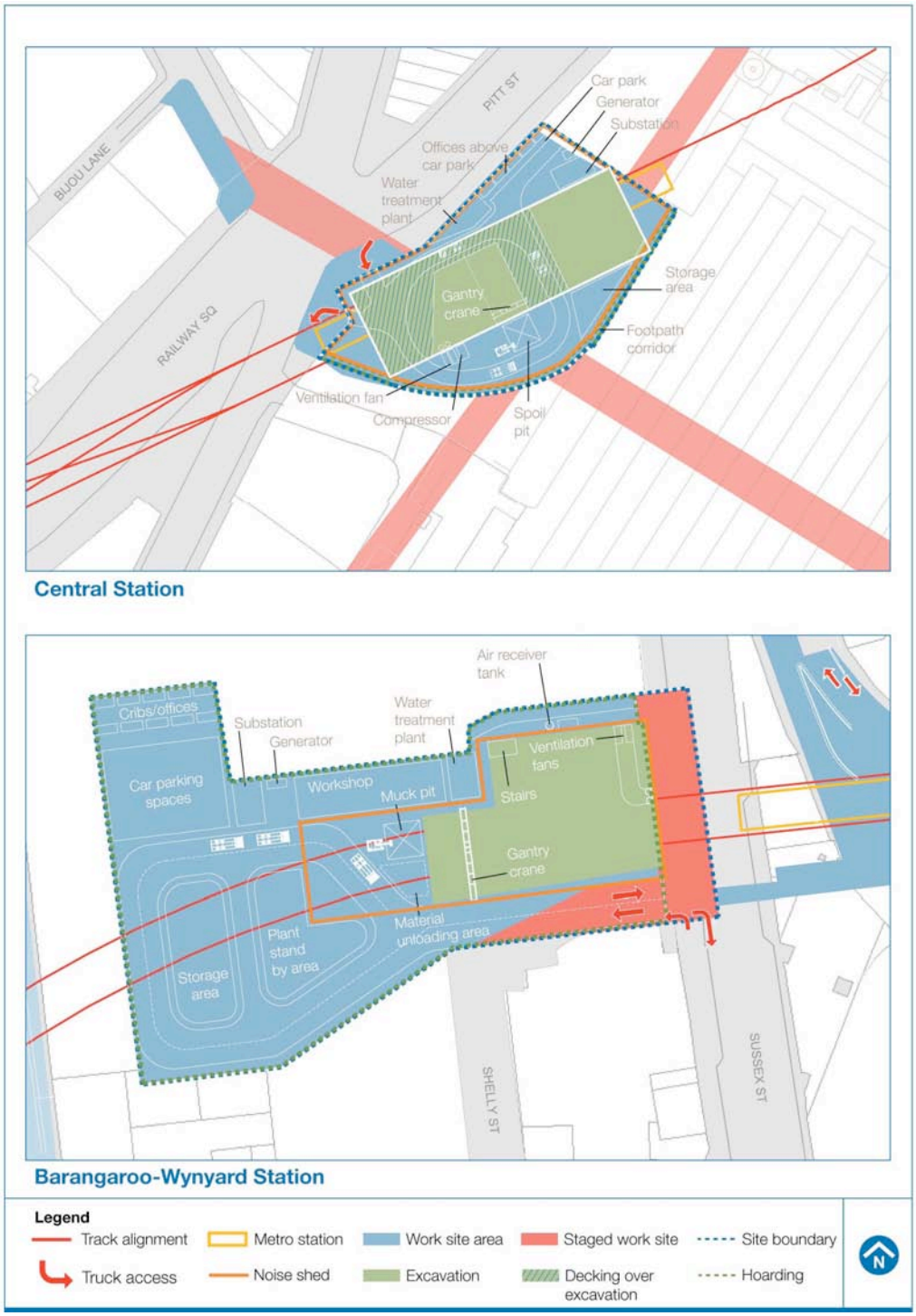
Figure 3.2 Lilyfield Rozelle construction layout



3.4.3 Other sites

The proposed construction site layouts for Central and Barangaroo-Wynyard are shown in Figure 3.3.

Figure 3.3 Proposed layout for main construction sites at central and Barangaroo - Wynyard



The proposed construction site layouts for Pyrmont and Rozelle are shown in Figure 3.4.

Figure 3.4 Proposed layout for the main construction sites at Pyrmont and Rozelle

The management of spoil extraction from other construction sites would be similar to that described for White Bay, in that spoil would be brought to the surface, placed in a temporary storage area or directly to a waiting truck, and removed by truck to a reuse / disposal area or to White Bay for temporary storage prior to removal to other sites. All construction sites would have similar elements such as air treatment processes and water treatment plants. Given the small size of the construction sites in the CBD, and at Pyrmont and Rozelle, only very limited spoil storage capacity would be provided at these sites. The spoil pits would have a capacity of about 200 cubic metres and would provide about half a day of storage based on predicted production rates. From these pits the spoil would be transported off-site or to the main spoil storage facility at White Bay. However, once the station caverns are about 50 per cent complete (after about 18 months), there would be the opportunity to temporarily store spoil within the station caverns. Truck movements would occur at specified times to minimise impacts on the road network operation and on the community. The spoil management of the other sites are summarised in Table 3.2.

Table 3.2 Spoil management of the construction sites

Site	Truck trip * numbers	Truck operation times	Maximum Truck trip * numbers per day	Access
Central	Truck numbers ($5m^3$ trucks) total 42,980	Truck operation time 9 hrs per day/ 6 days per week except for cavern extraction and mined tunnels where it is 18 hrs per day	116	Access via Pitt Street for shaft works, cavern and mined tunnels, Quay Street for Quay Street entrance.
Town Hall	Truck numbers ($5m^3$ trucks) total 16,060	Truck operation time 9 hrs per day/ 6 days per week except for cavern extraction and mined tunnels where it is 18 hrs per day	67	Access via Pitt Street and depart via Park Street.
Martin Place	Truck numbers ($5m^3$ trucks) total 22,720	Truck operation time 9 hrs per day/ 6 days per week except for cavern extraction and mined tunnels where it is 18 hrs per day	67	Access via Castlereagh Street, depart via Elizabeth Street.
Barangaroo-Wynyard	Truck numbers ($5m^3$ trucks) total 29,600	Truck operation time 9 hrs per day/ 6 days per week except for cavern extraction and mined tunnels where it is 18 hrs per day	78	Access and depart Barangaroo site from Sussex Street. Access for pedestrian link is via Napoleon Street. Access Transport House via Clarence Street and depart via York Street.
Pyrmont	Truck numbers ($5m^3$ trucks) total 18,180	Truck operation time 9 hrs per day/ 6 days per week	67	Access and depart western site via Miller Street. Access eastern site from Pyrmont Street and depart via Miller Street.
Rozelle	Truck numbers ($5m^3$ trucks) total 27,800	Truck operation time 9 hrs per day/ 6 days per week except for cavern extraction where it is 18 hrs per day	67	Access to main construction site via Victoria Road from the south, depart to the north.

*One truck trip = 2 movements, to and from the site.

4 Reuse and disposal

4.1 Spoil management hierarchy

The CBD Metro project creates an opportunity to reuse excavated spoil material. There is a limited opportunity for reuse (about 150,000 m^3 - about 15% of the total spoil volume) within the project itself at the Rozelle stabling and maintenance depot site, but as the excavations would be predominantly in Sydney sandstone, with some shale, there is a very high potential for reuse of much of this material through the wider construction industry.

Reuse opportunities outside the project include engineering fill and recycling of the material to produce by-products such as sand and crushed rock, which can be sold by the recycler. There are a number of recycling plants located around the metropolitan Sydney area and within 100 kilometres of the Sydney CBD.

The alternatives to reuse of spoil as construction materials are the opportunity for land management (reclamation) or the placement at sites to assist in their rehabilitation (former and existing quarries). The least preferred option would be disposal at designated landfill sites. Other disposal options such as dumping at sea are not likely to be acceptable and were not evaluated.

An appropriate spoil management hierarchy is shown below.

Most Preferred	Reuse in construction materials
↓	
Reuse in land management (e.g. reclamation)	
↓	
Disposal to sites licensed to accept VENM	
↓	
Least preferred	Disposal to Landfill

A predominately underground facility such as a metro system requires major excavation works and while there may be few opportunities to reuse near surface materials due to, for example, contamination or weathering, fresh rock excavated at depth is a valuable resource which can be reused quite readily when transported to a recycling plant for processing into valuable by-products.

A spoil management sub-plan would be prepared in accordance with the Construction Environmental Management Plan (CEMP).

4.2 Reusable spoil

The geology along the CBD metro alignment determines the spoil material and hence reuse options. The total excavated volume is expected to be around 1.27 million m^3. Of this total approximately 85 percent would be sandstone rock and 10 percent would be shale and 5 percent Other Than Rock (OTR). Both the sandstone rock and shale would have the potential for reuse as construction materials, which is the most preferred reuse option. The remainder of the OTR would be either fill material, highly weathered rock or contaminated material that would need to be sealed or sent to an appropriate landfill.

Table 4.1 lists some potential recycling sites together with their distance from the Sydney CBD, their operating hours, the volume of material that can be accepted and their recycled products.

Table 4.1 Potential recycling sites

Name/Company	Location and distance from CBD	Recycle	Recycling capacity	Operating hours
Eastern Creek/Dial a Dump	Eastern Creek, 40 km	Sandstone and Shale	Recycling plant will commence operation end of 2009. Greater than 500,000 m^3 3000 tonne/day.	Not known
Rocla Sand Quarry	Calga, 70 km	Sandstone	400,000 m^3 total, 1500 tonne/day.	Mon to Sat, 5am to 10pm
CSR Schofields Quarry	Schofields, 47 km	Sandstone and Shale	500 tonne/day clay for brick production, requiring 10 percent sandstone and 50 percent shale	Mon to Fri 7am to 5pm
CSR Cecil Park	Cecil Park, 50 km	Sandstone and Shale	1000 tonne/day clay brick production, 10 percent sandstone and 50 percent shale.	Mon to Sat 7am to 5pm
Austral Plant 3	Horsley Park, 40 km	Shale of appropriate quality	Active Brickworks	Mon to Fri 7am to 5pm

As shown in Chapter 3, there is potentially 70,000 m^3 of shale that could be generated from the Central Station site and the tunnels to the south of this station. This equates to 150,000 tonnes of shale. From Table 4.2 it can be seen that this shale could potentially be used in brick production, as there is a requirement for at least 750 tonne/day of shale just for the two CSR brick production sites.

It is not considered feasible to recycle sandstone rock on-site for reuse for other than backfill material and land reclamation. Sandstone rock is not suitable for use as an aggregate in structural grade concrete on this project.

Yellow Block sandstone

Yellow Block sandstone may occur in the geological profile in the Pyrmont area. Due to the importance of this geological resource, all practicable efforts would be made to extract accessible Yellow Block sandstone during excavation activities. If it occurs and is of suitable quality, an Excavation Works Method Statement (EWMS) would be prepared to outline the method for removal of the material in a usable size and form. The EWMS would be a contingency Plan under the Spoil Management Sub-plan. Management and storage would be coordinated with the NSW Department of Commerce.

4.3 Land reclamation

Port Kembla Port Corporation has produced a master plan for the Outer Harbour port development, and part of its plan involves land reclamation requiring over 5 million m^3 of fill material. In March 2009 the NSW Government announced that the first stage of the reclamation would proceed in 2010 and 2011, subject to project approval planned for 2009/2010.

An opportunity exists to transport spoil material from the CBD Metro to Port Kembla by sea for direct placement in the reclamation area. Alternatively a rail freight transport solution may be feasible to deliver to the Outer Harbour area. These are discussed in Chapter 5.

4.4 Disposal

Although preference for disposal would be given to recycling sites, in the event that it is not possible to recycle all materials, VENM would need to be placed in other land fill sites. Potential disposal sites for VENM material are shown in Table 4.2.

Table 4.2 Potential large scale spoil disposal sites

Name/Company	Location and distance from CBD	Capacity	Operating hours
Hornsby Shire Council/Hornsby Quarry	Hornsby	3 million m^3. Currently not an approved disposal site	Not Applicable
Wallgrove Quarry	Eastern Creek, 40km	11 million m^3. Currently not an approved disposal site	Not Applicable
Rocla Sand Quarry	Calga, 70km	To be confirmed.	Mon to Sat 5am to 10pm
CSR Schofields Quarry	Schofields, 47km	1 million m^3	Mon to Fri 7am to 5pm
CSR PGH Horsley Park	Horsley Park,	2 million m^3	Mon to Fri 7am to 5pm
Austral Plant 3	Horsley Park,	1.5 million m^3	Mon to Fri 7am to 5pm
Penrith Lakes Development Corporation	Penrith	1 million m^3 per annum for 10 years	Mon to Fri 7am to 5pm

4.5 Contaminated spoil

If excavated materials (spoil) are classified as waste (i.e. their physical or chemical characteristics do not allow them to be classified as VENM), they must be disposed of at an appropriately licensed landfill. There are sites in Western Sydney (such as Penrith Waste Services at Mulgoa) that regularly accept lightly contaminated soils.

For more heavily contaminated materials, the SITA landfill at Elizabeth Drive, Kemps Creek would be a likely option. The areas of shallow soil contamination within the White Bay construction site and the former Rozelle Marshalling Yard may be able to be retained on site. If there is a need to remove the material off-site, then it would be sent to an appropriate land fill site.

A review of other CBD Metro sites through data searches and aerial photography did not identify any additional areas of potential or existing soil contamination and it is likely spoil removed from these areas would be classified as VENM and be available for reuse or disposal at appropriate land fill sites.

Should subsurface investigations or excavations identify areas that have potential for contamination, then an appropriate Construction Environmental Management Plan (CEMP) would be required to outline appropriate operational and personal protective equipment (PPE) requirements to protect workers from soil contamination.

In addition to industry standard environmental procedures (i.e. sediment controls, drainage, etc), the CEMP would also include:

- materials tracking procedures
- stockpile construction, maintenance and management protocols
- unexpected material finds protocols
- waste classification procedures.

Any material identified as contaminated would need to be disposed of at an appropriately licensed facility.

5 Transportation

This chapter considers options for removal of spoil from White Bay. There are a number of options available to be considered for removing spoil from the construction sites to reuse or disposal sites.

Within the CBD area transport of spoil from station sites would be via trucks, but associated with truck transport are potential impacts on the neighbourhood amenity, access and traffic congestion. For the main tunnel drives under the CBD commencing from White Bay, excavated spoil would be transported back along the tunnels to the White Bay construction site, thus avoiding surface spoil transport in the CBD area.

The location of the main construction site at White Bay means, however, that opportunities for removal of spoil by road, rail and barge can be considered.

5.1 Road

The opportunities and impacts associated with spoil removal by truck from all construction sites are discussed in the Traffic and Transport Technical Paper and Chapter 10 – *Construction traffic*. They include:

- Access to and egress from the construction sites would ensure the safety of pedestrians, cyclists and other motorists and avoid suburban or residential streets, wherever practicable.
- Hours of transport would be appropriate for the maintenance of public amenity and safety in the vicinity of the construction site.
- The construction traffic management plan, prepared for the site, would include processes to minimise safety and amenity impacts on the neighbours to the site.
- Travel to recycling or disposal sites would be via the arterial road network where practicable.
- Trucks would be prevented from queuing in the streets around the construction site perimeter, where not approved under a traffic management plan, with dedicated waiting zones allocated along the truck routes.

Road haulage from White Bay specifically was discussed in section 3.4.1 of this paper. From City West Link Road the spoil haulage route would depend on location for disposal or reuse. These sites were identified in Chapter 4 and generally are located so that road haulage can be undertaken on arterial roads and the impacts on pedestrians, bicyclists and communities associated with this haulage would be minimal.

5.2 Rail

Rail haulage is often regarded as more cost effective over longer distances than haulage by road and can be considered in some circumstances as having lower environmental impacts than road travel. The opportunity exists for possible removal of spoil from White Bay by rail, using the existing but currently unused rail line from the site. The feasibility is, however, dependent on coordination of the use of the unused rail line with the earthworks and drainage for the new stabling and maintenance depot to be constructed throughout the area of the line.

This section summarises a study (provided in Appendix B) undertaken on the feasibility of rail option for spoil removal. It has been assumed that the spoil generated at the White Bay / former Rozelle Goods Yard sites would be loaded into trains at the White Bay construction site and transported to one, or a combination of, spoil receival sites. It is also possible that spoil from other construction sites could be brought to White Bay by truck and then removed by rail.

A train comprising either 30 x 76 tonne gross (58 tonne net capacity) or 23 x 100 tonne gross (77 tonne net capacity) bottom discharge hopper wagons would provide an average net capacity in the order of 1650 - 1700 tonnes of spoil and appears to be the preferable configuration for efficient operations. Based on the train configuration outlined, it is estimated that around 1560 train movements would be required to transport the 2,568,000 tonnes of spoil.

Irrespective of the final selection of receival site(s), the proposed spoil train operation would traverse the freight lines from the White Bay/Rozelle area to gain access to the broader rail network at Dulwich Hill. Services on this line section have been suspended since early 2009, and no maintenance has been performed since that time. The rail infrastructure from White Bay to Dulwich Hill is considered to be in a condition that is suitable, following some rehabilitation works, for the spoil train operations. It is considered that the rehabilitation works could be completed within the project establishment timeframe.

Three potential options for the loading of trains in the White Bay area were identified. From a rail perspective, the use of the Rozelle Yard area appears to be the most feasible. Advice from rail operators indicates that sufficient locomotives, wagons and train paths would be available for the transportation of the spoil.

A review of the identified receival sites has been completed utilising available information. The option of Port Kembla appeared to be the most promising from both a rail operations and materials handling perspective, although the construction of a wagon discharge facility and associated infrastructure would be required. Other sites considered had limitations in terms of area available, rail operations and track and infrastructure construction.

A number of risks with high to medium likelihood were identified, including:

- Potential expansion of Sydney Light Rail along the freight line between Rozelle and Dulwich Hill removes access to the freight line for spoil transportation.
- The timing of the construction works for the Sydney Metro stabling and maintenance depot at Rozelle versus the timing of the spoil removal prevents or restricts the use of the former Rozelle Marshalling Yard and connecting tracks for loading and train operations.
- Noise generated during loading and train movements impacts on residential development at White Bay/Rozelle and along the freight line to Dulwich Hill limiting the hours of operation for loading and transit of trains.
- The cost and time impact of establishing direct siding connections to the RailCorp network, limits the viability of some receival site options.
- Road haulage of spoil from potential rail discharge locations for most sites limits the viability of these options.
- The potential un-availability of sufficient locomotives, wagons and train paths for the additional volumes of spoil received at White Bay from other sites for transport by rail limits the viability of rail transport of this material.
- The consistency and wetness factor of the spoil increases the time taken to unload trains.

5.3 Water

The proximity of construction to Sydney Harbour foreshores at the Barangaroo-Wynyard and White Bay sites suggests that any opportunity for removal of spoil by barge to a disposal location should be investigated. There is an opportunity to barge spoil material from these two sites on this project to the proposed port development at Port Kembla (discussed in section 4.3). No other barging destination was considered as none is available. This barging opportunity was investigated in detail, as shown in Appendix C to this report.

Consideration was given to barging of spoil material from White Bay and from the current Cruise Ship Terminal wharf at Darling Harbour. The spoil to be removed by barging from White Bay would be from the cut and cover at White Bay, TBMs, road headers from tunnel to Rozelle and spoil from the former Rozelle Marshalling Yard.

The opportunity at the Barangaroo-Wynyard site in Darling Harbour is to load spoil from the station cavern of the Barangaroo-Wynyard Station and Barangaroo Pedestrian Link. The barges moored at Barangaroo could cross Sydney Harbour from Darling Harbour to White Bay construction site and then transfer the spoil to land for transport from that site. Alternatively, the barges may be able to travel directly to the reclamation site.

Three methods for loading barges were considered appropriate, with the viability of direct load via front end loader, dependent on the distance from the spoil receipt/stockpile location to the barge loading point. Of the three barge loading systems reviewed – conveyor, truck and direct front end loader operation, a conveyor system would have the least environmental impact in regard to noise, dust and spoil spillage. This is an important consideration with residential properties close to the boundary of the White Bay Port area.

Potential disruption to barging operations as a result of storms, mechanical breakdown etc., requires careful management of stock piles to ensure ample free storage capacity to accommodate spoil production during barge and loading system downtime.

Bearing in mind the residential property on the boundary of the White Bay Port area it would be highly desirable to undertake barge loading during daylight hours, with transit to Port Kembla unloading and return at night for a complete 24 hour operation cycle.

A split hopper barge is the ideal barge for transport and direct discharge of spoil at Port Kembla. These barges can be either self propelled or towed by tug.

Preliminary estimates indicate that two No. 50m self propelled split hopper barges of 1000m^3 hopper capacity (750 m^3/spoil) may handle the 950 m^3/day (solid) from the TBM running tunnels (White Bay to Central) on a 24 hour cycle, but they would not be able to handle the additional spoil from the running tunnels White Bay to Rozelle. Larger capacity self propelled barges could be more efficient and meet the 24 hour cycle time but would likely have larger drafts which could limit flexibility in discharging spoil at Port Kembla. Self propelled split hopper barges would be preferred over towed barges. They would better cope with open sea conditions, have fewer operational constraints and would be more likely to achieve a 24 hour cycle time with daylight loading of barges.

Port Kembla Port Corporation would be able to take advantage of reclamation material as it becomes available. They would be in a position to construct bunded walls from slag for containment of spoil material discharged directly from bottom dump or split hopper barges. With the provision of silt curtains discharge of spoil could be carried out to meet CBD Metro barging requirements. The smaller 1000m^3 capacity split hopper barges with loaded drafts around three metre provides flexibility for reclamation close to shore.

There are three potential loading points (Berths 1, 2 and 3) for barge operation out of White Bay. The suitability of the three methods for barge loading and infrastructure requirements are provided below.

Berths 1 and 2 have limitations in terms of the size of barges which can be used and the requirements for wharf structures. Berth 3, which is 250 to 350 metres from the CBD Metro allocated works area, comprises concrete caissons with a heavy duty pavement with a load limit of 50kPa and is a common user berth. Although further from the CBD Metro works area and stockpile this berth is more suited to use by large trucks and conveyor for loading barges and for berthing/loading of barges. Berth 3 would provide both a loading area and lay-by area for two barges envisaged.

The proposed construction compound for the western shaft for Barangaroo-Wynyard Station has a wharf frontage of approximately 90 metres at the southern end of Berth 8. The compound has a length of approximately 200m to Sussex Street. Provided on completion of the western shaft to the Wynyard Station box the compound could be used for spoil storage this would be a suitable loading point for barges. The berth comprises caissons and heavy duty pavement with a robust cylindrical rubber fendering system. Spoil barges would probably use their own fendering system such as rubber tyres to prevent damage to the wharf fenders at the various states of tide. The spoil delivery rate of approximately 500m^3/day (solid) could be handled by one split hopper barge per day with direct delivery to Port Kembla.

Barges could be loaded directly by trucks from the Wynyard Station box from a spoil storage area at the Berth 8 compound. Barges could also be loaded by front end loaders from a spoil storage area. A loading ramp would be required for both truck and front end loader loading of the barge. Equally a conveyor system either direct from the Wynyard Station box or spoil storage area could be used to load barges. Loading ramps or conveyor systems on the berth would be required to be compatible with mooring line requirements and a 30m security exclusion zone for passenger cruise ship berthing operations. It should be noted that the Overseas Passenger Terminal and early works for the Barangaroo Pedestrian Link may pose a constraint to barging activities from this site.

Barging to White Bay for transhipment to Port Kembla would not be cost effective because of the high cost of double handling spoil. Direct barging to Port Kembla is an option but it is questionable whether it would be cost effective to establish facilities to load barges for the quantity of spoil being removed. From a cost viewpoint it may be better to truck spoil direct to receival sites.

5.4 Conclusion

A review of transport alternatives for spoil removal indicated that removal of spoil from CBD construction sites would be via truck. From White Bay, however, removal by truck, rail or barge would all be logistically feasible.

Truck removal provides the greatest flexibility in terms of destination for the spoil. For barge removal the only practical option would be to Port Kembla. This location would also be preferred for rail operations, but other locations are possible. Both rail and barge would require investment in infrastructure for loading, transport and unloading.

Further assessment of spoil transport alternatives would be undertaken to determine opportunities for removal of spoil from White Bay by rail or barge. The results of that evaluation would form part of the contract options during construction and a decision as to whether alternatives to truck transport are implemented would be determined in the context of available disposal sites, cost and environmental impacts.

6 Spoil management strategy

A Spoil Management Sub-Plan would be prepared and implemented in accordance with the CEMP and would include the following mitigation and management measures:

- Spoil generated from construction activities would comprise mostly VENM, with limited potential for contaminated material to be removed. The Construction Environment Management Plan (CEMP) would include contingency plans for Acid Sulfate Soils, contaminated spoil and the reuse of Yellow Block Sandstone
- The preferred hierarchy for spoil management of VENM would be (in order of preference) on-site reuse, recycling and disposal to landfill as waste. Advice would be provided to contractors regarding that preference, along with available information on potentially available receiving locations.
- Procedures for assessing potential contamination of spoil generated at each site would be developed and implemented. Contaminated spoil would be treated on site or removed to an appropriately licensed landfill.
- Construction sites would be managed to ensure that dust from spoil handling is controlled to minimise amenity impacts on neighbours and water contaminated by spoil handling is treated before discharge to meet the requirements of the *Protection of the Environment Operations Act 1996* (POEO Act).
- For spoil removed from construction sites by truck, Traffic Management Plans would be developed for each site to ensure impacts on public amenity are managed adequately. Particular attention would be paid to timing for truck loading and movements and truck queuing in the adjoining streets.
- The timing for spoil handling and transport at each site would be based on the potential impacts on public amenity and safety and potential impacts on the road network. Arterial roads would be used wherever practicable to transport spoil to recycling or disposal locations.
- Further assessment of spoil transport alternatives would continue to be undertaken to determine opportunities for removal of spoil from White Bay by rail or barge. The results of that evaluation would form part of the contract options during construction and a decision as to whether alternatives to truck transport are implemented would be determined in the context of available disposal sites, cost and environmental impacts

Appendix A Contaminated land constraints assessment

Contaminated Land Constraints Assessment

Date: 29 June 2009
Revision: 3.0
Status: Draft

Prepared for SydneyMetro by:

SKM Sinclair Knight Merz Manidis Roberts SydneyMetro

Contents

1 Background

1.1 Introduction

The proposed CBD Metro will see a new high capacity rail service from Central Station to Rozelle. Proposed new stations will be at Central Station, Town Hall Square, Martin Place, Barangaroo–Wynyard, Pyrmont and Rozelle. A major construction site and reserved area for a future metro station would be located at White Bay, adjacent to the former White Bay Power Station, and a stabling and maintenance depot is proposed for the former Rozelle Marshalling Yard site.

This contaminated land constraints assessment is designed to look at the potential for contaminated soils to impact upon the CBD Metro project civil works and, where this is the case, to determine if there is sufficient information to delineate this contamination and allow preparation of management and/or remediation strategies. In addition the assessment will assess whether there is potential for other contaminated sites to be present within CBD Metro project work sites.

1.2 Objective

The objective of this Contaminated Land Constraints Assessment is to assess whether or not there is sufficient information on site from previous investigations to meet the Director-General's Requirements (DGR) for assessing the issue of contaminated land as part of the Environmental Assessment for the CBD Metro project. The requirement states:

"The EA must include consideration of, and a management framework for....

...the potential for contaminated spoil to be encountered during construction and an appropriate level of assessment of the contamination in accordance with Managing Contaminated Land: Planning Guidelines."

1.3 Scope of works

Based upon this objective, the following works were undertaken to assess the potential for contamination to be present at proposed work sites within the CBD Metro project:

- A review of NSW DECC Contaminated Sites Register to assess the potential for identified contaminated sites to be present along the route of the proposed CBD Metro.
- A review of historical and current land use to determine if potential sites exist or existed along, or adjacent to, the route of the proposed CBD Metro, which may have impacted on soils or groundwater at proposed work sites.
- A review of existing environmental investigation reports for the former Rozelle Bay Marshalling Yard site and the White Bay Power station site to identify areas of contamination and assess the impact of any contamination upon the proposed works at the two sites. These reviews will comprise:
  - Assess whether the investigations undertaken to date meet the requirements of the *"Managing Contaminated Land: Planning Guidelines (SEPP-55)".*
  - Assess whether potentially contaminated areas identified within the reports impact upon proposed CBD Metro work sites.
  - An assessment of whether the investigations undertaken to date provide sufficient information to clearly identify potential constraints for soils and groundwater within CBD Metro worksites, or whether additional investigations are

required to fill these data gaps. If further work is required, to identify whether this needs to be done prior to project approval or it can be included as a commitment within the Statement of Commitments provided in the Environmental Assessment and thus be undertaken after approval is granted but prior to construction work.

- A summary of the findings to outline potential constraints to site development (in terms of contaminated spoil management and as a matter of environmental and public health) at each of the proposed CBD Metro work sites and identify potential management strategies for contaminated spoil management and the operation of the sites.

2 Data review

The two key areas of environmental concern identified within the CBD Metro project are the former White Bay Power Station and the former Rozelle Marshalling Yard. Both sites have undergone a series of environmental investigations to assess the extent of contamination present and identify potential remediation strategies. The available documentation has been reviewed to assess the potential impact of contamination present upon the proposed CBD Metro project work sites. Although it is understood that there are identified areas of environmental concern at both sites, the impact of these areas has not been assessed with respect to the proposed CBD Metro works. The following sections outline the documents reviewed, the key areas of contamination identified within each site, the potential impact of these areas on the proposed CBD Metro project work sites, areas of uncertainty and potential further works which may be required.

In addition, a review was undertaken of NSW DECC Records and aerial photographs to identify any other sites which may have potential to act as a constraint to granting approval to the CBD Metro project.

2.1 Review of environmental data for White Bay Power Station

2.1.1 Previous investigations

A series of environmental investigations have been undertaken at the White Bay Power Station site as outlined below:

- *Electricity Commission of NSW PCB Contamination Investigation White Bay Power Station Final Report (Pollution Research Pty Ltd, November 1988).*
- *Electricity Commission of NSW PCB Contamination Investigation White Bay Power Station Follow Up Investigation Report (Pollution Research Pty Ltd, June 1989).*
- *Report on Supplementary Chemical Investigations at White Bay Power Station for Electricity Commission of NSW Environmental Process Chemistry Branch (Camp Scott Furphy Pty Ltd, October 1989).*
- *Report on Chemical Site Investigation and Restoration at White Bay Power Station for Electricity Commission of NSW Environmental Process Chemistry Branch (Camp Scott Furphy Pty Ltd, October 1990).*
- *Report on Subsurface Investigation White Bay Power Station for Pacific Power (Dames & Moore Pty Ltd, March 1996.*
- ***Preliminary Site Contamination Investigations Bays Precinct City West (Johnstone Environmental Technology Pty Ltd, July 1997).***
- ***Restricted Phase II Environmental Contamination Assessment of White Bay Rail Yard (Johnstone Environmental Technology Pty Ltd, March 1998).***
- *Stage 1 Preliminary Site Contamination Investigations Bays Precinct City West (Johnstone Environmental Technology Pty Ltd, May 1998).*
- *White Bay Power Station Due Diligence: Contamination Assessment Report for Sydney Harbour Foreshore Authority (Johnstone Environmental Technology Pty Ltd, November 1999).*
- *Report on Site Contamination Assessment White Bay Switchyard for Pacific Power (Dames & Moore Pty Ltd, March 2000).*
- *Contamination Report Review White Bay Power Station Switchyard Cnr Victoria Road and Robert Street, Rozelle NSW (HLA-Envirosciences Pty Ltd, July 2000).*

- ***Environmental Site Assessment, White Bay Power Station, Rozelle NSW (Parsons Brinckerhoff, 2003).***
- ***Advice Relating to Management of Contamination, Bays Precinct (Draft) (ENSR, 2008).***
- ***North West Metro Contract 136 Contamination Assessment Report (Coffey, 2009).***

The five reports highlighted above were reviewed. The report completed by Parsons Brinckerhoff (PB) in 2003 reviewed all of the previous investigations, with the exception of the Restricted Phase II Assessment (JET, 1998).
PB (2003) undertook further works to identify and delineate areas of environmental concern at the White Bay Power Station. These works comprised the drilling of 31 boreholes using a truck mounted drill rig and hand auger. The works also included the installation of four new monitoring wells.

2.1.2 Identified areas of environmental concern

The purpose of the PB (2003) investigation was to further investigate three key areas of contamination identified within the previous investigations. These areas included:

- TPH, PAH and metal contamination in the switchyard located to the west of the power station.
- PAH contamination across the north-eastern sector of the White Bay Power Station site.
- PAH contamination around the coal settling tank located to the east of the power station.

A fourth area of environmental concern was identified by the Restricted Phase II Environmental Contamination Assessment (JET 1998). This concerned an area of elevated lead contamination located to the southeast of the White Bay Power Station.
Of the four areas of environmental concern identified above, only two are directly relevant to the proposed CBD Metro White Bay works site. The boundary of the White Bay works site is shown on Figure 1.
The area of PAH contamination present in the north-eastern sector of the White Bay Power Station site encroaches into the northern part of the proposed CBD Metro work site. In addition, the lead contamination recorded in the JET (1998) investigation is located to the south-west of the future White Bay station, but within the proposed work sites. These two areas are both shown on Figure 1.
The investigation of the switchyard and the coal settling tank undertaken by PB (2003) found the contamination present to be localised to these two areas. The subsurface TPH contamination encountered beneath the switchyard was not detected in down hydraulic gradient groundwater monitoring wells, suggesting that the contamination is not migrating with groundwater flow. However, further investigation of groundwater quality may be required, should dewatering works be required to construct the future White Bay Station box (and also the TBM launch chamber). Any dewatering, large excavations or stressing of the water table could result in mobilisation of these contaminants. The contamination present in shallow soils surrounding the coal settling tank is not considered to impact upon the CBD Metro project work site.

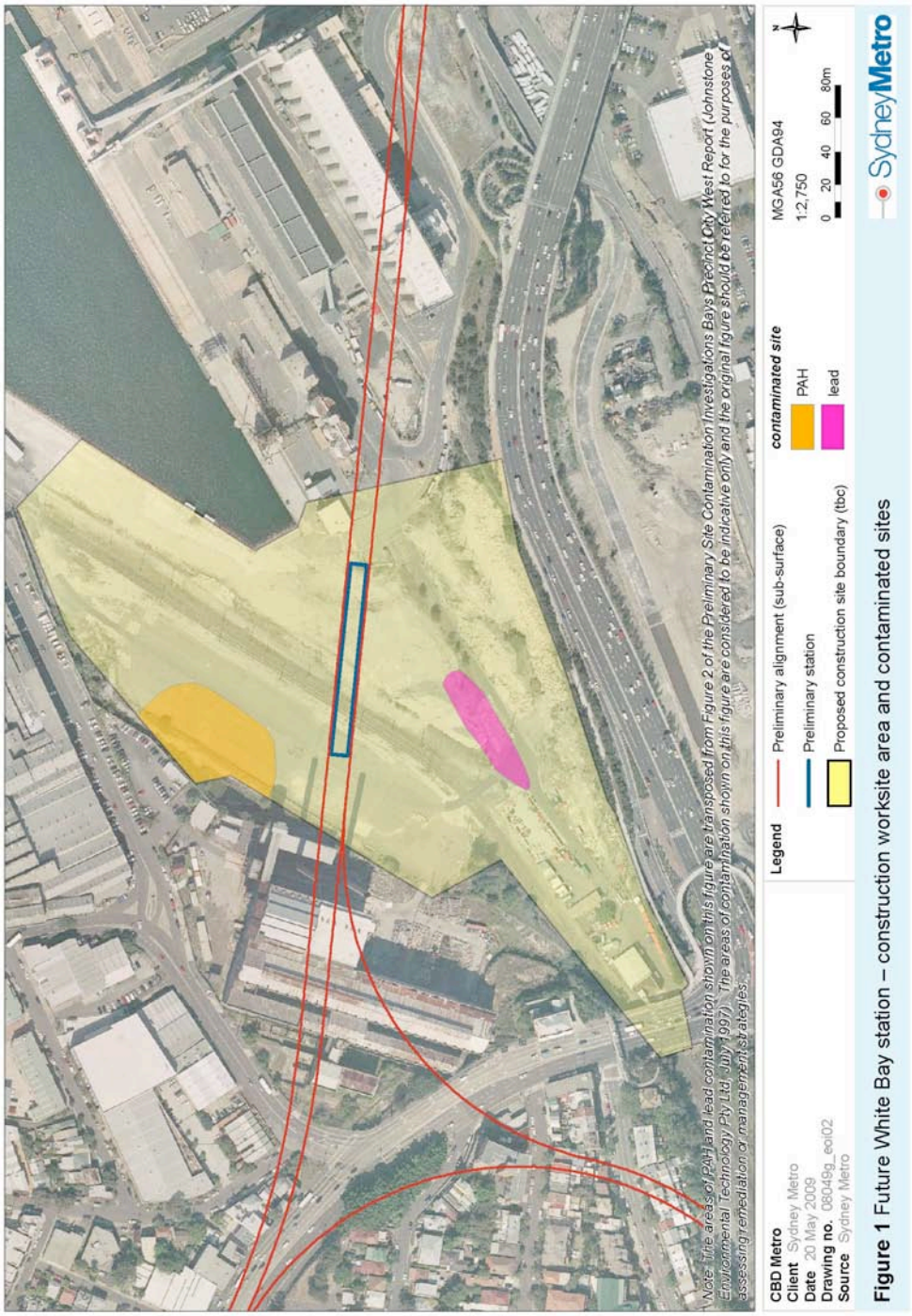


Figure 1 Future White Bay station – construction worksite area and contaminated sites

Four boreholes were drilled within the identified PAH contaminated area (as shown on Figure 1) which encroaches on to the proposed CBD Metro White Bay works site. Of these, two locations recorded benzo(a)pyrene concentrations above the NEPM F Commercial / Industrial Criteria for protection of human health. The other two located recorded concentrations below the laboratory detection limits and below the NEPM F criteria. The results suggest that the layer of ash and cinder present within the identified area in the north-eastern part of the White Bay site (shown on Figure 1) is intermittent and does not impact upon all soils.
The lead contamination recorded to the south-west of the future White Bay Station significantly exceeded the NEPM F Commercial / Industrial Criteria. The localised hotspot was only identified with one composite sample; hence the true extent of this contamination does not appear to have been clearly delineated to date. This area was probably outside the scope of the PB (2003) investigation. The lead contamination appears to be associated with former rail sidings, although the current ground cover within this area is unclear from the aerial photographs.
If exposed soils are present in this area, or excavations are likely to be undertaken within this area, then remediation of these soils would be necessary. Based upon the continuing commercial / industrial land use, it would be proposed that these soils would be capped. If excavations are considered necessary within this area, the material would require relocation and capping in an alternative location on site or off-site disposal. These remediation works would need to be undertaken as a preliminary phase of the construction works.
This approach also applies to the PAH contaminated soils which encroach over the northern boundary of the CBD Metro project work site. With the current ground cover the risk posed by the soils is low and the bitumen capping layer in place prevents a pathway between the contamination source and workers at the site. However, should excavations be required in this area, remediation of these soils will be required prior to construction.

2.1.3 Areas of uncertainty

On review of the previous investigations undertaken across the White Bay site, it is apparent that there are limited deep soil investigation locations in the actual position of the proposed future White Bay Station. This is considered to be due to the limited historical activity in the area. The history of the site in this area shows rail sidings, the presence of two warehouse structures and some on-site storage. It is considered that the surface sampling undertaken parallel to the rail sidings and the four boreholes completed provides adequate data to assess surface soils in the area.
However, the lack of deeper investigation locations results in a degree of uncertainty over whether or not deeper sub-surface conditions have been affected. Surface sampling has been undertaken across the area to a depth of 0.3 metres, but no deep sampling has been completed. It is considered that the risk of encountering significant deeper contamination to be low. This conclusion is based upon the surface results obtained to date and the historical land use.
Should a greater degree of certainty be required on potential waste classification for soils excavated during the construction the White Bay Station, then a number of deeper boreholes would be required. This investigation could be undertaken following the project approval but prior to any excavation.

2.1.4 Summary of potential constraints

There are two areas of shallow soil contamination within the White Bay project work site which pose a potential risk to human health and constraint on proposed works. Shallow PAH contamination present along the northern boundary of the CBD Metro work site is currently capped by a bitumen hard standing, prevents access to the underlying fill material and contaminants contained within. The second area of lead contamination is located to the south-west of the actual location of the future White Bay Station, although the state of groundcover in this location is unclear. Therefore, where the concrete and bitumen ground cover remains intact, the risk posed to human health is considered to be low. In addition, the impermeable ground cover will prevent precipitation infiltration and potential leaching of the contaminants to groundwater and into Rozelle Bay.
Should sub-surface investigations be required in either of these two areas, then an appropriate Construction Environmental Management Plan (CEMP) would be required to outline appropriate operational and personal protective equipment requirements to protect workers from soil contamination. The two areas of contamination identified to date do not impact directly on the future White Bay Station, therefore are considered lateral constraints to any excavations to be undertaken.
In addition to industry standard environmental procedures (i.e. sediment controls, drainage, etc), the CEMP should also include:

- Materials tracking procedures.

- Stockpile construction, maintenance and management protocols.
- Unexpected material finds protocols.
- Waste classification procedures.

These procedures would be outlined within the Remedial Action Plan (RAP) to be prepared (see section 2.1.5) and should be duplicated within the CEMP to account for areas which fall outside the scope of the RAP, to account for material encountered after the completion of remediation works.

2.1.5 Proposed further works

At this stage, no further investigation works would be considered necessary for the White Bay site. There is sufficient data to allow preliminary waste classification of soils and propose management strategies for any excavated material. During the construction of the future White Bay Station box (and the TBM launch chamber), additional chemical analysis of soils will be necessary to characterise spoil generated by the works for potential on-site reuse or off-site disposal. This phase of works is not considered necessary prior to project approval.
Reviewing the works undertaken to date for the White Bay Power Station site and assessing whether or not they meet the requirements of 'Managing Land Contamination: Planning Guidelines', the guidelines state that there are four stages to site investigation, which are sourced from 'Guidelines for Consultants Reporting on Contaminated Sites' (EPA 1997). These comprise:

- Stage 1 – Preliminary Site Investigation.
- Stage 2 – Detailed Site Investigation.
- Stage 3 – Remedial Action Plan (RAP).
- Stage 4 – Validation and Monitoring.

To date, only stages 1 and 2 have been completed. Stages 3 and 4 may need to be completed prior to the construction of the future White Bay Station. Therefore, once the extent of the proposed works at CBD Metro project site are understood, a RAP may need to be prepared to outline the procedures necessary to manage the two areas of contamination present on site. The RAP could be completed post project approval as the remediation strategies would be included within the works design. It is recommended that a NSW DECC Accredited Auditor be engaged for the project although this is not a statutory requirement.

2.2 Review of environmental data for the former Rozelle Marshalling Yard

2.2.1 Previous investigations

A series of environmental investigations have been undertaken at the former Rozelle Marshalling Yard as outlined below:

- ***Rozelle Marshalling Yards Redevelopment, Geochemical Investigation (PB, November 2003).***
- ***Rozelle Marshalling Yards Redevelopment, Remedial Action Plan (Final Report), (PB, November 2003).***
- ***Rozelle Marshalling Yards, Statement of Environmental Effects – Site Preparation Works (Final Draft), (GHD, March 2004).***
- ***Advice Relating to Management of Contamination, Bays Precinct (Draft) (ENSR, 2008).***
- ***North West Metro Contract 136 Contamination Assessment Report (Coffey, 2009).***

Reports from a number of previous investigations were contained within the Appendices of the Geochemical Investigation. These reports were:

- *Stage 1 Environmental Contamination Assessment – Rozelle Final Report (SKM, 1994).*
- *Phase 1 Environmental Contamination Assessment – Gillespie's Rozelle (New Environment, 1996).*
- *Preliminary Site Contamination Investigation, Rozelle Marshalling Yards (JET, 1997).*
- *Site Contamination Investigation, Rozelle Marshalling Yards (JET, 1998).*

The five reports highlighted above were reviewed.

2.2.2 Identified areas of environmental concern

The previous investigations sub-divided the former Rozelle Marshalling Yard into eight distinct areas. An indication of this sub-division is shown on Figure 2. This sub-division was based upon the proposed land use at the time of the reports. Although those proposed land uses are no longer applicable, the same areas are referred to in this report to allow comparison with previous figures. The review of the previous investigations concluded that the key areas of environmental concern across the former Rozelle Marshalling Yard were:

- Heavy metal contamination in near surface soils. The contamination was probably due to rolling stock, use of arsenic based herbicides and placement of ash, coal and ballast fill.
- TPH and PAH contamination in surface soils in Areas 1, 2, 3, 4 and 5 was likely to be associated with spills of hydrocarbons and ash fill. Widespread TPH and PAH contamination was encountered in Areas 6, 7 and 8 and was thought to be associated with the emoleum plant / siding.
- Potential for acid sulfate soils to be present.
- Contamination of groundwater in Area 6.

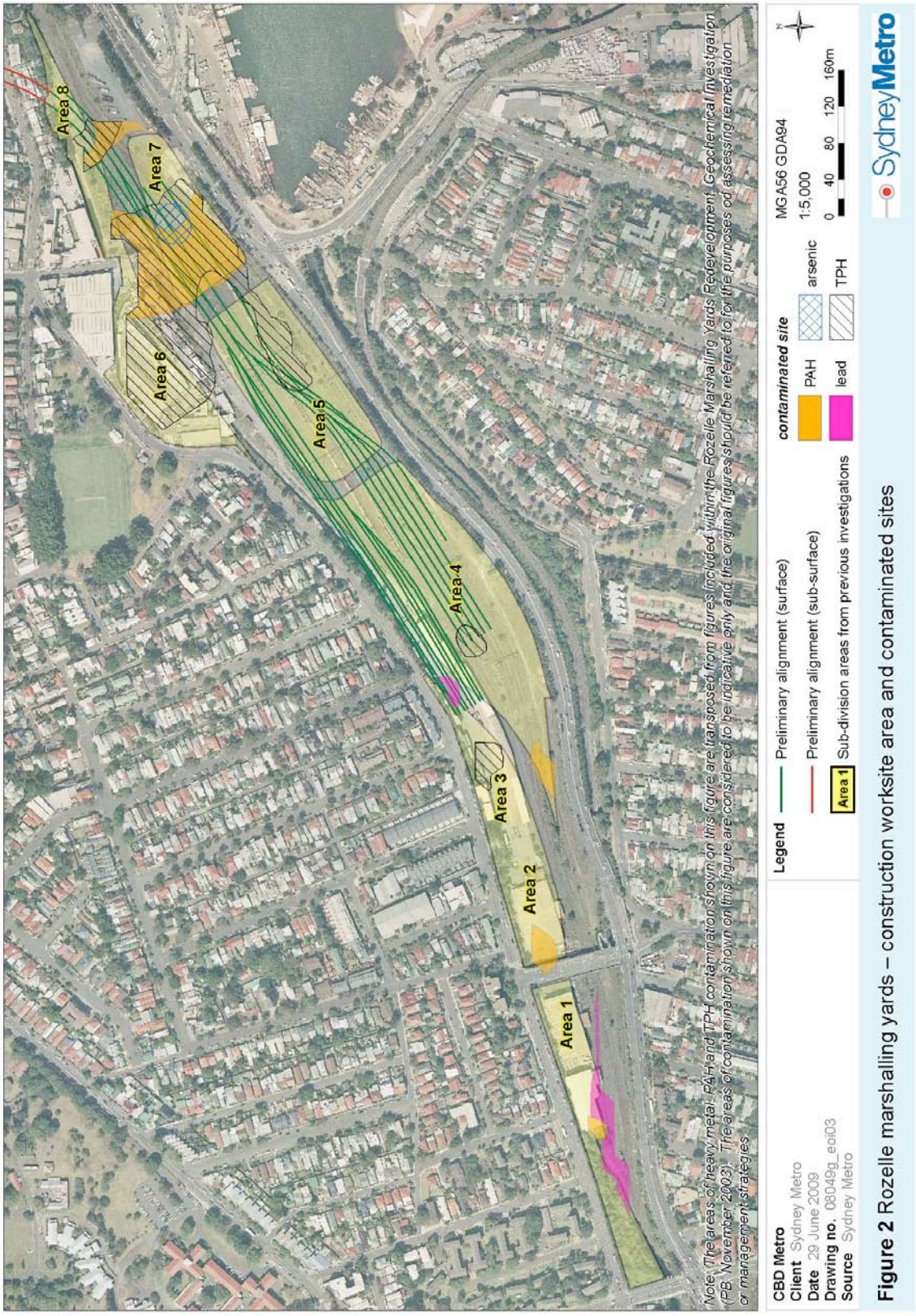


Figure 2 Rozelle marshalling yards – construction worksite area and contaminated sites

The PB 2003 Environmental Site Assessment compared chemical analysis results against a mixture of land uses ranging between high density residential and commercial / industrial (bulky goods storage). The proposed land use for the CBD

Metro project will be stabling sidings and associated infrastructure as well as maintenance buildings and offices. Due to the current proposed land use, the use of the entire site for commercial / industrial purposes reduces the risks posed by on-site contaminant concentrations.
The NSW DECC has endorsed the use of the Soil Investigation Levels (SILs) given in the 1999 NEPM 'Schedule B (1) Guideline on the Investigation Levels for Soil and Groundwater'. The guidelines provide both Health Based Investigation Levels (HILs) and Ecologically Based Investigation Levels (EILs) for a range of land uses.
The previous investigation results were reviewed against the NEPM F Commercial / Industrial Human Health Based Investigation Levels, the majority of the former Rozelle Marshalling Yard are considered chemically suitable for the proposed land use. Localised heavy metal contamination is present in Areas 1, 3 and 7. Area 1 appears to fall outside the proposed CBD Metro project work site, with the elevated metal concentrations present in Area 3 located to the west of the proposed infrastructure maintenance buildings. The elevated metal contamination present in Area 7 is located in the area of the proposed wash plant.
Reviewing the hydrocarbon chemical analysis results provided by the previous investigations indicates that the hydrocarbon contamination is limited to localised areas in Area 1, 2 and 3, with widespread TPH and PAH contamination across Area 6, 7 and 8.
The locations of the contaminants above NEPM F Commercial / Industrial Criteria are shown on Figure 2.
A limited groundwater investigation undertaken in Area 6 identified TPH contamination in one groundwater monitoring well above the adopted groundwater criteria. However, the groundwater investigation to date is limited in extent and does not provide sufficient information to determine if the TPH contamination is migrating across or off the site. This migration of contaminants towards Rozelle Bay is considered to pose a potential risk to the surrounding environment and potential liability to the property owner.

2.2.3 Summary of potential constraints

Following a review of the previous investigation results against the NEPM F Commercial / Industrial Criteria, the most significant areas impacted upon by contamination are Area 6 and Area 7. Of these Area 6 poses the greatest constraint to the CBD Metro project as it affects the construction of the administration building. Area 7, although heavily contaminated, only affects the proposed rail tracks leading into the CBD Metro project depot area.
Area 6 also posed another constraint in the groundwater contamination identified in this location. At this stage, the groundwater investigation is limited, and does not provide sufficient data to assess the potential impact of the hydrocarbon contamination encountered in one groundwater monitoring well in the area. Due to the timeframe and potential works associated with the remediation of groundwater and associated sources, the remediation of Area 6 (if required) may cause significant constraints on the development of this section of the former Rozelle Marshalling Yard.
The current remediation strategy proposed for the former Rozelle Marshalling Yard comprises predominately capping of contaminated areas with an impermeable capping layer to prevent access to the underlying contamination. Development of all areas would be undertaken using an appropriate Construction Environmental Management Plan (CEMP) to outline appropriate operational and personal protective equipment requirements to protect workers from soil contamination. In addition to industry standard environmental procedures (i.e. sediment controls, drainage, etc), the CEMP should also include:

- Materials tracking procedures.
- Stockpile construction, maintenance and management protocols.
- Unexpected material finds protocols.

These procedures would be outlined within the RAP and should be duplicated within the CEMP to account for areas which fall outside the scope of the RAP, to account for material encountered after the completion of remediation works.

2.2.4 Proposed further works

The most significant contamination and largest area of uncertainty is associated with TPH and PAH contamination of soils and groundwater in Area 6. Due to the TPH and PAH contamination present in soils in Area 6, excavation of soils for the construction of the administration building will need to be managed appropriately. In addition, the construction of these facilities may be delayed whilst the groundwater contamination is investigated and, if necessary, remediated.

Further groundwater investigations are considered necessary within Area 6 due to the potential risk of off-site migration of contaminated groundwater. These works would comprise installation of additional groundwater wells down hydraulic gradient of Area 6 to determine if groundwater contamination is migrating off-site. Additional soil samples should also be collected to further delineate soil contamination. It is recommended that these works are commenced as soon as practicable and completed prior to commencement of construction as groundwater remediation, should it be deemed necessary, could affect the overall timeframe for construction. The extent of required groundwater remediation works cannot be determined at this stage due to the limited information, therefore the additional investigation is necessary.
In addition, a review of the current and finish design levels across the site should be undertaken to allow an assessment of potential areas for capping of contaminated materials.
The works undertaken to date for the former Rozelle Marshalling Yard currently meet stages 1 to 3 of the requirements outlined within the 'Managing Land Contamination: Planning Guidelines'. However, a revised RAP may be required to outline the remediation strategy with respect to the new proposed land use following completion of the additional investigation works for the site.

2.3 Review of NSW DECC records

A search of the NSW DECC Public Register under Section 308 of the *Protection of the Environment Operations Act 1997* (the POEO Act) revealed seven former notices for the White Bay Power Station site. Each of these notices were 'Remediation Orders' issued between 1990 and 1998. The last notice was revoked in October 1998. No records associated with the former Rozelle Marshalling Yard were found.
There were also no other records for sites located within the proposed CBD Metro project works sites. However, a number of other sites located in close proximity to CBD Metro project work site were identified. These are listed in Table 2.1.

Table 2.1 NSW DECC Public Register search results

Site Name	Address	Notice	Proximity to CBD Metro Project
Balmain Power Station	Terry Street, Rozelle	Remediation Order – Revoked August 1997	~400m from Rozelle Station
Former Chemplex Factory	35 Terry Street, Rozelle	Remediation Order – Revoked September 1997	~400m from Rozelle Station
Former Unilever Sulphonation Plant	Reynolds Street, Rozelle	Remediation Order – Revoked March 1997	~350m from White Bay Station
Pyrmont Power Station	Pyrmont Road, Pyrmont	Remediation Order – Revoked May 1994	~150m from Pyrmont Station
Millers Point Gasworks	36 Hickson Road, Millers Point	Declaration of Investigation Area – Current: Issued May 2007	~300m from Barangaroo-Wynyard Station

With the exception of the Millers Point Gasworks, the other four sites appear to have been remediated and developed, with residential housing and a Star City Casino visible on the sites. Therefore, based upon the development of the sites and likely removal of the contamination sources which enacted the Remediation Notices, these four sites are not considered to pose a significant risk to the proposed CBD Metro project work sites.

Millers Point Gasworks – 36 Hickson Road, Millers Point

The Millers Point Gasworks is considered to pose a potential risk to the proposed Barangaroo-Wynyard Station. The Millers Point Gasworks, located on Hickson Road, is still being investigated and remediation works at the site have not commenced to date.
Declaration Notice No. 15036 for Lots 5 & 3 DP 876514 and Lot 12 DP 1065410 states that:

The EPA believes that the site is contaminated with the following substances ("the contaminants"):

- *Polycyclic aromatic hydrocarbons (PAHs);*
- *Benzene, toluene, ethylene and xylenes (BTEX);*
- *Copper; cyanide; lead; and phenol.*

The EPA has considered the matters in s.9 of the Act (Contaminated Land Management Act, 1997) and for the following reasons has determined that it has reasonable grounds to believe that the site is contaminated in such a way as to present a significant risk of harm to human health and the environment:

- *Groundwater in the area has been found to be contaminated by PAHs, BTEX, copper, cyanide, lead and phenol at concentrations significantly exceeding the relevant trigger values for the protection of aquatic ecosystems in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ, 2000).*
- *The groundwater contaminants include human carcinogens and substances toxic to aquatic ecosystems.*
- *Contaminated groundwater is likely to be migrating from the site to Darling Harbour and could ultimately affect aquatic ecosystems.*
- *Contaminated groundwater is migrating from the site into the basement of a residential building adjacent to the site and potentially could expose humans in that building to vapours; however it is currently being effectively controlled.*
- *Contaminated groundwater from the site may enter service trenches potentially exposing maintenance workers to vapours.*

The former gasworks is located approximately 300 metres to the north of the proposed Barangaroo-Wynyard Station. The presence of potentially contaminated groundwater raises the possibility that any dewatering activities undertaken as part of the construction of the Barangaroo-Wynyard Station may draw contaminants towards the work site.
Although groundwater is likely to flow in a westerly direction towards Darling Harbour and away from the proposed Barangaroo-Wynyard Station site, there is a potential for liquid coal tar to be present in sub-surface soils and also underlying bedrock, beneath the former gasworks site. The presence of coal tar is a potential secondary contamination source and may impact deeper groundwater in the bedrock which could potentially be drawn towards the station during dewatering activities.
Unpublished studies have identified groundwater contamination in the vicinity of the former Millers Point Gasworks, but not within groundwater monitoring wells located to the south of the gasworks site. Although no wells were located directly to the south-east of the former gasworks, the direction of the proposed station site and the localised nature of the groundwater contamination suggests that the impact from the gasworks site on the proposed station is likely to be low.
With a limited understanding of the potential contamination conditions present at the Millers Point Gasworks site and the extent of proposed dewatering activities required to construct the Barangaroo-Wynyard station it is not possible to assess the overall risk posed by the site. Therefore, it is recommended that any additional contamination investigation reports for the Millers Point Gasworks be obtained and considered in the context of the dewatering activities required for construction of the station.
Dependent upon this information it may considered necessary to install groundwater monitoring wells in close proximity to the proposed Barangaroo-Wynyard Station and assess groundwater quality in close proximity to where excavation works are planned at the CBD Metro project work site.
Without any of the above information it is not deemed necessary to discuss management strategies at this stage, as an actual contamination source has not been identified. With the potential off-site contamination sources being part of an ongoing investigation and future remediation programme, it is unlikely that the CBD Metro will have the opportunity to undertake any works to reduce the impact of any potential off-site sources, hence undertaking a groundwater investigation at the site prior to the project approval is not considered necessary. Once all information available for the Millers Point Gasworks is obtained, it will be possible to design any potential dewatering works in light of this constraint.

The process for obtaining further information and undertaking groundwater studies, if necessary, should be listed as a commitment to inform the design of dewatering works to be implemented during construction.

2.4 Review of historical aerial photographs

A review of aerial photographs from 1941 and 2008 was undertaken to identify any additional land uses (to those outlined above), that may have a potential impact upon the CBD Metro project.

With the majority of the works proposed for the CBD Metro being undertaken underground, the focus of the review was to identify potential sites in close proximity to the above ground work sites or to identify sites which could potentially impact groundwater (i.e. service station).

Table 2.2 identifies the historical activities conducted at CBD Metro project sites and surrounding areas.
The aerial review did not identify any additional areas of environmental concern that have not previously been identified by the DECC Records review or the environmental reports held by Sydney Metro. The development of the majority of the CBD Metro project corridor as Sydney CBD or mixed commercial and residential land use appears to have resulted in the remediation of any industrial legacies associated with the historical land use. The Millers Point Gasworks, White Bay Power Station and the former Rozelle Marshalling Yard appear to represent the last significant areas of environmental concern along or close to the proposed corridor to require management / remediation.

Belmore Park, located to the north of Central Station, has been in existence since 1868. A historical review of the park suggests that it has always been used as a park and that no significant contaminating activities have been undertaken at the site. The uncovered nature of the site make it one of the few locations within the Sydney CBD where surface soils are exposed and contaminants could impact upon shallow soils and also migrate towards groundwater. Based upon the site history, it is not considered likely that significant contamination is present. However, there may be a potential for the historical use of pesticides or weedicides to have left residual contamination in surface soils. The risk posed by these potential contaminants is considered low and the immobile nature of these types of contaminants suggests that any residual contamination present is unlikely to have migrated downwards and impacted upon groundwater. Without any further historical evidence of potential contamination activities, further investigation of this site is not considered necessary.

Table 2.2 Historical activities

Date of aerial photograph	Subject site	Surrounding area
1940	Moving from Central through to Rozelle Station, Central Station appears fully developed in 1940, with Belmore Park located to the north. Moving north, Sydney CBD appears fully developed, although without some of the taller buildings present today. The CBD appears completely hard covered and office buildings cover the majority of the route. The location of the Pyrmont Station is developed with a mixture of residential and industrial land use. The Pyrmont Power Station appears to be present to the north. The White Bay Power Station is visible in Rozelle. Two large warehouse structures are located over the position of the proposed future White Bay Station. The location of the future station appears largely uncovered, with disturbed soils visible. The former Rozelle Marshalling Yard appear developed and active with a large number of rail cars present on the site.	The CBD surrounding the proposed route appears developed mostly as office buildings, with no obvious sources of contamination visible. A large site to the north of the Barangaroo-Wynyard Station is being developed with disturbed soils visible. The surrounding area has been developed with large warehouse buildings present. The Millers Point Gasworks has ceased operations and the majority of the significant structures have been removed. The Chemplex Factory is visible in Pyrmont with a large number of above ground tanks. A chemical / industrial plant is present to the east of the White Bay Power Station.
2008	The 2008 aerial photograph shows the majority of the proposed route between Central and Wynyard to be highly developed as part of Sydney's CBD. The hard covered nature of the land use and limited access to soils suggests a low risk of contamination sources being present. Belmore Park is present to the north of Central Station. With the exception of the White Bay Power Station and the former Rozelle Marshalling Yard, the only site that may pose a contamination risk, is the large industrial / commercial site located to the east of the White Bay Power Station. However, the presence of wharf and large numbers of cars suggests it is a storage facility for unloading cargo ships.	The land surrounding the proposed CBD Metro project work sites have a similar land use to those present in the route corridor. No significant sources of contamination were observed.

3 Conclusions and recommendations

3.1 Conclusions

Based upon a review of the available information, the key constraints to the proposed CBD Metro project are:

- Two areas of shallow surface contamination present at the White Bay Power Station site.
- PAH and TPH contamination within Area 6 and Area 7 at the former Rozelle Marshalling Yard.
- TPH contaminated groundwater within Area 6 at the former Rozelle Marshalling Yard.
- Potential groundwater contamination associated with the former Millers Point Gasworks.

The available information is adequate to allow approval for the CBD Metro project, as long as commitments are made in the Environmental Assessment to address issues associated with the constraints identified.

3.2 Recommendations

The following studies are required:

- Obtaining site investigation information for the Millers Point Gasworks and undertaking any further groundwater studies at the site to inform the design of dewatering works at Barangaroo-Wynyard;.
- Undertaking an additional groundwater investigation within Area 6 of the former Rozelle Marshalling Yard.

It may also be beneficial to undertake further soil investigation of the White Bay Power Station site to determine the waste classification of spoil generated by the construction of the station.

It is also recommended that the existing RAP for the former Rozelle Marshalling Yards is updated and a new RAP for the White Bay site is prepared. There would also be benefits in engaging a NSW DECC Accredited Auditor to review the RAPs and post remediation Validation Reports for both the White Bay site and the former Rozelle Marshalling Yard.

Appendix B Transport of tunnel spoil by rail

SYDNEY METRO

TRANSPORT OF TUNNEL SPOIL BY RAIL

INTERIM REPORT

REPORT NO : ITPLR/TA1894/02

AUTHOR : MICHAEL MURRAY

DATE : 7 JULY 2009

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TITLE	: SYDNEY METRO – TRANSPORT OF TUNNEL SPOIL BY RAIL
REPORT NO	: ITPLR/TA1894/02
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DATE	: 7 JULY 2009

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PAGE NUMBER

1. EXECUTIVE SUMMARY

Sydney Metro is preparing an Environmental Assessment for the construction phases of the project. The Environmental Assessment first draft is due to be published at the end of June 2009 with a one month edit and review period and Sydney Metro has sought independent advice on the feasibility of removing tunnel spoil from White Bay by rail.

Key considerations to be addressed in the review are:

- Availability of freight resources including train paths, wagons and locos;
- Suitability of infrastructure at White Bay and soil disposal site;
- Logistical issues (how handled at sites etc); and,
- Constraints and risks to the project.

This report considers the implications of the transport by rail of approximately 400,000 cubic metres solid, or around 960,000 tonnes, of spoil produced at White Bay, along with additional volumes of spoil received at White Bay from other sites for transport by rail to make a total rail task of approximately 2,568,000 tonnes.

It has been assumed that the spoil will be loaded into trains at or near the White Bay worksite and transported to one, or a combination of, spoil receival sites currently identified:

- Rocla Sand Quarry at Newnes Plateau near Lithgow;
- Vineyard Employment Area at Riverstone;
- Outer Harbour at Port Kembla; and,
- Dunmore Sand Quarry near Shellharbour.

The task of transporting the tunnelling spoil from the Sydney Metro by rail mirrors the transport of the spoil from the Northside Storage Tunnel project c1998. Here, around 1,800,000 tonnes of spoil was transported in approximately 1,100 train loads from White Bay to St Marys in Western Sydney using bottom discharge hopper wagons.

On the basis of the likely disruptions to rail operations, it is considered that a loading site stockpile should be sufficient to accommodate 4 days of production. Based on an estimated density of excavated sandstone of around 1.37t/m3, a stockpile capacity of around 16,000 m3 with a minimum footprint of approximately 120m x 30m would be required (assuming 10m height).

Loading of the trains by Front End Loader is considered to be the base case for the loading of the Sydney Metro spoil, but alternative methods using overhead storage bins could also be utilised if required. Should the overhead storage bin option be pursued, a means of controlling the load mass will be required to assure that the gross mass on rail of the wagons will not be exceeded.

Assuming the use of bottom discharge hopper wagons, a under track "dump station" and associated materials handling conveyors would be required at the receival site.

This dump station would typically accommodate one wagon at a time for unloading, and be equipped with hoppers and conveyors of sufficient capacity to accommodate the

discharge of around 80 tonnes per wagon as a minimum. An average discharge rate of approximately 600 tonnes per hour should be achievable.

A review of potential loading sites in the White Bay area has been completed following a site visit and review of available information including maps, photographs and RailCorp Train Operations data. From a rail perspective, the use of the Rozelle Yard area initially appears to be the most feasible option; however, it is considered that each would require a more detailed review and financial assessment to allow finalisation of a preferred option.

A review of the identified receival sites has been completed utilising available information including maps, photographs and RailCorp Train Operations data. A visit was conducted to assess the Port Kembla site and the Dunmore site was viewed from adjacent public areas. The assessment of the options for the Rocla Quarry at Newnes Plateau, and the Riverstone site was based on review of the available information and on Interfleet's knowledge of the sites and adjacent rail installations.

The Port Kembla site appeared to be the most promising from both a rail operations and materials handling perspective, however construction of a rail wagon discharge facility and associated infrastructure would be required.

The Riverstone site was considered impractical from a rail operations point of view and an alternative of using a site at St Marys (with associated road haulage) was considered.

Three options were assessed for the Newnes Plateau site, with locations at Lithgow and Bell offering most promise. Aside from the additional cost associated with the double handling of the spoil, an assessment of the localities suggests that there may not be sufficient area available to establish the additional infrastructure and receival stockpiles. There is also considered to be a risk of dust and noise complaints associated with these locations.

Dunmore Quarry is located on a short branch line off the single track main line south of Unanderra and other train operations in the area potentially reduce the practicality of this site. Construction of an under track discharge facility and stockpile area within the confines of the Dunmore Quarry would be required and it may be necessary to construct additional track to accommodate the unloading facility. As the Dunmore site can only accept Virgin Excavated Natural Material, pre-classification of material for transport to this location would be required.

Interfleet used its knowledge of the national locomotive and wagon fleet, review of publically available information and discussions with RailCorp (as the rail infrastructure owner) and with Pacific National, El Zorro and Freightliner Australia (potential rail operators) in formulating a view on workable train operations for the spoil transport task.

The rail operators expected that they would be able to source sufficient locomotives, either owned or leased, to fulfil the estimated task.

A train comprising either 30 x 76 tonne gross (58 tonne net capacity) or 23 x 100 tonne gross (77 tonne net capacity) bottom discharge hopper wagons would provide an average net capacity in the order of 1,650 - ,1700 tonnes of spoil for a maximum train mass of around 2,300 tonnes (excluding locomotives).

Based on the train configuration outlined above, it is estimated that around 1,560 train loads would be required to transport the 2,568,000 tonnes of spoil.

Indicatively, trains of around 2,300 tonnes gross operating to Port Kembla/Dunmore or to Riverstone would require 2 x 3,000hp locomotives, whilst operations to Newnes Plateau would require at least 3 of these locomotives.

RailCorp has indicated that sufficient train paths are available for train operations to Port Kembla, and St Marys, with only limited paths being available to Dunmore. There are sufficient paths available to Newnes Plateau/Lithgow should a practical option for unloading and handling of spoil in the area emerge.

The proposed spoil train operation will traverse the freight lines from the White Bay/Rozelle area to access the broader rail network at Dulwich Hill. Services on this line section have been suspended since early 2009, with no maintenance having been performed since that time and the installed signalling is reported to be unserviceable. Some rehabilitation works will be required prior to the spoil train movements commencing around October 2010. From a brief assessment of the track infrastructure, and from discussions with RailCorp, it is considered that the works could reasonably be completed within the project establishment timeframe.

A review of the published train running times was conducted for each of the routes considered viable for the spoil transport task. To these times, allowances were added for the expected loading and unloading periods to establish a base case cycle time. Consideration was given to the potential for clashes between the spoil train operation and the RailCorp peak hour curfews and the avoidance of night time train and loading operations at White Bay. On this basis, the following indicative train cycle times have been estimated:

Port Kembla:	1 cycle per 24 hours
Dunmore:	1 cycle per 24 hours
Newnes/Bell/Lithgow:	1 cycle per 24 hours
St Marys:	2 cycles per 24 hours

The final train operational plan will be dependent on the confirmation of the number of locomotives, wagon and crew available from the rail operators and establishment of commercial arrangements for the train operations.

A number of risks, and potential mitigations related to the movement of the Sydney Metro tunnelling spoil by rail operations have been identified and have been tabulated.

2. INTRODUCTION

Sydney Metro is preparing an Environmental Assessment for the construction phases of the project. The Environmental Assessment first draft was due to be published at the end of June 2009 with a one month edit and review period.

Sydney Metro has sought independent advice on the feasibility of removing tunnel spoil from White Bay by rail.

Key considerations to be addressed in the review are:

- Availability of freight resources including train paths, wagons and locos;
- Suitability of infrastructure at White Bay and soil disposal site;
- Logistical issues (how handled at sites etc); and,
- Constraints and risks to the project

The excavation of the Sydney Metro rail tunnels, station sites and pedestrian tunnels will produce a significant volume of spoil, predominantly sandstone, excavated by Roadheader and Tunnel Boring Machine.

This report considers the implications of the transport by rail of approximately 400,000 cubic metres solid, or around 960,000 tonnes, of spoil produced at White Bay, along with additional volumes of spoil received at White Bay from other sites for transport by rail to make a total rail task of approximately 2,568,000 tonnes.

It has been assumed that the spoil will be loaded into trains at or near the White Bay worksite and transported to one, or a combination of, spoil receival sites currently identified as:

- Rocla Sand Quarry at Newnes Plateau near Lithgow – capacity approx. 2 million m^3
- Vineyard Employment Area at Riverstone– capacity approx. 0.5 million m^3
- Outer Harbour at Port Kembla– capacity approx. 4 million m^3
- Dunmore Sand Quarry near Shellharbour – capacity unknown , but will accept virgin excavated natural material only

The task of transporting the tunnelling spoil from the Sydney Metro by rail mirrors the transport of the spoil from the Northside Storage Tunnel project c1998. Here, around 1,800,000 tonnes of spoil was transported in approximately 1,100 train loads from White Bay to St Marys in Western Sydney using bottom discharge hopper wagons.

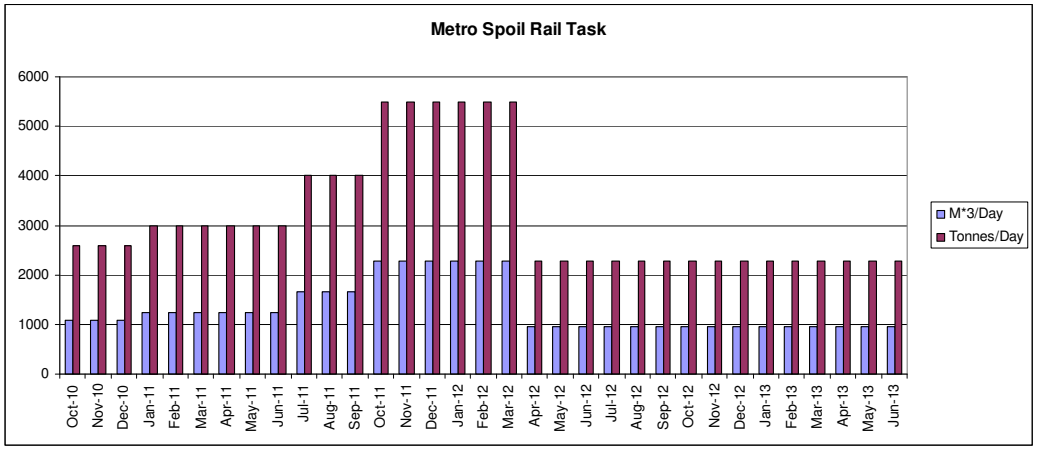
3. THE TASK

Sydney Metro provided data on the estimated volume of spoil potentially available for transport by rail. The data was in the form of cubic metres of solid rock with an assumed density of 2.4 tonnes per cubic metre. This was converted to an estimate of tonnes per day to allow assessment of the rail transport task.

The excavated material was advised to consist of rock, mainly sandstone (around 820,000 cubic metres or 77% of volume) and soft material (around 250,000 cubic metres or 23% of volume).

The total rail transport task from October 2010 to June 2013 is estimated at approximately 2,568,000 tonnes of spoil.

The number of train movements required per day to transport the spoil was estimated on the basis of a nominal net train capacity of 1600 tonnes.



Date Range	Spoil Volume for Rail Transport (m^3 per day)	Approx. Tonnes per Day	No. of 1600 tonne Train Loads
October 2010 – December 2010	1080	2592	5 per 2 days
January 2011 – June 2011	1250	3000	2 per day
July 2011 – September 2011	1670	4008	5 per 2 days
October 2011 – March 2012	2290	5496	7 per 2 days
April 2012 – July 2013	950	2280	3 per 2 days

4. MATERIALS HANDLING

4.1. LOADING SITE STOCKPILE

Sections of the rail network are routinely closed for major maintenance and/or infrastructure renewal throughout the year. These works are planned several months in advance and involve consultation with the various Rail Operators likely to be affected by the closures.

Most closures are of 2 – 3 days duration however, on occasion, such as the Christmas – New Year period, they may be longer. Dependent on the actual location of the closure, alternative routes may be made available to allow continuity of train operations.

On occasion, unforeseen incidents may also result in closure of sections of track. The length of the closure will depend on the magnitude of the incident, but may be several days. Where possible, alternative routes are usually made available to allow continuity of train operations.

Major events which require intensive passenger operations can also impact freight train operations, but are usually of shorter duration.

On the basis of the likely disruptions to rail operations, it is considered that a loading site stockpile should be sufficient to accommodate 4 days of production.

Based on an estimated density of excavated sandstone of around 1.37t/m3, a stockpile capacity of around 16,000 m3 with a minimum footprint of approximately 120m x 30m would be required (assuming 10m height).

4.2. WAGON LOADING

For the Northside Storage Tunnel project, trains were loaded at White Bay by Front End Loader from a stockpile area located adjacent and parallel to the rail track. The mass of the payload per wagon was controlled by the use of load weighing equipment fitted to the Loaders. This method is considered to be the base case for the loading of the Sydney Metro spoil, but alternative methods using overhead storage bins could also be utilised if required.

Should the overhead storage bin option be pursued, a means of controlling the load mass will be required to assure that the gross mass on rail of the wagons will not be exceeded.

For the Front End Loader operation, the working face (and the stockpile length) would preferably accommodate at least 50% of the train length (around 230 m) with sufficient track available to allow re-positioning of the train without splitting the train consist.

A total track length of around 900m would be required to comfortably accommodate the train, including locomotives, for loading by this method. The

use of shorter loading faces would require multiple train re-positioning during the loading, adding to the loading time.

It is estimated that a loading rate of around 400 tonnes per hour should be achievable using Front End Loaders.

4.3. WAGON DISCHARGE

Assuming the use of bottom discharge hopper wagons, a under track "dump station" and associated materials handling conveyors would be required at the receival site.

This dump station would typically accommodate one wagon at a time for unloading, and be equipped with hoppers and conveyors of sufficient capacity to accommodate the discharge of around 80 tonnes per wagon as a minimum. An average discharge rate of approximately 600 tonnes per hour should be achievable.

A facility of this type was installed at St Marys for the unloading of the trains used for the Northside Storage Tunnel project and is considered to be the base case for efficient train operation.

A total track length of around 1200m would be required to comfortably accommodate the train, including locomotives, for unloading by this method.

4.4. LOADING AT WHITE BAY

A review of potential loading sites in the White Bay area has been completed following a site visit and review of available information including maps, photographs and RailCorp Train Operations data. The findings of this preliminary review are outlined below:

Three potential loading sites have been identified:

4.4.1. ROZELLE YARD

Loading at Rozelle Yard would require the establishment of a rail stockpile and a working area for the Front End Loader operation on the North West side of the yard, or alternatively toward the middle of the existing yard area.

A conveyor installation would be required to transport the spoil from the White Bay work site, through an existing opening in the Victoria Road bridge, to the stockpile site.

Apart from some point work that would require replacement and some expected general rehabilitation of the loading sidings and connection tracks, the rail assets in the area are considered to be generally fit for purpose.

The rehabilitation of additional sidings in Rozelle Yard would provide capacity for storage of spoil trains during planned and unplanned downtime.

Lighting would be required for loading and train operations to continue after dark.

It appears viable to establish road connections to the stockpile site from Victoria Road via local streets and from City West Link for the receival of spoil by road transport.

4.4.2. THE FORMER GRAIN SIDINGS AREA AT WHITE BAY

Loading in the general area of the former wheat sidings (adjacent to the Anzac Bridge eastbound approach) would require the construction of a siding or sidings from Rozelle Yard, and passing through the South Eastern arch of the Victoria Road bridge. A rail stockpile and a working area for the Front End Loader operation would be established generally to the South East of the White Bay station excavation, connected by conveyor to the tunnel exit.

Apart from the siding construction and some expected general rehabilitation of the connection tracks, the rail assets in the area are considered to be generally fit for purpose.

The rehabilitation of additional sidings in Rozelle Yard would provide capacity for storage of spoil trains during planned and unplanned downtime.

Lighting would be required for loading and train operations to continue after dark.

It appears viable to establish road connections to the stockpile site from the general White Bay work site for the receival of spoil by road transport.

An identified constraint to this option is the existing/proposed Power Substation adjacent to the North West site boundary.

4.4.3. ADJACENT TO THE PROPOSED BARGE STOCKPILE AREA AT WHITE BAY

This is generally in the area previously utilised for the Northside Storage Tunnel loading, however the excavation for the White Bay station site potentially places severe restrictions on the viability of this option.

A working area for the Front End Loader operation would be established to the North West of the proposed stockpile area.

It would be necessary to either provide a bridge over the White Bay station excavation, or to construct a deviation between the excavation and the Power Station site, to access the tracks adjacent to the

stockpile. This would require a detailed design and financial assessment outside the scope of this review.

Otherwise, apart from some point work that would may require replacement in Rozelle Yard and some expected general rehabilitation of the loading sidings and connection tracks, the rail assets in the area are considered to be generally fit for purpose.

The rehabilitation of additional sidings in Rozelle Yard would provide capacity for storage of spoil trains during planned and unplanned downtime.

Refurbishment and/or relocation of existing lighting in the area would be required for loading and train operations to continue after dark.

It appears viable to establish road connections to the stockpile site from the general White Bay work site for the receival of spoil by road transport.

From a rail perspective, the use of the Rozelle Yard area initially appears to be the most feasible option; however, it is considered that each would require a more detailed review and financial assessment to allow finalisation of a preferred option.

4.5. RECEIVAL SITES

A review of the identified receival sites has been completed utilising available information including maps, photographs and RailCorp Train Operations data. A visit was conducted to assess the Port Kembla site and the Dunmore site was viewed from adjacent public areas (contact could not be made with the nominated site manager at the time of inspection).

The assessment of the options for the Rocla Quarry at Newnes Plateau, and the Riverstone site was based on review of the available information and on Interfleet's knowledge of the sites and adjacent rail installations.

The findings of this review are outlined below:

4.5.1. ROCLA QUARRY AT NEWNES PLATEAU

There is no existing access to the site by rail. The nearest potential discharge point could be on the nearby Clarence Colliery coal loading loop. However, the coal loop is built through high rail cuttings and it is understood that consideration has been given in the past to build a second loader to move product from the Rocla mine.

The proposed loader was discounted due to distance from the mine, lack of a suitable location for product storage and lack of a suitable location to establish the additional loading station.

There are three other identified options for handling spoil for the Rocla Quarry site:

Newnes Plateau
Construct a rail siding and under track discharge facility with a connection to the Clarence Colliery balloon loop near Newnes Junction.

The topography in the area of the Colliery loop is expected to mitigate against the viability of this option.

Lithgow
Construct an under track discharge facility within the confines of the RailCorp yard at Lithgow with road haulage from Lithgow to the Rocla Quarry.

Aside from the additional cost associated with the double handling of the spoil, an assessment of the locality suggests that there may not be sufficient area available to establish receival stockpiles, and that the proximity to residential areas is likely to result in dust and noise complaints.

Bell
Construct of a siding and under track discharge facility with a connection to the RailCorp yard at Bell with road haulage from Bell to the Rocla Quarry.

Aside from the additional cost associated with the double handling of the spoil, an assessment of the locality suggests that there may not be sufficient area available to establish the additional rail infrastructure and receival stockpiles. There is also considered to be a risk of dust and noise complaints associated with this location.

4.5.2. RIVERSTONE

Access by rail to this site is considered to be marginal. The Richmond line is single line only and any freight traffic would have to compete with existing and planned passenger services. It is noted that RailCorp are currently upgrading and duplicating the Richmond line beyond Riverstone which is likely to generate additional passenger train movements.

There are two identified options handling spoil for the Riverstone site:

Riverstone
Construction of a rail siding with associated discharge facility and stockpile area connected to the RailCorp Richmond line to the North West of Riverstone station,

There is considered to be a potential risk of dust and noise complaints associated with spoil train operations at this location

St Marys

There are existing sidings, associated under track discharge structure and stockpile areas on the Pacific National site at St Marys. The unloading facility would require refurbishment and re-equipping for further use. It would also be necessary to establish the currency of the Development Approval for use of the site for spoil receival and handling.

A road haulage component would be required from St Marys to Riverstone and there is considered to be a potential risk of dust and noise complaints associated with spoil train and materials handling operations at this location.

4.5.3. PORT KEMBLA

There is existing operational rail infrastructure within the confines of the Port Corporation land, and adjacent to the port development site which would be suitable for spoil train operations.

The Port Corporation indicated that suitable land was available to establish a stockpile area, or alternatively, that unloaded spoil could be placed directly at the landfill location.

An under track discharge facility would need to be constructed.

The Port Kembla site is reported to be available 24 hours per day, 7 days per week. The potential risk of dust and noise complaints associated with spoil train and materials handling operations at this location is expected to be negligible.

4.5.4. DUNMORE

Dunmore Quarry is located on a short branch line off the single track main line south of Unanderra. Passenger and freight trains currently operating on this line potentially place restrictions on the movement of other trains.

There are currently 2 quarry product trains loaded at Dunmore each week day and these trains are expected to have priority over spoil trains.

Construction of an under track discharge facility and stockpile area within the confines of the Dunmore Quarry would be required and it may be necessary to construct additional track to accommodate the unloading facility.

The potential risk of dust and noise complaints associated with spoil train and materials handling operations at this location is expected to be manageable.

As the Dunmore site can only accept Virgin Excavated Natural Material, pre-classification of material for transport to this location would be required.

5. TRAIN CONFIGURATION AND OPERATIONS

Interfleet used its knowledge of the national locomotive and wagon fleet, review of publically available information and discussions with RailCorp (as the rail infrastructure owner) and with Pacific National, El Zorro and Freightliner Australia (potential rail operators) in formulating a view on workable train operations for the spoil transport task.

5.1. SELECTION OF PREFERRED WAGON TYPE

Tunnelling spoil can be transported in a variety of wagon types including open or "gondola" wagons, side dump wagons, or bottom discharge hopper wagons. The characteristics of the individual wagons will dictate the loading, transit and discharge components of the train's operational cycle.

The open or "gondola" wagons would require the use of a "backhoe" excavator for unloading, which is expected to add significant time to the discharge component of the train operation compared to the bottom discharge hopper wagons. The number of open wagons available from the rail operators and leasing companies is expected to be low, as many have been converted to container wagons in recent years. RailCorp has a small fleet of open wagons utilised for track maintenance work, predominantly on weekends. The availability of these wagons is expected to be minimal as they are typically discharged on week days ready for the next weekend.

Whilst side dump wagons provide an efficient means of discharge, and require the minimum facilities at the receival site, only 25 are known to be available in the Sydney area, and these are regularly utilised in RailCorp track maintenance activities, so their availability is expected to be minimal. These wagons are also of low capacity (42 tonnes net) compared to the bottom discharge hopper wagons.

Considering the likely availability of wagons from the rail operators and leasing companies, the efficiency in loading and unloading, and the previous positive experience in transporting the Northside Storage Tunnel spoil, the most effective wagons for the task are considered to be the bottom discharge hopper type.

Experience with the Northside Storage Tunnel spoil operation suggests that the consistency and wetness factors of the spoil can affect the efficiency of the unloading operation resulting in train operational delays and potential loss of train paths. The provision of wagon shakers and/or high pressure water jetting equipment can assist in discharging "sticky" material.

5.2. AVAILABILITY OF WAGONS AND LOCOMOTIVES

Both Pacific National and El Zorro own bottom discharge hopper wagons, with Pacific National having direct access to wagons of both 55 tonnes and 77 tonnes nominal capacity. The El Zorro fleet is limited to around 26 x 50 tonne capacity wagons.

Freightliner Australia does not currently own hopper wagons, but indicated that they have relationships with equipment suppliers that could potentially address the requirement.

It is understood that Chicago Freight Car Leasing Australia have around 76 hopper wagons potentially available for lease to rail operators

The rail operators expected that they would be able to source sufficient locomotives, either owned or leased, to fulfil the estimated task.

5.3. TRAIN CONFIGURATION

A train comprising either 30 x 76 tonne gross (58 tonne net capacity) or 23 x 100 tonne gross (77 tonne net capacity) bottom discharge hopper wagons would provide an average net capacity in the order of 1,650 – 1,700 tonnes of spoil for a maximum train mass of around 2,300 tonnes (excluding locomotives).

Based on the train configuration outlined above, it is estimated that around 1,560 train loads would be required to transport the 2,568,000 tonnes of spoil.

Locomotive requirements are dependent on the selected destination(s) and are reflective of the gradients encountered on the route(s).

Indicatively, trains of around 2,300 tonnes gross operating to Port Kembla/Dunmore or to Riverstone would require 2 x 3,000hp locomotives, whilst operations to Newnes Plateau would require at least 3 of these locomotives.

5.4. TRAIN PATHS

Train paths for transit between White Bay and the potential receival sites are published in the RailCorp working timetable. Freight train operations are restricted by a peak hour curfew which is imposed to give free running to passenger trains. The peak periods are generally 0500 to 0900 and 1500 to 1900, however these times can be effectively extended by up to an hour to allow passenger trains to return to their depots after the peak.

Whilst it is generally planned for freight train operations to avoid the peak hour curfew, delays sometimes occur. In these circumstances, it is usual for the delayed train to be "parked" during the peak periods. As there are limited sites available for these trains to be "parked" it is often the case that a train which is marginally late will not be allowed to run unless there is a suitable location available where it can be "parked" if necessary.

A summary of identified train paths follows:

5.4.1. WHITE BAY – PORT KEMBLA

There are numerous train paths available from Sydney to Port Kembla. The available paths are split into 2 categories, spare "mandatory" paths which are available for hire and "conditional" paths such as Grain Paths which may not be used from time to time.

Twelve (12) spare RailCorp paths are shown in the current timetable with 8 available Monday to Friday and 4 on Saturday and Sundays.

5.4.2. WHITE BAY – DUNMORE

There are 4 spare "mandatory" paths available to Dunmore. Three (3) are available Monday to Fridays and 1 on weekends. This reduced number compared to those to Port Kembla is due to there being only a single line from Unanderra to Dunmore.

A review of the published timetable indicates that when trains from White Bay would preferably unload at Dunmore, other outward bound quarry product trains would be loading.

As the branch line to Dunmore Quarry is a single line, the operation of two trains would not be allowed under current train operating rules. Additionally, the site length is 520 metres which restricts the length of train that can operate to Dunmore.

5.4.3. WHITE BAY – ST MARY'S OR WHITE BAY – NEWNES JUNCTION

There are 9 spare paths available Monday to Friday and 4 spare paths available on the weekend.

The above paths are "mandatory" paths but numerous "conditional" paths also exist over this route.

5.4.4. WHITE BAY – RIVERSTONE

Due to the intensive passenger operations on the Richmond line, RailCorp has indicated that it is unlikely that sufficient train paths could be made available for operation of spoil trains direct to the Riverstone site.

5.5. TRAIN CYCLE TIMES

A review of the published train running times was conducted for each of the routes considered viable for the spoil transport task. To these times, allowances were added for the expected loading and unloading periods to establish a base case cycle time.

Consideration was then given to the potential for clashes between the spoil train operation and the RailCorp peak hour curfews and the avoidance of night time train and loading operations at White Bay.

On this basis, the following indicative train cycle times have been estimated:

- Port Kembla: 1 cycle per 24 hours
- Dunmore: 1 cycle per 24 hours
- Newnes/Bell/Lithgow: 1 cycle per 24 hours
- St Marys: 2 cycles per 24 hours

The final train operational plan will be dependent on the confirmation of the number of locomotives, wagon and crew available from the rail operators and establishment of commercial arrangements for the train operations.

6. CONDITION OF RAIL INFRASTRUCTURE

Irrespective of the final selection of receival site(s), the proposed spoil train operation will traverse the freight lines from the White Bay/Rozelle area to access the broader rail network at Dulwich Hill. Services on this line section have been suspended since early 2009, with no maintenance having been performed since that time and the installed signalling is reported to be unserviceable.

Some rehabilitation works will be required prior to the spoil train movements commencing around October 2010. From a brief assessment of the track infrastructure, and from discussions with RailCorp, it is considered that the works could reasonably be completed within the project establishment timeframe and would include, but not be limited to:

Re-establishment of the connection to the rail network at Wardell Road Junction (Dulwich Hill) including re-instatement of mainline signalling. It is understood that an estimate for the cost of these works has been provided by RailCorp to Sydney Metro,

- Removal of vegetation;
- Selected sleeper renewal;
- Clearing of drainage systems;
- Possible replacement of point work removed from Rozelle Yard; and,
- Re-activation of signalling systems and/or establishment of alternative methods of safe train operation.

RailCorp advise that a maximum speed of 20kph is likely to apply from White Bay to Dulwich Hill.

7. IDENTIFIED RISKS

The following risks, and potential mitigations related to the movement of the Sydney Metro tunnelling spoil by rail operations have been identified:

Identified Risk	Likelihood	Consequence	Potential Mitigation
Expansion of Sydney Light Rail along the freight line between Rozelle and Dulwich Hill removes access to the freight line for spoil transportation	Medium	High	Co-ordination of timing of proposed Metro excavation works and potential SLR extension.
Timing of the construction works for the Sydney Metro maintenance facility prevents or restricts spoil loading and train operations	Medium		Co-ordination of timing of proposed Metro excavation works and Metro maintenance facility construction
Noise generated during loading and train movements impacts on residential development limiting the hours of operation for loading and transit of trains	High	Medium	Plan train operations to ensure train loading and transit is at low impact times of day. Implement noise minimising operating practices
The cost and time impact of establishing direct siding connections to the RailCorp network, limits the viability of some receival site options	High	High	Avoid the use of sites which require the establishment of new connections to the RailCorp network (cost & time impact)
The viability of establishing unloading facilities and/or siding connections on privately owned tracks such as the privately owned coal balloon loop at Newnes Plateau, at Port Kembla, and at Dunmore limits the viability of these options	High (Newnes, Dunmore) Low (Pt Kembla)	High	Utilise sites where rail and/or materials handling facilities suitable for the operation are in existence
Road haulage of spoil from potential rail discharge locations for the Rocla Quarry and Riverstone receival sites limits the viability of these options	Medium	Medium	Assign priority to sites suitable for direct rail delivery
The potential un-availability of sufficient locomotives, wagons and train paths for the additional volumes of spoil received at White Bay from other sites for transport by rail limits the viability of rail transport of this material	Low - Medium	High	Facilitate early commitment of locomotive and wagon resources from potential supplier(s)
The consistency and wetness factor of the spoil increases the time taken to unload the train	High	Medium	Provide wagon shakers and/or high pressure water jetting equipment at unloading site

8. CONCLUSIONS

This report has considered the implications of the transport by rail of approximately 400,000 cubic metres solid, or around 960,000 tonnes, of spoil produced at White Bay, along with additional volumes of spoil received at White Bay from other sites for transport by rail to make a total rail task of approximately 2,568,000 tonnes.

The task mirrors the transport of the spoil from the Northside Storage Tunnel project c1998 where around 1,800,000 tonnes of spoil was transported from White Bay to St Marys in Western Sydney.

A train comprising either 30x 76 tonne gross (58 tonne net capacity) or 23 x 100 tonne gross (77 tonne net capacity) bottom discharge hopper wagons would provide an average net capacity in the order of 1650 - 1700 tonnes of and appears to be the preferable configuration for efficient operations.

Based on the train configuration outlined above, it is estimated that around 1630 train movements will be required to transport the spoil from White Bay.

The rail infrastructure from White Bay to Dulwich Hill is considered to generally be in a condition that would be suitable, following some rehabilitation works, for the spoil train operations. It is considered that the rehabilitation works could be completed within the project establishment timeframe.

Three potential options for the loading of trains using Front End Loaders have been identified in the White Bay area. From a rail perspective, the use of the Rozelle Yard area appears to be the most feasible; however, it is considered that each would require a more detailed review and financial assessment to allow finalisation of a preferred option.

Discussion with RailCorp and rail operators suggests that that sufficient locomotives, wagons and train paths would be available for the transportation of the proposed volume of spoil.

A review of the identified receival sites has been completed utilising available information including maps, photographs and RailCorp Train Operations data and site visits to Port Kembla and Dunmore.

The Port Kembla site appeared to be the most promising from both a rail operations and materials handling perspective, however construction of a rail wagon discharge facility and associated infrastructure would be required.

The Riverstone site was considered impractical from a rail operations point of view and an alternative of using a site at St Marys (with associated road haulage) was considered.

Three options were assessed for the Newnes Plateau site, with locations at Lithgow and Bell offering most promise. Aside from the additional cost associated with the double handling of the spoil, an assessment of the localities suggests that there may not be sufficient area available to establish the additional infrastructure and receival stockpiles. There is also considered to be a risk of dust and noise complaints associated with these locations.

Dunmore Quarry is located on a short branch line off the single track main line south of Unanderra and other train operations in the area potentially reduce the practicality of this site. Construction of an under track discharge facility and stockpile area within the confines of the Dunmore Quarry would be required and it may be necessary to construct additional track to accommodate the unloading facility. As the Dunmore site can only accept Virgin Excavated Natural Material, pre-classification of material for transport to this location would be required.

A number of potential risks related to the train operations have been identified and tabulated. These would need to have mitigating strategies identified and implemented.

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AMENDMENT RECORD			
ISSUE	DATE	COMMENTS	NAME

Appendix C Barging of spoil

CBD Metro

Barging of spoil

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Contents

1 Barging of spoil

1.1 Introduction

There is an opportunity to transport spoil material from the CBD Metro Project to Port Kembla by sea for land reclamation as part of the proposed Outer Harbour Port Development. Options and facilities for barge loading at White Bay and Barangaroo to handle the spoil transfer are reviewed in this report.

1.2 Material movement

Consideration is given to barging of spoil material from White Bay and from the current Cruise Ship Terminal wharf at Darling Harbour. The spoil to be removed by barging from White Bay will be from the cut and cover at White Bay, TBMs, road headers from Tunnel to Rozelle and potentially spoil from other station sites. Spoil barged from Darling Harbour is from the Wynyard station box and pedestrian link from Barangaroo.

Spoil volumes, daily rates and timing were based on the CBD Metro Spoil quantities and program at 17 June 2009. Total spoil volume which may be available for barging from White Bay is of the order of 425,000 cubic metres (solid) at a maximum rate of 1,280 cubic metres per day (solid) based on spoil from running tunnels White Bay to Rozelle and White Bay to Central. If spoil from tunnel boxes is included the quantity of spoil is significantly increased and the maximum rate is increased to 2,290 cubic metres per day (solid). Total spoil volume available for barging from Darling Harbour is of the order of 150,000 cubic metres (solid) at a rate of 498 cubic metres per day (solid).

1.3 Overview of barge loading methods

Three methods for loading barges were considered appropriate, with the viability of direct load via front end loader dependent on the distance from the spoil receipt/stockpile location to the barge loading point. The methods considered were:

- Conveyor loading system.
- Truck loading system.
- Direct front end loader system.

1.3.1 Conveyor loading system

The main components of the conveyor loading system are:

- Conveyor loads spoil to barge direct from hopper fed from tunnel TBM spoil system or from stockpile.
- Lower level of noise than diesel trucks and front end loaders.
- Lighter structural support and infrastructure at barge loading point.

- Initial high establishment cost spread over two to three year operation.
- Good control over loading barges with minimal spillage.
- Electrically powered conveyor is cleaner operation than alternative of diesel trucks and front end loaders.
- Reasonable reliability with conveyor, however a breakdown is much more critical than with truck or front end loader alternatives.
- Can be covered or water sprays for dust control.

1.3.2 Truck loading system

Truck loading components are:

- Depending on location either 10 cubic metre off-road trucks or five cubic metre on-road trucks, loaded by front end loader from stockpile, to elevated loading ramp at wharf to load barge.
- Requiring double handling of material.
- Difficult to dump from height for control in loading barge plus need controls for spillage on ramp and from barge.
- Requiring heavy structural support for barge loading ramp.
- High level of noise pollution requiring noise barriers even for daytime operation.

1.3.3 Direct front end loader system

Direct front end loader components are:

- Typical three cubic metre bucket to load direct from stockpile to barge via elevated loading ramp.
- Quicker cycle time than truck (within travel limit).
- 100 metre limit for travel for viability.
- More control in loading barge than from truck and less potential for spillage than trucks as loads more cleanly.
- Minimum two loaders required – one for standby in case of breakdown.
- Requires heavy structural support for barge loading ramp.
- High level of noise pollution requiring noise barriers even for daytime operation.

1.4 Barges and operation

A split hopper barge is the ideal barge for transport and direct discharge of spoil at Port Kembla. These barges can be either self propelled or towed by tug.

Bearing in mind the residential property on the boundary of the White Bay Port area it will be highly desirable to undertake barge loading during daylight hours, with transit to Port Kembla unloading and return at night for a complete 24 hour operation cycle.

Preliminary estimates indicate that 2 No. 50m self propelled split hopper barges of 1000 cubic metre hopper capacity (750 cubic metres/spoil) may handle the 950 cubic metres per day (solid) from the TBM Running Tunnels White Bay to Central on a 24 hour cycle but they would not be able to handle the additional spoil from the running tunnels White Bay to Rozelle. The inclusion of spoil from running tunnels White Bay to Rozelle increases the maximum rate of spoil to 1280 cubic metres per day (solid) but the duration of this peak rate is only of the order of four months. It could either be handled by additional 50 metre self propelled barges, larger capacity self propelled barges or by trucking the additional spoil to spoil receival sites. Larger capacity self propelled barges could be more efficient and meet the 24 hour cycle time but would likely have larger drafts which could limit flexibility in discharging spoil at Port Kembla. This would need further evaluation, as would the use of towed split hopper barges to confirm they could meet transit times to achieve a 24 hour cycle time.

The maximum rate of 1280 cubic metre per day of spoil from running tunnels is a reasonable limit for loading barges by truck or front end loader systems. It is also a reasonable limit for barge capacity and 24 hour cycling of barges. Additional spoil received at White Bay from other sites would unlikely to be able to be removed by barging and should be trucked directly to spoil receival sites.

1.5 Port Kembla outer harbour reclamation

Port Kembla Port Corporation is seeking Department of Planning approval for the whole of the planned reclamation for the outer harbour so that they can take advantage of reclamation material as it becomes available. They would be in a position then to construct bunded walls from slag for containment of spoil material discharged directly from bottom dump or split hopper barges. With the provision of silt curtains discharge of spoil could be carried out around the clock to meet CBD Metro barging requirements. The smaller 1000 cubic metre capacity split hopper barges with loaded drafts around three metres provide flexibility for reclamation close to shore.

1.6 White Bay barging operations

There are three potential loading points for barge operation out of White Bay. The suitability of the three methods for barge loading and infrastructure requirements are provided below.

1.6.1 Berth 1

The original wharf at Berth 1 has been removed and it now comprises a rock revetment. The full time use of Glebe Island Berths 7 and 8 opposite for unloading cement, sugar and gypsum limit the use of Berth 1 for barging. In particular vessels manoeuvring in and out of Berth 8 under tug control would at best allow berthing of one barge at the eastern end of Berth 1. This would be subject to more detailed assessment of vessel operation and clearances by the Harbour Master.

For a two barge operation a loading berth could be located within 100 metres of the CBD Metro allocated work area and spoil storage area. All these methods of barge loading – conveyor, truck and direct front end loader operations are feasible. Two sets of three piled berthing dolphins at the revetment would be required to moor the barge during loading. A ramped platform supported on piles over the water would be required for loading by conveyor, truck or front end loader. The conveyor support would be a lighter structure than that for the truck or front end loader use to load barges.

The western end of Berth 2 could be used as a lay by berth for a second barge waiting to move to the loading berth.

1.6.2 Berth 2

Berth 2 which is 150 to 200 metres from the CBD Metro allocated works area comprises a concrete deck on steel piles and is in very poor condition with no live load permitted on the suspended deck area and a 27.5kPa load limit behind the berth. The berth is used for the mooring of small barges under a long term arrangement.

Berth 2 is beyond the nominal 100m limit for viability of direct loading of barges from front end loaders and with the deck load limitations may not be suitable for either front end loader or truck loading of barges without substantial structural support for a loading ramp. The cost to strengthen this berth for loading of barges may well be prohibitive although these costs could be offset by reduced berthing facilities i.e. no requirement for mooring dolphins.

A lighter conveyor loading system may be able to be accommodated on the existing berth with limited strengthening of the deck support structure.

The ability to use this berth for loading barges would need to be further evaluated.

1.6.3 Berth 3

Berth 3 which is 250 to 350 metres from the CBD Metro allocated works area comprises concrete caissons with a heavy duty pavement with a load limit of 50kPa and is a common user berth. Although further from the CBD Metro works area and stockpile this berth is more suited to use by large trucks and conveyor for loading barges and for berthing/loading of barges.

Berth 3 would provide both a loading area and lay-by area for two barges envisaged.

1.7 Darling Harbour Barangaroo barging operation

If the existing cruise ship operation and CBD Metro construction coexist, barging of spoil from Darling Harbour may be possible but subject to operational constraints. Potential loading points and methods for barge loading and infrastructure requirements are outlined below.

The operational requirements of the cruise ships dictate the wharf space available for barging operations. On average cruise ships will use Berth 8 Darling Harbour once every seven days but often more frequently and will effectively require the total length of Berth 8 and Berth 7 for berthing and mooring. Generally the cruise ship often up to 260 metres in length combined with bow and stern mooring lines and requirements of the Marine Offshore Transport Security Act that no vessel is closer than 30 metres will preclude any other vessel using Berth 7 or 8 while a cruise ship is in port.

The cruise ship terminal Berth 8 and Berth 7 at Darling Harbour will therefore only be available for barging spoil when not required for cruise ship operation. A second possible loading point for barge operation is Berth 5 at Darling Harbour adjacent to and north of Berth 7.

1.7.1 Berth 8 – Cruise ship terminal

The proposed construction compound for the western shaft for Barangaroo-Wynyard Station has a wharf frontage of approximately 90 metres at the southern end of Berth 8. The compound has a length of approximately 200 metres to Sussex Street. Provided on completion of the western shaft to the Wynyard Station box the compound could be used for spoil storage this would be a suitable loading point for barges.

The berth comprises caissons and heavy duty pavement with a robust cylindrical rubber fendering system. Spoil barges, depending on their size could use their own fendering system such as rubber tyres to prevent damage to the wharf fenders at the various states of tide.

The spoil delivery rate of approximately 500 cubic metres per day (solid) could be handled by one split hopper barge per day with direct delivery to Port Kembla. Barging to White Bay for transhipment to Port Kembla would not be cost effective because of the high cost of double handling spoil. It is also questionable whether it would be cost effective to establish the facilities to load barges for the quantity of spoil to be removed. From a cost viewpoint it may be better to truck spoil direct to receival sites.

Barges could be loaded directly by trucks from the Barangaroo-Wynyard Station box or from a spoil storage area at the Berth 8 compound.

Barges could also be loaded by front end loaders from a spoil storage area. A loading ramp would be required for both truck and front end loader loading of the barge.

Equally a conveyor system either direct from the Wynyard Station box or spoil storage area could be used to load barges.

Loading ramps or conveyor systems on the berth would require to be compatible with mooring line requirements for cruise ships.

The interruption to barging operations when cruise ships are in port would require that either:

- There is sufficient buffer capacity in the spoil storage area at Berth 8.
- Spoil trucks are temporarily diverted to White Bay or other disposal locations.

Also a temporary mooring or lay by area at Barangaroo or White Bay will be required for the barge while the cruise ship is in port.

1.7.2 Berth 5 – Darling Harbour

A barge loading point at Berth 5 Darling Harbour backed by a spoil storage area would be a feasible alternative. This location would not be affected by the cruise ship operation and could operate uninterrupted.

The berth comprises caisson construction with heavy duty pavement and a robust fendering system. All three barge loading options – truck, front end loader and conveyor are possible at this location.

As for a barging facility at Berth 8 it is questionable whether it would be cost effective to establish facilities to load barges for the quantity of spoil to be removed. From a cost viewpoint it may be better to truck spoil direct to receival sites.

1.8 Barges

The split hopper barges proposed for transport of spoil to Port Kembla as previously discussed could be either self propelled or towed by tug. Characteristics of each type and their operational constraints are discussed below.

The main risks associated with barging are:

- Availability of suitable barges either within Australia or out of Asia.

- The weather which will directly affect the transit of barges on the open sea between Sydney and Port Kembla.
- Potential for spillage of spoil at sea, accidental damage or a barge washed up on the coastline.

1.8.1 Towed barges

Non-powered barges in transit between Sydney and Port Kembla would require to be towed by two tugs in Sydney Harbour, a main tug and a smaller tug for control. Tug requirements within the harbour at Port Kembla require to be confirmed with the Harbour Master.

Towage of a single barge would be the norm but it may be an option to couple barges and using larger tugs reduce the overall number of tugs required for the open sea leg.

NSW Maritime Authority is responsible for setting the towage requirements on the open sea leg between Sydney and Port Kembla. From the safety standpoint they would undertake towage inspections and unless tugs are sufficiently powered the barging operation may be restricted to fine weather operation only.

For an efficient barging operation of 24 hour total cycle time enabling barges to be loaded in daylight would require travel time between Sydney and Port Kembla of less than nine hours.

This is on the basis of 100 kilometres between Sydney and Port Kembla and the following estimation of times:

- sea port to port and return = 18hours
- discharge spoil at Port Kembla = 0.5 hours
- travel in and out of Sydney Harbour = 2 hours
- loading barge = 3.5 hours

Total = 24 hours

This would require a very efficient barge loading operation, achieving more than six knots at sea and little or no downtime.

A 24 hour total cycle time using towed barges would appear to be very difficult to achieve.

The main tow barge would likely be required for the full 24 hours as it would also be used in moving the barge along the berth during spoil loading.

There is a higher risk of an accident with a tug tow than a self propelled barge, especially in bad weather at sea, the connection between the tug and the tow being the weak link.

1.8.2 Self propelled barges

The self propelled barge can be compared with a small ship and it is the master's operating certificate which determines limitations on operation rather than NSW Maritime Authority towage inspections limiting operation. The self propelled barge would better handle the open sea leg, and depending on the vessel achieve a required speed for a total 24 hour cycle time.

The self propelled barge is also able to position itself and move along the berth as required during spoil loading. Being a single unit, not dependent on tugs in the open sea, there is a lower risk of an incident or spillage.

1.9 Risks and mitigation

Risks identified and potential mitigation measures associated with barging of spoil are outlined in Table 1.1. Additional background information is also provided on barge operation and stockpile capacity requirements to clarify risk issues with barging.

Table 1.1 Risks associated with barging operations

Identified Risk	Likelihood	Consequence	Potential Mitigation
Noise generated during loading of barges and impacts on residential development	High	Medium	• Loading during daylight hours • Noise mitigation such as noise barriers • Noise minimising operating practices on mobile plant and equipment • Cover conveyors to reduce noise if required.
Dust generated during loading with plant and trucks and loading barges close to residential development or cruise line terminal operations	High	High	• Water spray spoil stockpile and loading points for dust suppression • Covered conveyor with possible water spray system. • Telescopic barge loading chutes and dust extractors with conveyor barge loading if required
Lighting for barge loading impacting on residential development - short term requirement	Medium	Medium	• Restrict barge loading to daylight hours. • Minimal loading in poor light conditions (eg. winter late afternoon).
Disruption to barge travel at sea due to prolonged storms and sea swell. - cessation of barging - increase cycle time	High	High	• Adequate stockpile capacity to store a minimum of 1 weeks spoil production • Spare capacity in barge operation to remove built up surplus of spoil during downtime. • Ability to remove spoil by road (or rail) as well to alternative spoil disposal sites.
Barge or loading plant and equipment breakdown	High	Medium	• Adequate stockpile capacity for spoil storage during breakdown and spare capacity to remove surplus. • Stand by front end loader and trucks. • Barge replacement strategy in place - alternative barge availability. • Responsive conveyor repair/maintenance plan in place. • Ability to remove spoil by road (or rail) as short term measure.
Availability of suitable barges in Australia or Asia	Medium	High	• Early commitment of barges from potential contractors or barge suppliers.
Limited suitable barge loading sites due to existing commercial shipping requirements and suitable berths	High	High	• Detailed assessment of vessel operations, navigation requirements and wharf load limits to finalise possible berths for barge loading and lay by.

1.9.2 Barging and Stockpile Requirements

For barge operation it would be adviseable to have at least seven days production capacity free in the site spoil stockpile to accommodate disruptions to barge operation from bad weather or mechanifcal breakdown. Barges may not be able to operate or be restricted in their operation in prolonged storm conditions or large sea swell. Also on resumption of barging after downtime from storms or mechanical breakdown there is a need to reduce the spoil stockpile at a faster rate so there is sufficient buffer for any further downtime. If this cannot be met by barging, surplus will need to be removed by truck (or rail) to alternative spoil receival sites.

Assuming a stockpile capacity at White Bay of 16,000 cubic mettres based on a footprint of 120 metres by 30 metres and 10 metres height, this corresponds to:

12 days spoil production at 950m^3/day (solid)

9 days spoil production at 1280m^3/day (solid)

5 days spoil production at 2290m^3/day (solid)

For the longer term operation assuming a spoil delivery rate of 950 cubic metres per day (solid) expected from the TBM running tunnels White Bay to Central, there should be sufficient buffer storage capacity available provided the operation is carefully managed. Additional spoil delivery in excess of 950 cubic metres per day would likely require removal of spoil by truck (or rail) to alternative spoil receival sites.

1.10 Conclusions

This report has considered the issues associated with barging of spoil material from CBD Metro project to Port Kembla for land reclamation. Consideration was given to barging spoil from White Bay and Darling Harbour-Barangaroo. The following points summarise the outcome of this study.

White Bay

- The removal of spoil from running tunnels – White Bay to Rozelle and White Bay to Central is a reasonable upper limit for barge capacity, daylight loading and 24 hour cycling of barges. Additional spoil from other sites should be trucked directly to spoil received sites.
- Loading of barges could potentially occur from facilities on Berths 1, 2 or 3. However the ability to use Berths 1 or 2 would require a more detailed review.
- Of the three barge loading systems reviewed – conveyor, truck and direct front end loader operation, a conveyor system would have the least environmental impact in regard to noise, dust and spoil spillage. This is an important consideration with residential properties close to the boundary of the White Bay Port area.

Darling Harbour-Barangaroo

- Operational requirements of cruise ships at Berth 8 limit the viability of barging from Berth 8. Barging from Berth 5 is less constrained.
- Barging to White Bay for transhipment to Port Kembla would not be cost effective because of the high cost of double handling spoil. Direct barging to Port Kembla is an option but it is questionable whether it would be cost effective to establish facilities to load barges for the quantity of spoil being removed. From a cost viewpoint it may be better to truck spoil direct to receival sites.

Barging – Generally

- Self propelled split hopper barges would be preferred over towed barges. They would better cope with open sea conditions, have fewer operational constraints and would be more likely to achieve a 24 hour cycle time with daylight loading of barges.

- Potential disruption to barging operations as a result of storms, mechanical breakdown etc., requires careful management of stock piles to ensure ample free storage capacity to accommodate spoil production during barge and loading system downtime.