North Penrith

Civils Report

Summary

The North Penrith development site is located immediately to the north of Penrith railway station. The development consists of a variety of residential, commercial and employment zones. It is anticipated that approximately 1,000 residential dwellings will be provided as part of the proposed development. The North Penrith Concept Plan layout is included as **Diagram 1**.

The construction of the North Penrith development will be staged. As such, this report has been prepared to:

a. outline the civil works associated with the North Penrith development in support of Concept Plan application; and

b. outline the civil works associated with Stage 1 of the North Penrith development in support of the Stage 1 Project Application.

Objectives

The objectives of this report are:

- to summarise the bulk earthworks strategy for the site;
- to outline any temporary civil works associated with Stage 1;
- to respond to the relevant Director General's Requirements (*DGRs*); and
- to outline how the bulk earthworks strategy will maximise the re-use of existing materials.

DGRs have been issued for the Concept Plan (*MP 10-0075*) and for the Stage 1 Project Application (*MP 10-0078*). Both sets of DGRs were issued on 2 July 2010. The DGRs that this report responds to are nominated in **Table 1**.

Table 1 DGRs addressed in this report

Director General's Requirements	Key Assessment Requirements Addressed	Description
Concept Plan (*MP 10-0075*)	10 (2)(a)	A detailed survey showing existing and proposed levels and proposed quantities of cut and fill necessary for site preparation works.

Director General's Requirements	Key Assessment Requirements Addressed	Description
	10 (2)(b)	Details on the source of fill including types of materials and their source.
Project Application (*MP 10-0078*)	2 (1)	Provide an overview of the site preparation works to be undertaken in each stage of the development including how this contributes to the development of the whole site with reference to the staging plan submitted with the Concept Plan application.
	4 (1)	Provide a detailed survey showing existing and proposed levels and proposed quantities of cut and fill necessary for the proposed works.
	4 (2)	Details on the source of fill including types of materials and their source.
	4 (3)	Details of the location for the disposal of excess cut and the methodology of transportation to this location.

Methods and findings

The existing topography of the North Penrith site is predominately flat (*i.e., less than 1%*), except for a region of moderate grade (*i.e., greater than 1% but less than 7%*) towards the south-eastern boundary of the site.

The bulk earthworks strategy has been prepared to ensure the topography of the development provides an integrated solution that satisfactorily meets the requirements of:

- the '*North Penrith Regional Flooding Assessment Report*', WorleyParsons, October 2010;
- provides appropriate grades for the internal road network to the satisfaction of Penrith City Council;
- the '*North Penrith Drainage Stormwater and Groundwater Report*', WorleyParsons, October 2010;
- the '*North Penrith Utilities Servicing Report*', WorleyParsons, October 2010;
- meets the requirements for site access at the property boundaries;
- minimises the elevation difference at property boundaries; and

- minimises the imbalance between cut and fill volumes.

A bulk earthworks strategy has been prepared for the entire site using the industry standard 3-Dimensional spatial software package, "12D". The bulk earthworks strategy has been developed based on the design constraints present within the development.

The bulk earthworks strategy for the North Penrith development seeks to maximise the advantages of the existing topography of the site, natural grading and land features as well as striking an optimal balance between cut and fill volumes.

The Stage 1 Project Application adopts the proposed surface derived from the bulk earthworks strategy for the North Penrith development. Minor temporary works (*eg temporary basin, batters, diversion drains, etc*) will be required around the Stage 1 boundary to enable the proposed surface levels to be tied back to existing surface levels.

The bulk earthworks strategy will require excavation to occur to depths up to 4.50 m in the vicinity of the constructed wetland and central canal. Cut of up to 7.0 m will be required in an isolated location to remove an existing stockpile in the area to the west of the constructed wetland.

It is likely that a proportion of the material cut from deeper than 2.50 m will not be suitable for reuse as engineering fill. Works undertaken to this point have assumed that 25% of this material would not be suitable for reuse of engineering fill. This unsuitable material will need to be exported off-site. After stripping and stockpiling of topsoil, the remaining cut volume is assumed to be suitable for re-use as engineering fill. These assumptions will need to be clarified with additional geotechnical investigations during the detailed design and construction phases. Potential volumes of unsuitable cut material are included in **Table 2**.

Bulk earthworks volume estimates were undertaken by comparing the existing and proposed surface levels. The earthworks volumes based on the bulk earthworks strategy are shown in **Table 2**. At this stage no allowance has been made in volume estimates for stripping of topsoil or boxing out of road pavements.

Table 2 Approximate bulk earthworks volumes

	Cut Volume (m^3)	Unsuitable Cut (m^3)	Fill Volume (m^3)	Balance (m^3)
Concept Plan	115,000	30,000	205,000	120,000
Stage 1 Project Application	38,000	9000	49,000	20,000

Re-use of existing materials

Cut and fill

Where possible excavated cut volumes will be classified and placed as engineering fill within the site.

Topsoil

The bulk earthworks strategy will incorporate the stripping and stockpiling of topsoil. Stripped topsoil will be reused in areas of public open space and vegetation.

Existing hardstand areas

Under existing conditions the site contains a series of concrete building footings and asphalt roads. The concrete building footings and asphalt roads cover approximately 2.5 and 5.0 hectares respectively.

The existing asphalt and concrete could be crushed and placed as road sub-grade in fill areas or could be treated to a standard compliant with RTA guidelines for road sub-base and base course.

Landcom has a preference for re-using existing materials. However, the decision to re-use existing materials will require additional geotechnical testing and consultation with the contractor to confirm the approach to recycling.

Community Consultation

In preparing the bulk earthworks strategy various stakeholders have been consulted to discuss the impact of the bulk earthworks strategy on the existing landform. The following State Government Authorities, service providers and stakeholders have been consulted:

- Penrith City Council;
- NSW Department of Environment Climate Change and Water;
- NSW Roads and Traffic Authority;
- NSW Ministry of Transport;
- Sydney Water Corporation;
- Integral Energy;
- Telstra;
- Jemena;
- Railcorp;
- Museum of Fire; and
- Department of Defence.

Conclusions

The existing topography of the site does not provide scope to provide adequate grades to achieve:

- building footings above the 100 year ARI regional flood level;

- an appropriate drainage solution;
- an internal road network to the satisfaction of Penrith City Council guidelines; and
- sufficient grades to service the site with a wastewater network.

As such, approximately 121,000 m^3 of fill will need to be imported into the site to provide a topography that is conducive with urban development.

The bulk earthworks strategy set out to provide an appropriate integrated solution that:

- meets the requirements of the regional flood assessment report (*prepared by WorleyParsons*);
- provides appropriate grades for the internal road network to the satisfaction of Penrith City Council;
- affords adequate grades to provide stormwater drainage;
- provides appropriate grades to service the site;
- meets the requirements for site access at the property boundaries;
- minimises the elevation difference at property boundaries; and
- minimises the imbalance between cut and fill volumes.

Recommendations

A major priority of the bulk earthworks strategy is to minimise the amount of fill that needs to be imported to site. Works undertaken to date show that the required fill volumes at the site are particularly sensitive to road grades.

Thus, it is recommended that during the detailed design process associated with the Stage 1 Project Application that road grades are discussed with Council to potentially minimise the amount of fill required at the site. This would assist in providing a more sustainable outcome and would also reduce the extent of retaining walls required at the property boundary.

Additional geotechnical investigations are required to confirm the extent of excavated cut volumes that can be placed as engineering fill within the site.

It is also recommended that testing of the existing asphalt and concrete slabs be tested for their respective suitability for re-use in the road profile of the internal road network.

Contents

1. Objectives of assessment

At a glance

A Civils Report has been prepared to document the preliminary bulk earthworks strategy for the North Penrith development and for Stage 1 of the North Penrith development. The purpose of this report is:

- to outline the methodology associated with the bulk earthworks strategy;
- to document the bulk earthworks strategy by showing a proposed grading plan;
- to nominate the required cut and fill volumes;
- to nominate how the imbalance between cut and fill volumes can be reduced; and
- to nominate potential sourcing options to service the required fill volume at the site.

Objectives
The objective of the bulk earthworks strategy is to provide an integrated solution that satisfies the requirements of:

- the '*North Penrith Regional Flooding Assessment Report*', WorleyParsons, October 2010;
- provides appropriate grades for the internal road network to the satisfaction of Penrith City Council;
- the '*North Penrith Drainage Stormwater and Groundwater Report*', WorleyParsons, October 2010;
- the '*North Penrith Utilities Servicing Report*', WorleyParsons, October 2010;
- meets the requirements for site access at the property boundaries;
- minimises the elevation difference at property boundaries; and
- minimises the imbalance between cut and fill volumes.

Ultimately the North Penrith development will require a considerable fill volume to achieve appropriate grades conducive with urban development.

Finding the optimal balance between cut and fill volumes at the site was a priority. By optimising this balance the extent of importing / exporting material is minimised thus the opportunity to provide a sustainable bulk earthworks solution is maximised.

2. Site analysis

At a glance

The existing topography of the North Penrith site is predominately flat (*i.e., less than 1%*), except for a region of moderate grades (*more than 1% but less than 7%*) towards the south-eastern boundary of the site. Fill will need to be imported into the site to ensure that appropriate grades are afforded to align with the regional flooding assessment, drainage, servicing and internal road design.

This chapter provides descriptions of the existing land form for the North Penrith development as well as Stage 1 of the North Penrith development.

Stakeholders at the property boundaries are also identified.

Concept Plan

The North Penrith Concept Plan is shown on **Diagram 1**.

Diagram 1 North Penrith Concept Plan Layout

Existing topography

The North Penrith development site covers approximately 40 hectares. Under existing conditions the site is generally flat. Minor grade exists from the north-western corner of the site in the easterly and southerly direction. A small region of moderate grade exists towards the south-eastern boundary of the site.

The site is currently drained via a network of open drainage channels. These channels grade from the south and east in a north-westerly direction towards existing Council owned drainage infrastructure located near the intersection of Coreen Avenue and the access road to the existing commuter car park.

Existing contours are provided on drawing number 301015-00NP-CD-F02 of the WorleyParsons drawing set '*North Penrith Defence Land Concept Plan Application Drawings*'.

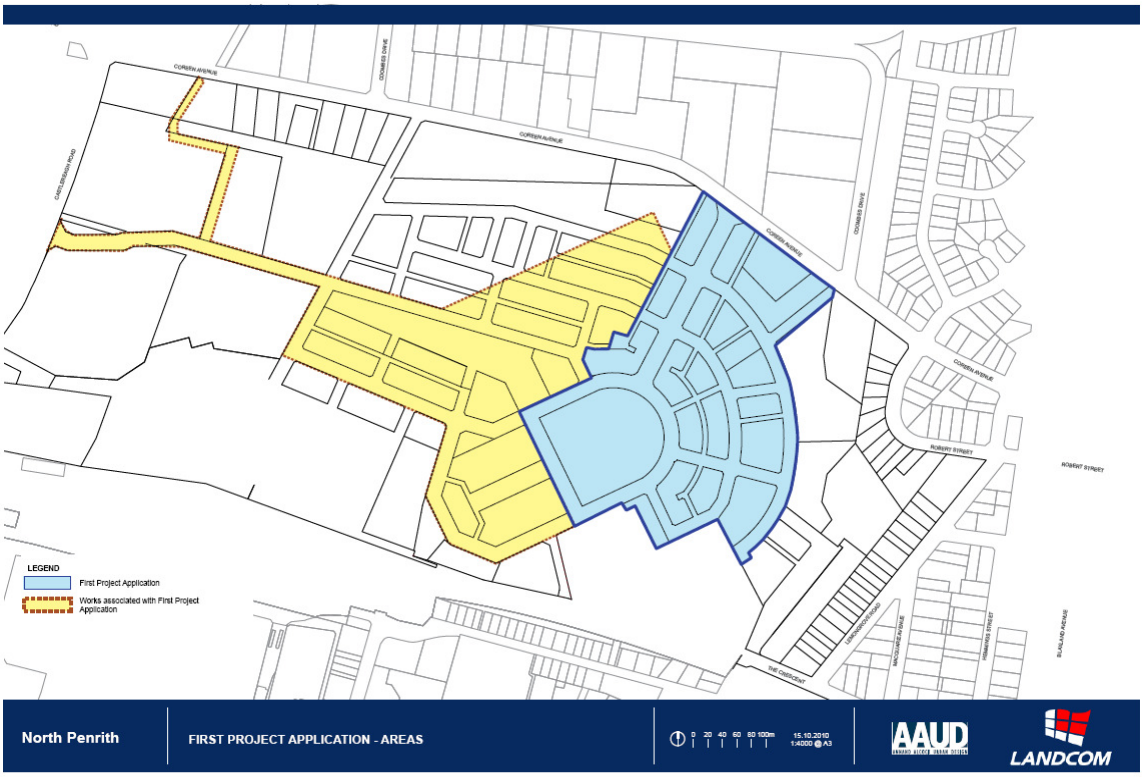
Stakeholders at property boundaries
The North Penrith development shares property boundaries with:

- Department of Defence to the south;
- Railcorp to the south;
- Museum of Fire to the west;
- Skillswest training centre to the west;
- Kenards Hire to the west;
- Coreen Avenue and the Mobil site to the north; and
- Existing residential properties to the east;

Stage 1 Project Application

The Stage 1 Project Application boundary is shown on **Diagram 2**.

Diagram 2 Stage 1 Project Application Boundary



Existing topography

The Stage 1 development covers approximately 12 hectares. Under existing conditions the site is generally flat. Moderate grades (*up to 7%*) exist from the western extent of Stage 1 to the eastern extent of Stage 1. Only minor grade (*less than 1%*) exists from the northern extent of Stage 1 to the southern extent of Stage 1.

The existing drainage regime within the Stage 1 boundary is consistent with that for the whole site. That is, networks of open channels direct stormwater runoff to the north-west towards existing Council drainage infrastructure.

Stakeholders at property boundaries

Stage 1 of the North Penrith development shares property boundaries with Department of Defence to the south and Coreen Avenue to the north. The eastern and western extents of Stage 1 do not extend to the property boundary.

3. Regulatory context

At a glance

The bulk earthworks strategy has been prepared based on relevant legislation, government policies and professional standards appropriate to the industry for each of the following:

- regional flood management strategies;
- internal road design;
- stormwater drainage; and
- site servicing.

Regional flooding

A regional flooding assessment has been prepared by WorleyParsons for the North Penrith development. This document explains in full the regulatory context governing flood management at the proposed development.

In summary, minimum road levels within the site are to be set at 25.4 mAHD and minimum habitable floor levels within the development are to be set at 25.9 mAHD.

Internal road design

A preliminary road network has been prepared for the North Penrith development as well as Stage 1 of the North Penrith development. The road network plan has been prepared in consultation with the Traffic and Transport Consultant for the project, Parsons Brinckerhoff.

In preparing the internal road network the following policies and relevant professional standards of the industry were applied:

- Australian Standards;
- Penrith City Council Guidelines for Engineering Works for Subdivisions and Developments;
- Landcom Street Design Guidelines; and
- matching existing levels at the vehicular entry / exit points of the site.

Stormwater drainage

A stormwater drainage strategy has been prepared for the North Penrith development as well as Stage 1 of the North Penrith development. In preparing the stormwater drainage network the following policies, standards and relevant professional standards / objectives of the industry were applied:

- Australian Standards;

- Penrith City Council Guidelines for Engineering Works for Subdivisions and Developments; and
- maintenance of existing flow regimes upstream and downstream of the site to prevent adverse impact arising from the development for events up to the 100 year Average Recurrence Interval storm.

Site Servicing

The internal reticulation of potable water and sewer networks affects the bulk earthworks strategy in some pockets of the site. As such, appropriate measures have been adopted to ensure that Sydney Water's minimum cover requirements can be met for sewer and potable water infrastructure. Documents referenced were:

- Water Supply Code of Australia Sydney Water Edition Version 1, Water Services Association of Australia, 2002; and
- Sewerage Code of Australia Sydney Water Edition Version 2, Water Services Association of Australia, 2002.

The internal reticulation of telecommunications, gas and electrical services does not impact upon the bulk earthworks strategy.

4. Methods and results

At a glance

A bulk earthworks strategy has been prepared for the North Penrith development. The bulk earthworks strategy incorporates appropriate design constraints stemming from the stormwater drainage, internal road design, regional flood management and site servicing requirements. The bulk earthworks strategy also looks to minimise construction costs as well as minimising elevation differences at the property boundaries.

The industry standard 3-Dimensional spatial software package, "12D", was used to generate existing and proposed surfaces. The existing surface was generated based on the detailed site survey provided by Craig and Rhodes whilst the proposed surface was generated based on the outputs of the bulk earthworks strategy.

Stage 1 of the North Penrith development will adopt the proposed surface levels established as part of the bulk earthworks strategy. Some temporary civil works will be required at the boundaries of Stage 1 to achieve an appropriate integration between the proposed levels and existing levels. Such works include temporary batters, retaining walls and stormwater diversion drains.

The bulk earthworks strategy will require excavation to occur to depths up to 4.50 m in the vicinity of the constructed wetland and central canal. Cut of up to 7.0 m will be required to remove an existing stockpile located to the west of the constructed wetland.

It is likely that a proportion of the material cut from deeper than 2.50 m will not be suitable for reuse as engineering fill. Works undertaken to this point have assumed that 25% of this deep cut volume would not be suitable for reuse of engineering fill. This unsuitable material will need to be exported off-site. After stripping and stockpiling of topsoil the remaining cut volume is assumed to be suitable for re-use as engineering fill. These assumptions will need to be clarified with additional geotechnical investigations during the detailed design and construction phases. Potential volumes of unsuitable cut are included in **Table 3**.

The estimates of cut and fill volumes for the North Penrith development and Stage 1 are shown below in **Table 3**. At this stage no allowance has been made in volume estimates for stripping of topsoil or boxing out of road pavements.

Table 3 Approximate bulk earthworks volumes

	Cut Volume (m^3)	Unsuitable Cut (m^3)	Fill Volume (m^3)	Balance (m^3)
Concept Plan	115,000	30,000	205,000	120,000
Stage 1 Project Application	38,000	9000	49,000	20,000

Methods

Review of Geotechnical Reports
The '*Geotechnical & Groundwater North Penrith Assessment Report*', Geotechnique, October 2010 was reviewed to consider the impacts of groundwater and salinity within the North Penrith site.

Review of the report has resulted in the following conclusions being made:

- the groundwater table within the site is at depths greater than 5.0 m;
- groundwater does not appear to rise significantly following heavy rainfall;
- based on the Salinity Potential in Western Sydney map the site is classified as a being of 'Moderate Salinity Potential';
- soils excavated from depths greater than 2.50 m may not be suitable for re-use as engineering fill and will need to be exported off-site; and
- soils within 2.50 m of existing surface level may be re-used by means of excavation and filling.

Modelling techniques
The industry standard 3-Dimensional spatial software package, "12D", was used to generate models of the existing and proposed surfaces for the North Penrith development. The existing surface model was developed based on detailed survey provided by Craig and Rhodes whilst the proposed surface model was developed as an outcome of the preliminary bulk earthworks strategy.

12D has the capacity to calculate volume differences between two surfaces. As such, the existing and proposed surfaces were compared to determine bulk earthworks volumes for the North Penrith Concept Plan and the Stage 1 Project Application.

Design constraints
The preliminary bulk earthworks strategies for the North Penrith Concept Plan and Stage 1 Project Application were constrained by:

- the '*North Penrith Regional Flooding Assessment Report*', WorleyParsons, October 2010;
- the provision of appropriate grades for the internal road network to the satisfaction of Penrith City Council;
- the '*North Penrith Drainage Stormwater and Groundwater Report*', WorleyParsons, October 2010;
- the '*North Penrith Utilities Servicing Report*', WorleyParsons, October 2010;
- the requirements for site access at the property boundaries;

- minimising the elevation difference at property boundaries; and
- minimising the imbalance between cut and fill volumes.

The adopted design constraints for the North Penrith Concept Plan and Stage 1 Project Application are nominated under the relevant sub-headings below.

Concept Plan

The North Penrith Concept Plan bulk earthworks strategy adopted the following design constraints:

1. provide drainage infrastructure and overland flow paths to ensure that the majority of stormwater runoff generated within the site is directed towards a central water body;
2. maintenance of the existing drainage regime from the Penrith Training Depot through the North Penrith site;
3. 1% as a general minimum longitudinal grade for all internal roads;
4. provision of adequate cover to utility services within the development in accordance with utility providers' requirements;
5. matching existing surface levels at all intersections between the existing road network and the proposed internal roads;
6. matching design road levels for the proposed Penrith Commuter Car Park entry roads; and
7. minimise the height of any batters or retaining walls along the site's boundaries.

Stage 1 Project Application

The Stage 1 Project Application bulk earthworks strategy is governed by the proposed surface levels nominated for the North Penrith development. Accordingly, the Stage 1 Project Application bulk earthworks strategy adopts the same design constraints as the North Penrith Concept Plan.

In addition to the constraints nominated above some temporary works will be required during Stage 1 to ensure appropriate integration into existing surface levels at the Stage 1 boundary as well as to accommodate stormwater runoff generated external to the Stage 1 boundary.

Design objectives

The bulk earthworks strategies for the North Penrith site and Stage 1 Project Application are governed by the same design objectives, namely:

- to provide a cost effective bulk earthworks strategy;
- to provide a bulk earthworks strategy that minimises the need to import or export material to or from the North Penrith site;

- to provide a bulk earthworks strategy that delivers a proposed surface conducive to urban development;
- to provide a bulk earthworks strategy that minimises elevation changes at property boundaries;
- to meets the requirements for site access at the property boundaries; and
- to satisfy the design requirements of relative approval authorities.

Results

Concept Plan

Analysis of the bulk earthworks strategy for the North Penrith site was undertaken. The results of this analysis are summarised below under the relevant sub-headings.

Bulk earthworks volumes

The bulk earthworks strategy for the North Penrith site yields the following volumes:

- 115,000m^3 of cut;
- 30,000m^3 of unusable cut; and
- 205,000m^3 of fill.

Thus, approximately 120,100m^3 of fill will need to be imported into the North Penrith development to provide a proposed surface that meets the grading design objectives.

Site grading plan

A site grading plan has been prepared for the North Penrith Concept Plan based on the bulk earthworks strategy.

The site grading plan is included as drawing number 301015-00NP-CD-F02 of the '*North Penrith Concept Plan Application Drawings'*, WorleyParsons, October 2010. The site grading plan has been prepared in accordance with the Director General's Requirements and shows the existing and proposed surface levels.

A bulk earthworks plan for the North Penrith Concept Plan showing the location, extent and quantities of cut and fill volumes required to produce a proposed surface conducive for urban development is included as drawing number 301015-00NP-CD-F03 of the '*North Penrith Concept Plan Application Drawings'*, WorleyParsons, October 2010.

Retaining walls

The bulk earthworks strategy will require retaining walls to be constructed along segments of the following property boundaries:

- Penrith Training Depot;
- Railcorp;

- Commuter Car Park; and
- Mobil.

The location of the required retaining walls is shown on drawing number 301015-00NP-CD-F02 of the WorleyParsons '*North Penrith Defence Land Concept Application Drawings*', drawing set. The characteristics of the retaining walls are summarised below in **Table 4**.

Table 4 Retaining wall characteristics

Retaining Wall Identification	Approximate Length (m)	Maximum Height (m)	Average Height (m)
Penrith Training Depot (A)	150	0.5	0.25
Penrith Training Depot (B)	460	1	0.70
Penrith Training Depot (C)	150	1	0.60
Railcorp	500	2	1.25
Commuter Car Park (A)	120	1.5	0.75
Commuter Car Park (B)	60	1.5	1.5
Mobil	500	2	1.25

Penrith railway station access

The bulk earthworks strategy proposes to fill in the vicinity of the upgraded Commuter Car Park. As such, the existing access arrangements to Penrith railway station from the commuter car park will need to be revised.

Based on the proposed open space design strategy for the Station Square the existing lift will need to be reconfigured or replaced and alternative stair arrangements will need to be provided to enable access to the railway platforms. The arrangement of pedestrian access from the North Penrith development to the Penrith railway station will be finalised during detailed design works of the Stage 2 Project Application (*i.e., not part of this scope of work*).

Commuter Car Park

The existing Commuter Car Park will be upgraded. The Commuter Car Park is not part of this application and will begin construction prior to the area subject to this application.

It is understood that the upgraded commuter car park will be integrated into the North Penrith development by:

- providing vehicular access to the car park off Coreen Avenue and Castlereagh Road;
- providing services to the Commuter Car Park via the North Penrith development; and
- 9,00providing pedestrian access from the Commuter Car Park through the North Penrith development into Penrith railway station.

The staged construction of the North Penrith development will result in the Commuter Car Park being completed prior to any construction works occurring around the Commuter Car Park boundary. Temporary access arrangements will be provided for pedestrians from the Commuter Car Park to the railway station for two scenarios:

1. once the construction of the Commuter Car Park is completed but there are no works within the North Penrith development affecting access (*note: Pedestrians will not traverse the Landcom site during this scenario*); and
2. the construction phase of the North Penrith development whilst construction activities are occurring within the vicinity of the North Penrith / Railcorp boundary.

Temporary arrangements have been subject to concept planning with a view to confirming the nature and extent of any temporary arrangements during detailed design documentation as well as the Construction Environmental Management Plan associated with the North Penrith development. These details will be dealt with as part of the Stage 2 Project Application.

Potential sources of fill

The North Penrith bulk earthworks strategy will require approximately 121,000m^3 of fill material to be imported into the site.

The sourcing of fill will be subject to negotiations between Landcom and the contractor. In the first instance Landcom has a preference to import fill from Landcom development sites with an excess of cut. In the absence of an appropriate Landcom source fill would be sourced from construction works as close to the development site as is practical.

Imported fill would need to be free of contamination and validated by a geotechnical engineer to ensure adequacy for use as engineering fill for road reserves and buildings.

Stage 1 Project Application

Analysis of the bulk earthworks strategy for Stage 1 was undertaken. The results of this analysis are summarised below under the relevant sub-headings.

Bulk earthworks volumes

The Stage 1 Project Application bulk earthworks strategy yields the following earthworks volumes:

- 38,000m^3 of cut;
- 9,000m^3 of unsuitable cut material; and

- 49,000m^3 of fill.

Thus, approximately 20,000m^3 of fill will need to be imported into Stage 1 of the North Penrith development to provide a proposed surface that is conducive with urban development.

Site grading plan

A site grading plan has been prepared for the Stage 1 Project Application based on the bulk earthworks strategy.

The site grading plan is included as drawing number 301015-00NP-ST1-F03 of the WorleyParsons '*North Penrith Stage 1 Project Application Drawings*' drawing set. The site grading plan has been prepared in accordance with the Director General's Requirements and shows the existing and proposed surface levels.

A bulk earthworks plan for the Stage 1 Project Application showing the location, extent and quantities of cut and fill volumes required to produce a proposed surface conducive for urban development is included as drawing number 301015-00NP-ST1-F04 of the WorleyParsons '*North Penrith Stage 1 Project Application Drawings*' drawing set.

Retaining walls

A retaining wall will be constructed along part of the Stage 1 / Penrith Training Depot boundary. This retaining wall location is shown on drawing number 301015-00NP-ST1-F03 of the WorleyParsons '*North Penrith Defence Land Stage 1 Project Application Drawings*' and corresponds to the retaining wall identified as "Penrith Training Depot (B)" in **Table 4**.

Temporary batters

A series of temporary batters will be constructed around the Stage 1 boundary. These temporary batters will ensure that the proposed surface levels associated with Stage 1 can be tied back into existing surface levels. Batters will be constructed at 1(vertical):5(horizontal). Batter extents vary around the Stage 1 boundary, however at their maximum the temporary batters extend approximately 8.50 m.

The location of temporary batters is shown on drawing number 301015-00NP-ST1-F03 of the WorleyParsons '*North Penrith Defence Land Stage 1 Project Application Drawings*' drawing set.

Potential sources of fill

The Stage 1 bulk earthworks strategy will require approximately 20,000m^3 of fill material to be imported into the site.

In the first instance fill would be sourced from within the North Penrith site boundary. By sourcing fill volumes from within the site the possibility of having to export cut volumes off site during the later stages of the development is minimised. Potential sources of excavation during Stage 1 include along the alignment of the central canal and in the footprint of the constructed wetland.

The sourcing of additional fill volumes (*i.e., that beyond which can be sourced on site*) will be subject to negotiations between Landcom and the contractor. In the first instance Landcom has a preference to import fill from Landcom development sites with an excess of cut. In the

absence of an appropriate Landcom source fill would be sourced from construction works as close to the development site as is practical.

Imported fill would need to be free of contamination and validated by a geotechnical engineer to ensure adequacy for use as engineering fill for road reserves and buildings.

Export of excess material

Any excess material will be stockpiled outside the Stage 1 boundary. Thus, no excess material will be exported off site during Stage 1.

An appropriate strategy for exporting unsuitable material off-site will be submitted as part of the Stage 2 Project Application (*i.e., not part of this scope of works*).

5. Assessment

At a glance

The bulk earthworks strategy prepared for the North Penrith site will require approximately 121,000m^3 of fill to be imported on to the site.

Initial earthworks calculations estimate that approximately 20,000m^3 would need to be imported during Stage 1.

Whilst the bulk earthworks strategy is governed by a series of constraints the cut and fill volumes are most sensitive to the internal road design requirements. The potential reduction in longitudinal road grades to less than 1% for some portions of the internal road network should be investigated. This would result in the fill volume needing to imported to the site being reduced from the current estimates.

Groundwater & Salinity

Review of the '*Geotechnical & Groundwater North Penrith Assessment Report*', Geotechnique, October 2010 results in the following general comments:

- excavation activities within the site are unlikely to encounter groundwater;
- cut volumes should be placed as fill in areas deemed to have a similar salinity classifications to limit the potential for spreading saline spoil;
- additional geotechnical investigations will be required during detailed design to finalise the Soil and Water Salinity Management Plan; and
- additional geotechnical investigations will be required during detailed design to determine the extent of anticipated cut volumes that can be reused as engineering fill within the site.

Concept Plan

The North Penrith Concept Plan bulk earthworks strategy will require 121,000m^3 of fill to be imported to the site to prepare a proposed surface that is conducive with urban development. The preliminary bulk earthworks strategy was prepared based on design constraints and with a view to minimising the imbalance between cut and fill volumes.

As the bulk earthworks strategy design has evolved it has become evident that fill volumes are sensitive to road levels at three locations within the development. It is recommended that the potential reduction in longitudinal road grades to less than 1% for some small sections of road be discussed with Council.

By optimising the locations of road grades of less than 1% the fill volume required within the development would be minimised. This would result in the extents and heights of the retaining walls required along the property boundaries to be reduced.

Stage 1 Project Application

The proposed surface for the Stage 1 Project Application is consistent with the earthworks strategy prepared for the North Penrith Concept Plan. Any revisions to the bulk earthworks strategy occurring during detailed design of the North Penrith development would be incorporated into Stage 1.

6. References

- '*North Penrith Regional Flooding Assessment*', WorleyParsons, October 2010;
- '*North Penrith Drainage Stormwater and Groundwater Report*', WorleyParsons, October 2010;
- '*North Penrith Utilities Services Report*', WorleyParsons, October 2010;
- '*North Penrith Defence Land Concept Plan Application Drawings*', WorleyParsons, October 2010;
- '*North Penrith Defence Land Stage 1 Project Application Drawings*', WorleyParsons, October 2010;
- *'Water Supply Code of Australia Sydney Water Edition Version 1*', Water Services Association of Australia, 2002;
- '*Sewerage Code of Australia Sydney Water Edition Version 2*', Water Services Association of Australia, 2002; and
- '*Geotechnical & Groundwater North Penrith Assessment Report*', Geotechnique, October 2010.