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The Northern Road Upgrade Mersey Road, Bringelly to Glenmore Parkway, Glenmore Park

NSW Environmental Impact Statement /
Commonwealth Draft Environmental Impact Statement

Appendix L – Technical working paper: Soils, water and contamination

June 2017

The Northern Road Upgrade –

Mersey Road to Glenmore Parkway

Prepared for Roads and Maritime Services by Jacobs Australia

Soils, Water and Contamination Assessment

Final

15 May 2017

The Northern Road Upgrade (Mersey Road to Glenmore Parkway)

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1. Introduction

Roads and Maritime Services (Roads and Maritime) is seeking approval to upgrade about 16 km of The Northern Road between Mersey Road, Bringelly and Glenmore Parkway, Glenmore Park (the project).

The upgrade of The Northern Road is part of the Western Sydney Infrastructure Plan (WSIP). The WSIP involves major road and transport linkages that will capitalise on the economic gains from developing the Western Sydney Airport site at Badgerys Creek whilst boosting the local economy and liveability of western Sydney.

Jacobs Group (Australia) Pty Ltd (Jacobs) was commissioned by Roads and Maritime to undertake an assessment of the potential environmental impacts of the project, and prepare an Environmental Impact Statement (EIS) in accordance with the *Environmental Planning and Assessment Act 1979* (EP&A Act) that adequately addresses the Secretary's Environmental Assessment Requirements (SEARS) and in accordance with the Commonwealth *Environmental Protection Biodiversity Conservation Act 1999* (EPBC Act) that adequately addresses the Commonwealth EIS Guidelines.

1.1 Description of the project

Roads and Maritime is seeking approval to upgrade 16km of The Northern Road between Mersey Road, Bringelly and Glenmore Parkway, Glenmore Park (the project). The project generally comprises the following key features:

- A six-lane divided road between Mersey Road, Bringelly and Bradley Street, Glenmore Park (two general traffic lanes and a kerbside bus lane in each direction). The wide central median would allow for an additional travel lane in each direction in the future, if required
- An eight-lane divided road between Bradley Street, Glenmore Park and about 100 m south of Glenmore Parkway, Glenmore Park (three general traffic lanes and a kerbside bus lane in each direction separated by a median)
- About eight kilometres of new road between Mersey Road, Bringelly and just south of the existing Elizabeth Drive, Luddenham, to realign the section of The Northern Road that currently bisects the Western Sydney Airport site and to bypasses Luddenham
- About eight kilometres of upgraded and widened road between the existing Elizabeth Drive, Luddenham and about 100 m south of Glenmore Parkway, Glenmore Park
- Closure of the existing The Northern Road through the Western Sydney Airport site
- Tie-in works with the following projects:
  - The Northern Road Upgrade, between Peter Brock Drive, Oran Park and Mersey Road, Bringelly (to the south)
  - The Northern Road Upgrade, between Glenmore Parkway, Glenmore Park and Jamison Road, South Penrith (to the north)
- New intersections including:
  - A traffic light intersection connecting the existing The Northern Road at the southern boundary of the Western Sydney Airport, incorporating a dedicated u-turn facility on the western side
  - A traffic light intersection for service vehicles accessing the Western Sydney Airport, incorporating 160 m of new road connecting to the planned airport boundary
  - A traffic light intersection connecting the realigned The Northern Road with the existing The Northern Road (west of the new alignment) south of Luddenham
  - A 'give way' controlled intersection (that is, no traffic lights) connecting the realigned The Northern Road with Eaton Road (east of the new alignment, left in, left out only)
  - A four-way traffic light intersection formed from the realigned Elizabeth Drive, the realigned The Northern Road and the existing The Northern Road, north of Luddenham

- A traffic light intersection at the Defence Establishment Orchard Hills entrance, incorporating a u-turn facility

- New traffic lights at four existing intersections:
  - Littlefields Road, Luddenham
  - Kings Hill Road, Mulgoa
  - Chain-O-Ponds Road, Mulgoa
  - Bradley Street, Glenmore Park incorporating a u-turn facility
- Modified intersection arrangements at:
  - Dwyer Road, Bringelly (left in, left out only)
  - Existing Elizabeth Drive, Luddenham (left out only)
  - Gates Road, Luddenham (left in only)
  - Longview Road, Luddenham (left in, left out only)
  - Grover Crescent south, Mulgoa (left in only)
  - Grover Crescent north, Mulgoa (left out only)
- Dedicated u-turn facilities at:
  - The existing The Northern Road at Luddenham, south-west of Elizabeth Drive
  - The existing Elizabeth Drive, Luddenham around 800 m east of The Northern Road
  - Chain-O-Ponds Road, Mulgoa
- Twin bridges over Adams Road, Luddenham
- Local road changes and upgrades, including:
  - Closure of Vicar Park Lane, east of the realigned The Northern Road, Luddenham
  - Eaton Road cul-de-sac, west of the realigned The Northern Road, Luddenham
  - Eaton Road cul-de-sac, east of the realigned The Northern Road, Luddenham
  - Elizabeth Drive cul-de-sac, about 300 m east of The Northern Road with a connection to the realigned Elizabeth Drive, Luddenham
  - Extension of Littlefields Road, east of The Northern Road, Mulgoa
  - A new roundabout on the Littlefields Road extension, Mulgoa
  - A new service road between the Littlefields Road roundabout and Gates Road, including a ‘give way’ controlled intersection (that is, no traffic lights) at Gates Road, Luddenham
  - Extension of Vineyard Road, Mulgoa between Longview Road and Kings Hill Road
  - A new roundabout on the Vineyard Road extension at Kings Hill Road, Mulgoa
- A new shared path on the western side of The Northern Road and footpaths on the eastern side of The Northern Road
- A new shared path on the western side of The Northern Road and footpaths on the eastern side of The Northern Road where required
- The upgrading of drainage infrastructure
- Operational ancillary facilities including:
  - Heavy vehicle inspection bays for both northbound and southbound traffic, adjacent to Grover Crescent, Mulgoa and Longview Road, Mulgoa respectively
  - An incident response facility on the south-western corner of the proposed four-way traffic light intersection at Elizabeth Drive, Luddenham

- New traffic management facilities including variable message signs (VMS)
- Roadside furniture and street lighting
- The relocation of utilities and services
- Changes to property access along The Northern Road (generally left in, left out only)
- Establishment and use of temporary ancillary facilities and access tracks during construction
- Property adjustments as required
- Clearance of undetonated explosive ordinance (UXO) within the Defence Establishment Orchard Hills as required.

The project assessed in this EIS does not include surveys, test drilling, test excavations, geotechnical investigations or other tests, surveys, sampling or investigation for the purposes of the design or assessment of the project.

1.2 Location and context

The Northern Road is about 45 km west of the Sydney central business district and traverses the local government areas of Penrith in the north and Liverpool in the south.

The Northern Road is a key north–south road between Narellan and Richmond, connecting the North West and South West Priority Growth Areas (see Figure 1-1). The corridor intersects with a number of regional motorway, arterial and collector roads such as (north to south) Richmond Road, Great Western Highway, M4 Motorway, Elizabeth Drive, Bringelly Road, and Camden Valley Way.

South of Glenmore Parkway (the southern extent of The Northern Road Upgrade, Glenmore Parkway to Jamison Road), the project area is surrounded by rural residential zoned land as well as pastures and grasslands. Land to the east of The Northern Road in this section is occupied by the Commonwealth Defence Establishment Orchard Hills. Further south, The Northern Road passes through the village of Luddenham (including a small number of residential and commercial properties), before continuing through agricultural grasslands to its junction with Mersey Road (the northern extent of The Northern Road Upgrade, Peter Brock Drive to Mersey Road).

A seven kilometre section of the existing The Northern Road alignment bisects the Western Sydney Airport site south-east of the Luddenham town centre.

The regional context of The Northern Road Upgrade is provided on Figure 1-1.

1.3 Scope and purpose of this report

This report presents the results of a soils, surface water, groundwater and contamination assessment for the project. The purpose of this report is to assess the existing conditions, assess the impacts of the project and recommend any mitigation measures required to address these impacts. The outcomes of this report would be used to inform the EIS.

The area assessed as part of this report includes the proposed construction and operational footprint of the project as outlined in the EIS. The scope of this report includes:

- An outline of the existing soil, surface water, groundwater and contamination conditions in the assessed project area
- Identifying water quality objectives and criteria for the assessment of potential water quality impacts
- Development of a conceptual groundwater model
- Assessing the potential impacts of the project on the existing environment during both construction and operation
- Identifying environmental management measures required to address these impacts.

1.4 NSW and Commonwealth Assessment Requirements

Table 1-1 lists the Secretary's Environmental Assessment Requirements (SEARs) of relevance to this Soils, water and contamination report and where in the report they are addressed.

Table 1-1 SEARs – Soils, water and contamination

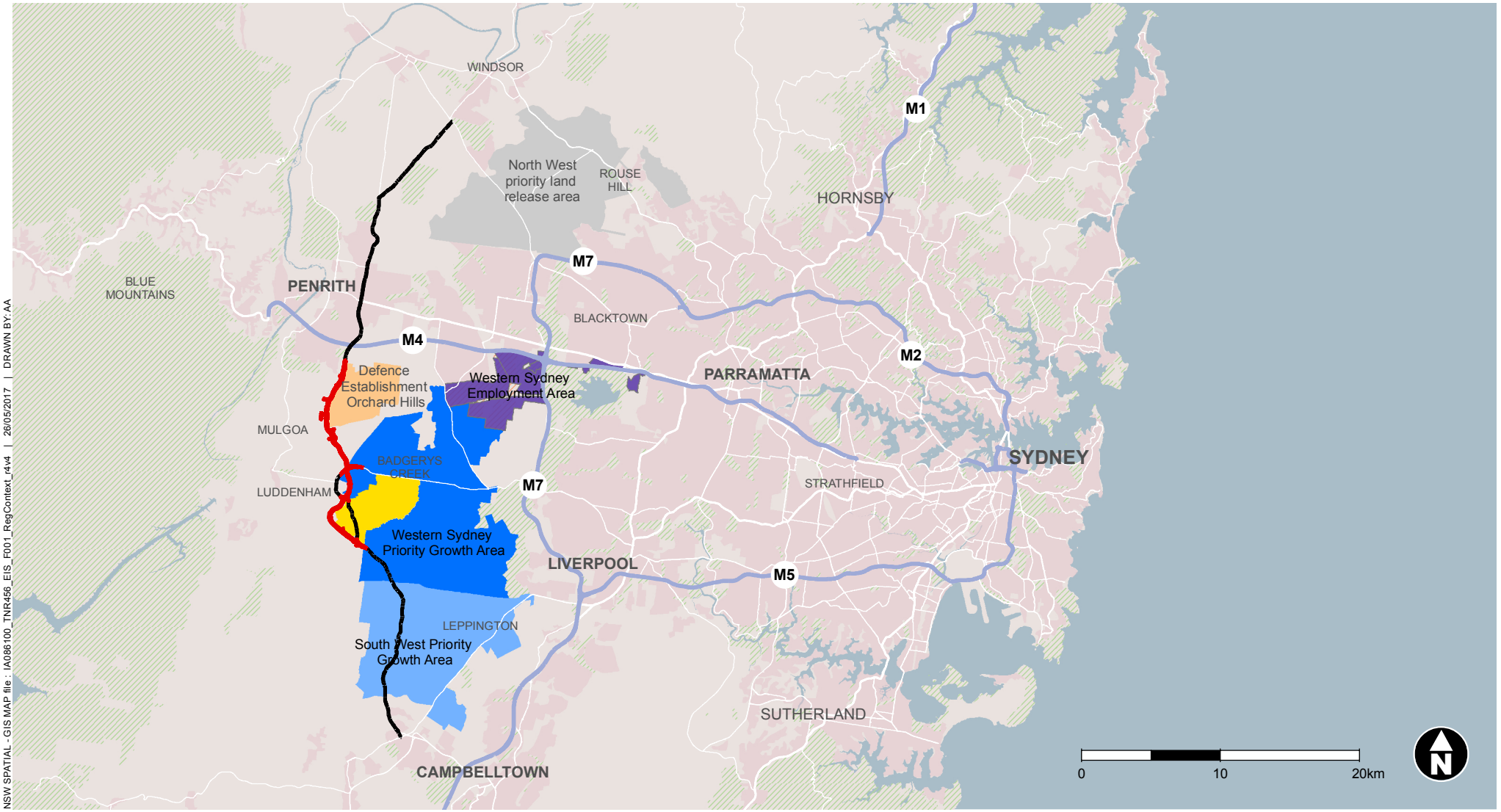
Secretary's requirement	Where addressed in Document
The EIS must address the following specific matters: impacts on watercourses, surface water flows (including stormwater drainage systems), quality, quantity, availability and users (commercial and recreational), with particular reference to any likely impacts on surrounding water bodies and their catchments, wetlands and their habitats, including how these are to be monitored;	Potential construction phase impacts on surface water are provided in Section 5.3. Operational impacts are described in Section 6.3. Surface water flows are addressed in Hydrology and Flooding Working Paper (**Appendix K** of the EIS). Habitat impacts are addressed in the Biodiversity Assessment Working Paper (**Appendix I** of the EIS).
An assessment of construction water quality impacts, taking into account impacts from both accidents and runoff (i.e. acute and chronic impacts), having consideration to impacts to surface water runoff, soil erosion and sediment transport, mass movement, and spoil and waste management. The assessment of water quality impacts is to have reference to relevant public health and environmental water quality criteria, including those specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000), any applicable regional, local or site-specific guidelines, water quality objectives, and any licensing requirement.	Consideration of construction water quality impacts is described in Section 5.3 including acute and chronic impacts. The water quality guidelines and objectives applied in the assessment of surface water quality are presented in Section 3.3 and Table 3-1.
assessment of waterways to be modified as a result of the project, including ecological, hydrological and geomorphic impacts (as relevant), including temporary crossings, and measures to rehabilitate the waterways to preconstruction conditions or better, including fish passage requirements consistent with Policy and Guidelines for Fish Friendly Waterway Crossings (DPI 2004);	Identification of Key fish Habitat is provided in Section 3.3.3 and discussion of temporary waterway crossings is presented in Section 5.3. Relevant safeguards and mitigations are outlined in Section 7. Further detail is presented in the Hydrology and Flooding Working Paper (**Appendix K** of the EIS) and the Biodiversity Assessment Working Paper (**Appendix I** of the EIS).
groundwater impacts taking into consideration impacts associated with geotechnical ground treatments, dewatering, deep cuttings and fill locations, and cumulative impacts on regional hydrology. The assessment shall consider, where relevant, the extent of drawdown, impacts to groundwater characteristics, quality, quantity, and connectivity, groundwater flow direction and levels, discharge and recharge rates, and implications for water courses, groundwater users, groundwater dependent ecosystems, riparian areas and wetlands. The assessment should be prepared having consideration to the NSW Aquifer Interference Policy;	Construction and operational groundwater impacts are discussed in Section 5.4 and Section 6.4 respectively. The methodology around the assessment of groundwater impacts, including consideration of the NSW Aquifer Interference Policy, is presented in Section 3.2.

Secretary's requirement	Where addressed in Document
measures to manage, monitor and/or mitigate impacts;	Proposed measures to manage, monitor and/or mitigate impacts are outlined in Section 7 and summarised in Section 8.
Identify potential impacts of the development on acid sulfate soils in accordance with the relevant guidelines and a description of the mitigation measures proposed to minimise potential impacts.	The likelihood of encountering acid sulfate soils is described in Section 4.4 with a low probability of occurrence identified; therefore impacts and mitigation measures are not further assessed in this report.
Provide a contaminated land assessment in accordance with relevant guidelines.	A Stage 1 Contamination Assessment has been undertaken for the project as provided in **Appendix A** of this report. A summary of the findings is described in Section 4.6. Potential impacts during construction and operation of the project are discussed in Section 5.2 and Section 6.2 respectively. The management of potential contamination impacts is detailed in Section 8.

Table 1-2 lists the requirements under the Commonwealth EIS Guidelines for the project of relevance to this Soils, water and contamination report and where in the report they are addressed.

Table 1-2 Commonwealth EIS Guidelines – Soils, water and contamination

Commonwealth EIS Guidelines (Commonwealth EPBC Act)	Where addressed in Document
The EIS must include a description of the environment of the proposal site and the surrounding areas that may be affected by the action. It is recommended that this include the following information: A description of the environment in all areas of potential impact, including all components of the environment as defined in Section 528 of the EPBC Act: Landscapes and soils Natural and physical resources, including water resources.	Discussion of the existing environment, including landscapes and soils and water resources is included in Section 4 of this report.
Impacts to the environment (as defined in section 528) should include but not be limited to the following: Changes to water quality on site and downstream of the site Changes to siltation Changes in recreational use and amenity of natural areas.	Potential construction and operational impacts are discussed in Section 5 and Section 6 respectively.



Legend

- The Northern Road upgrade - Mersey Road to Glenmore Parkway
- The Northern Road
- Western Sydney Airport site (Commonwealth Land)
- Defence Establishment Orchard Hills
- Western Sydney Employment Area
- South West Priority Growth Area
- Western Sydney Priority Growth Area
- Reserves and parklands
- Growth centres
- Built areas

Figure 1-1 | Location of the project

2. Legislation and policy framework

The following section provides consideration of the legislative and policy framework for the water quality and contamination assessment work.

2.1 Surface Water

2.1.1 NSW Legislation

***Protection of the Environment Operations Act 1997* (POEO Act)**

The *Protection of the Environment Operations Act 1997* (POEO Act) is administered by the NSW Office of Environment and Heritage (OEH). The POEO Act regulates air and water pollution, noise control and waste management. The provision of environmental protection licences are a core strategy under the POEO Act. In accordance with section 115ZH of the EP&A Act, such a licence cannot be refused for an approved project and is to be substantially consistent with the Part 5.1 approval. An environmental protection licence would be required for the project.

Protection of the Environment Administration Act 1991

The *Protection of the Environment Administration Act 1991* aims to protect, restore and enhance the quality of the environment and to reduce risks to human health. As such any discharges into water of substances likely to cause harm to the environment must be reduced to harmless levels.

***Water Management Act 2000* and Water Management (General) Regulation 2011**

The Water Management Act 2000 together with the Water Management (General) Regulation 2011 are intended to ensure that NSW water resources are conserved and properly managed for sustainable use benefitting both present and future generations. However a number of approvals are not required for the project as it is being assessed and approved under Part 5.1 of the EP&A Act (refer to section 115ZG of the EP&A Act). This includes various approvals under the Water Management Act 2000, including water use approvals under section 89, water management work approvals under section 90, and activity approvals (other than aquifer interference approvals) under section 91.

2.1.2 Policy and Guidelines

Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC/ARMCANZ 2000)

The Australian and New Zealand Environment Conservation Council water quality guidelines (2000) provide a framework for conserving ambient water quality in rivers, lakes, estuaries and marine waters. They form part of the National Water Quality Management Strategy and list a range of environmental values assigned to that waterbody. The ANZECC/ARMCANZ (2000) *National Water Quality Guidelines for Fresh and Marine Water Quality* have been applied to understand the current health of the waterways in the study area and the ability to support nominated environmental values, particularly the protection of aquatic ecosystems. The Guidelines provide recommended trigger values which have been applied to understand the existing water quality and key indicators of concern.

***The Healthy Rivers Commission – Hawkesbury Nepean River* (HRC 1998)**

The Healthy Rivers Commission was established in 1995 (under section 23 of the *Pollution Control Act 1970*) by the NSW Government to make recommendations on:

- Suitable objectives for water quality, flows and other goals central to achieving ecologically sustainable development in a realistic time frame
- The known or likely views of stakeholder groups on the recommended objectives
- The economic and environmental consequences of the recommended objectives
- Strategies, instruments and changes in management practices needed to implement the recommended objectives (DECCW 2006).

Managing Urban Stormwater – Soils and Construction

The Managing Urban Stormwater – Soils and Construction series of handbooks are an element of the NSW Government's urban stormwater program specifically applicable to the construction phase of developments. These are aimed at providing guidance for erosion and sediment controls during construction in a manner that protects the health, ecology and amenity of urban waterways through better management of stormwater quality.

The Managing Urban Stormwater handbooks were produced to provide guidelines, principles, and recommended minimum design standards for managing erosion and sediment control during the construction of main roads. The construction of main roads and highways frequently involves extensive earthworks, with significant potential for erosion and consequently sedimentation of waterways. Of particular relevance to the project are Volume 1, 4th Edition (Landcom, 2004) (commonly known as The Blue Book 1) and Volume 2D, Main Road Construction (DECC, 2008) (commonly known as The Blue Book 2).

2.1.3 Construction phase mitigation guidelines

The following design guidelines and management procedures are relevant in determining the appropriate water quality management and mitigation measures to be implemented during the construction phase of the project:

- NSW DECC (2008), *Managing Urban Stormwater-Volume 2D Main Road Construction*, NSW Department of Environment, Climate Change and Water (known as the Blue Book Volume 2): Sydney
- Landcom (2004), *Managing Urban Stormwater- Soils and Construction, Volume 1, 4th Edition* (known as the Blue Book Volume 1): Sydney
- RTA (2003b), *Road Design Guideline: Section 8 Erosion and Sediment, Roads and Traffic Authority of NSW*: Sydney
- RTA (2003d*), Guideline for Construction Water Quality Monitoring*, Roads and Traffic Authority of NSW: Sydney
- RTA (2009), *Erosion and Sediment Management Procedure*, Oct 2009, Roads and Traffic Authority of NSW: Sydney
- RTA (1999), *Code of Practice for Water Management - Road Development and Management*, Roads and Traffic Authority of NSW: Sydney
- Roads and Maritime (2012), *Environmental Direction: Management of Tannins from Vegetation Mulch*, Roads and Maritime Services: Sydney
- RTA (2005), *Guidelines for the Management of Acid Sulphate Materials: Acid Sulphate Soils, Acid Sulphate Rock and Monosulfidic Black Ooze*, Roads and Traffic Authority of NSW: Sydney
- RTA (2001), *Stockpile Site Management Procedures*, Roads and Traffic Authority of NSW: Sydney
- Roads and Maritime (2011), *Technical Guideline: Temporary Stormwater Drainage for Road Construction*, Roads and Maritime Services: Sydney
- Roads and Maritime, (2011), *Technical Guideline – Environmental Management of Construction Site Dewatering*, Roads and Maritime Services: Sydney.

These guidelines seek to minimise land degradation and water pollution from road construction sites in NSW. The guidelines have been used to identify appropriate management procedures during construction works and physical controls to minimise erosion and to prevent sediment moving off site during the construction phase of development.

2.1.4 Operational phase mitigation guidelines

The following design guidelines and management procedures are relevant in determining the appropriate water quality management and mitigation measures to be implemented during the operational phase of the project:

- RTA (2003a), Procedures for Selecting Treatment Strategies to Control Road Runoff, Roads and Traffic Authority of NSW: Sydney
- RTA (1999), RTA Code of Practice for Water Management, Roads and Traffic Authority of NSW: Sydney

- EPA (1997), Managing Urban Stormwater: Council Handbook, NSW Environmental Protection Authority: Sydney
- Austroads (2001), Road Runoff and Drainage: Environmental Impacts and Management Options, Austroads AP-R180
- Austroads (2003), Guidelines for Treatment of Stormwater Runoff from the Road Infrastructure, Austroads AP-R232
- Austroads (2010), Guide to Road Design, Part 5: Drainage Design, Austroads: Sydney
- DECCW (2007), Managing Urban Stormwater, Environmental Targets Consultation Draft, NSW Department of Environment, Climate Change and Water: Sydney
- VicRoads (2011), Integrated Water Management Guidelines, VicRoads: Melbourne
- Fairfull & Witheridge (2003) Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings,
- DPI (2004) Policy and Guidelines for Fish Friendly Waterway Crossings, NSW.

The objective of these documents is to provide guidance on water management practices, water quality and quantity, and water conservation issues related to the design, operation and maintenance of the roads and traffic system. This is in order to protect waterways and water quality where practicable and feasible. They provide guidance on the process of designing permanent water quality treatment in a consistent and practicable manner. The design for the proposed upgrade would address the sensitivity of receiving waters and local environment along the preferred route corridor. Operational water quality controls would be provided upstream of any sensitive receiving waters.

2.2 Groundwater

2.2.1 Statutory requirements

The following federal and NSW legislation and statutory requirements apply to the groundwater assessment work:

- *Australian Groundwater Modelling Guidelines*
- *Water Management Act 2000*
- *Water Management Regulation 2011*
- *NSW Guidelines for Controlled Activities on Waterfront Land (NOW, 2012)*
- *NSW Aquifer Interference Policy (NOW, 2012)*
- *Risk Assessment Guidelines for Groundwater Dependent Ecosystems (NOW, 2012)*
- *NSW State Rivers and Estuary Policy (1993)*
- *NSW State Groundwater Policy Framework Document (1997)*
- *NSW State Groundwater Quality Protection Policy (1998)*
- *NSW State Groundwater Dependent Ecosystems Policy (2002)*
- *NSW Water Extraction Monitoring Policy (2007)*
- *NSW Wetlands Management Policy (2010)*
- *NSW Water Sharing Plans.*

Further details as to how the above legislation is relevant to the construction and operational phase mitigation guidelines that were considered are outlined in **Section 2.2.2** to **Section 2.2.15**.

2.2.2 Australian Groundwater Modelling Guidelines

The purpose of the Australian groundwater modelling guidelines is to promote a consistent and sound approach to the development of groundwater flow and solute transport models in Australia.

2.2.3 NSW Water Management Act 2000

The NSW Department of Primary Industries (DPI Water) administers the NSW Water Management Act 2000 (WM Act). The intent of the WM Act is to ensure water resources are properly managed and conserved for sustainable use benefitting present and future generations. The WM Act is intended to provide a formal means for the protection and enhancement of the environmental qualities of waterways and their in-stream uses as well as to provide for protection of catchment conditions. The intent and objective of the WM Act have been considered as part of this assessment.

2.2.4 Water Management (General) Regulation 2011

The Water Management (General) Regulation 2011 provides various exemptions for volumetric licencing and activity approvals. The legislation also provides detail on requirements for dealings and applications.

2.2.5 NSW Guidelines for Controlled Activities on Waterfront Land (NOW, 2012)

Controlled activities carried out in, on or under waterfront land are regulated by the Water Management Act 2000 (WM Act). The NSW Department of Primary Industries (Water) administers the WM Act and is required to assess the impact of any proposed controlled activity to ensure that no more than minimal harm will be done to waterfront land as a consequence of carrying out the controlled activity. Waterfront land includes the bed and bank of any river, lake or estuary and all land within 40 metres of the highest bank of the river, lake or estuary.

2.2.6 NSW Aquifer Interference Policy (NOW, 2012)

The purpose of the Aquifer Interference Policy is to explain the role and requirement of the Minister administering the WM Act in the water licencing and assessment processes for aquifer interference activities under the WM Act and other relevant legislative frameworks.

2.2.7 Risk Assessment Guidelines for Groundwater Dependent Ecosystems (NOW, 2012)

The Risk Assessment Guidelines for Groundwater Dependent Ecosystems (NOW, 2012) provides a conceptual framework for identifying and assessing ecosystems. The guidelines discuss the identification of high probability GDEs and also discuss the ecological value of GDEs.

2.2.8 NSW State Rivers and Estuary Policy (1993)

The NSW State and Rivers and Estuary Policy encompass a suite of component policies each focussing on the protection or management of ecosystem processes and associated values. The Policy provides clear management objectives and principles which will reflect the State's commitment to resource sustainability and which must be consciously balanced against other social and economic objectives in resource management decisions.

2.2.9 NSW State Groundwater Policy Framework Document (1997)

The purpose of the Groundwater Framework Policy document is to provide a clear NSW government policy direction on the ecologically sustainable management of the State's groundwater resources. The document is used to guide the decision-making of State and local government, as well as landholders in their management and use of groundwater.

2.2.10 NSW State Groundwater Quality Protection Policy

The NSW State Groundwater Quality Protection Policy is one of three component policies, which in association with the Framework Document, make up the State Groundwater Policy. The focus of this Policy is to protect from pollution water below the ground surface in a geological structures or formations known as 'aquifers', and the ecosystems from which these waters are recharged or into which they discharge.

2.2.11 NSW State Groundwater Dependent Ecosystems Policy (2002)

The NSW State Groundwater Quality Protection Policy is one of three component policies, which in association with the Framework Document, make up the State Groundwater Policy. The State Groundwater Dependent Ecosystems Policy is specifically designed to protect valuable ecosystems which rely on groundwater for survival so that, wherever possible, the ecological processes on biodiversity of these dependent ecosystems are maintained or restored, for the benefit of present and future generations.

2.2.12 NSW Water Extraction Monitoring Policy (2007)

The purpose of the NSW Water Extraction Monitoring Policy (2007) is to increase the extent of active monitoring of water extraction. The policy sets out roles and responsibility for Federal Water, State Water and holders of water extraction licences.

2.2.13 NSW Wetlands Management Policy (2010)

The NSW Wetlands Management Policy provides a set of guiding principles that all government agencies will adopt, and all stakeholders can refer to when making decisions on wetlands management and conservation.

2.2.14 Water Sharing Plans

Water sharing plans under the *Water Management Act (2000)* provide the basis for equitable sharing of surface water and groundwater between users including the environment. If an activity leads to a take from a groundwater or surface water source covered by a water sharing plan, then approval and/or a licence is required. It is noted that Roads and Maritime is exempt, as a road authority, under Clause 18(1) of the Water Management (General) Regulation 2011 from the requirement to hold an access licence.

Surface Water Sharing Plan

The project alignment falls within the *Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2011*. The relevant water source is the Hawkesbury and Lower Nepean Rivers Water Source and the relevant management zone for the northern portion of the project is the Lower Nepean River Management Zone, and the Mid Nepean River Catchment Management Zone and the Upper South Creek Management Zone for the southern portion of the project.

Groundwater Sharing Plan

With respect to groundwater, the project lies within the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011*. The relevant water source is the Sydney Basin Central Groundwater Source.

2.2.15 NSW Aquifer Interference Policy

The Aquifer Interference Policy (NOW, 2012) presents the requirements of assessment of aquifer interference activities administered by the *Water Management Act* 2000.

The groundwater assessment prepared in Section 5 and Section 6 presents an assessment of the Project against the Level 1 Minimal Impact Considerations of the NSW Aquifer Interference Policy (DPI Water, 2012). It is demonstrated that the Project meets the Level 1 Impact Considerations. Key components of the Aquifer Interference Policy are:

- All water taken must be properly accounted for
- The activity must address minimal impact considerations with respect to water table, water pressure and water quality
- Planning for measures in the event that actual impacts are greater than predicted, including making sure there is sufficient monitoring in place.

Activities such as temporary dewatering works are identified as aquifer interference activities under the *Water Management Act 2000* and the Aquifer Interference Policy. These activities require aquifer interference approvals under the *Water Management Act 2000*, however, provisions for aquifer interference approvals have yet to be enabled. As such, licensing aspects of these activities is currently carried out under the *Water Act* 1912.

Any minor take of water as a result of temporary dewatering activities, that is estimated to be less than 3 ML/y, including both during construction dewatering and subsequent managed inflows, would generally not require a licence from the DPI Water.

Roads and Maritime is exempt, as a road authority, under Clause 18(1) of the Water Management (General) Regulation 2011 from the requirement to hold an access licence. The Water Management (General) Regulation 2011 is the primary regulation instrument under the *Water Management Act 2000*. Roads and Maritime is also exempt under Clause 31(1) of those regulations from the requirement to hold a water use approval. As per Part

1 of Schedule 5 of the regulations, this is in relation to water required for road construction and maintenance. Road authorities are not exempt, however, from the requirement to hold a water supply work approval to construct a works. A water licence may need to be obtained should dewatering of surface water and groundwater be required. In this case, there are no proposed activities associated with the Project that will require a water supply work. As such, there are no licensing requirements associated with the Project.

2.3 Contamination

In preparing the contamination section of this report, the following guidelines were considered (where relevant):

- *Managing Land Contamination: Planning Guidelines SEPP 55 – Remediation of Land*, (NSW Department of Urban Affairs and Planning & NSW Environmental Protection Authority, 1998)
- *Guidelines for Consultants Reporting on Contaminated Sites* (NSW Office of Environment and Heritage, 2000).

Should RMS purchase properties and take responsibility for existing contamination and contamination sources within these properties, the requirements of the Contaminated Land Management Act 1997 would be applicable for the management of contamination.

Should remediation or other construction activities be undertaken which would involve the offsite disposal of materials (both uncontaminated and contaminated), the requirements of the Protection of the Environment Operations (Waste) Regulations 2014 would need to be considered and implemented where applicable.

Should further investigations, remediation works and validation be undertaken, these activities would need to be undertaken in accordance with the following guidelines or other appropriate/endorsed guidelines available at that time:

- *Australian Standard (AS 4482.1-2005) Guide to the sampling and investigation of potentially contaminated soil. Part 1: Non-volatile and semi-volatile compounds*
- *Australian Standard (AS 4482.2-1999) Guide to the sampling and investigation of potentially contaminated soils – Volatile substances*
- *National Environment Protection (Assessment of Site Contamination) Measure 1999 (as revised 2013)*
- *ANZECC & ARMCANZ, (2000) Australian and New Zealand Guidelines for Fresh and Marine Water Quality*
- *NSW EPA (2014) Waste Classification Guidelines*
- *DECCW (2009) Guidelines for the Implementing the Protection of the Environment Operations (Underground Petroleum Storage Systems) Regulation 2008*
- *NSW EPA (1995) Contaminated Sites: Sampling Design Guidelines*
- *DEC (2006) Contaminated Sites: Guidelines for the NSW Site Auditor Scheme (2nd Edition)*
- *DEC (2007) Contaminated Sites: Guidelines for the Assessment and Management of Groundwater Contamination*
- *NSW EPA (2015) Contaminated Sites: Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997*
- *NSW EPA (2015) Technical Note: Light Non-Aqueous Phase Liquid Assessment and Remediation*
- *NSW EPA (2014) Technical Note: Investigation of Service Station Sites*
- *NSW EPA (2014) Best Practice Note: Landfarming*
- *DEC (2005) Information for the assessment of former gasworks sites*
- *DECW (2010) Vapour Intrusion: Technical Practice Note*
- *NSW EPA (2012) Guidelines for the Assessment and Management of Sites Impacted by Hazardous Ground Gases*
- *Workcover NSW (2014) Managing asbestos in or on soil.*

3. Methodology

The process of assessing the potential impacts of the project and developing impact mitigation measures for the various aspects of this report are outlined in the following sections.

3.1 Contaminated land

A Stage 1 Contamination Assessment has been carried out to identify potential Areas of Environmental Interest (AEIs) which would assist in identifying construction limitations/constraints within the project area with respect to contamination.

The AEIs were considered to be those potential risks associated with soil, groundwater and vapour contamination which may be present as a result of historic and / or current activities undertaken on and / or adjacent to the project area. To achieve these objectives, Jacobs undertook the following scope of works:

- Review of publically available information (NSW EPA, CSIRO ASRIS database, NSW Department of Primary Industries groundwater database, Commonwealth Department of Defence Unexploded Ordinance (UXO) database)
- Review of historical aerial photography of the general project area
- Site walkover and inspection
- Preparation of a Stage 1 contamination assessment report based on the data obtained from the desktop background review and observations from the inspection of the project area. The expected ground conditions are presented together with any contamination issues identified and recommendations for further investigations, if required
- A number of potential AEIs were identified during the information review and site inspection. **Table 5-1** outlines the potential AEIs located within and in the near vicinity of the project area and their associated risks to environmental receptors and site users (associated with the construction of the road upgrades). Please note the risks have been assessed qualitatively. The potential risks have not been confirmed / quantified through a sampling and analysis program.

The Stage 1 Contamination Assessment is attached to this working paper as **Appendix A**.

The framework for the soil and land contamination assessment was developed in accordance with guidelines 'made or approved', by the EPA, under section 105 of the (NSW) *Contaminated Land Management Act 1997*.

3.2 Groundwater

There are a number of guidelines and management procedures relevant to the assessment of groundwater. These guidelines and procedures have been used to determine impacts to groundwater along the project and identifying the appropriate groundwater management and mitigations measures for implementation during the construction and operational phases of the project.

The methodology below was used to assess the potential groundwater impacts of the project:

- Review of existing literature relating to the project, including consideration of climate conditions, geological maps (regional and local shallow and deep geological units, structural geology, ASS and salinity maps), available groundwater level and quality data (NSW PINNEENA bore search based on a 400m search radius) and existing conditions using available non-project literature to obtain background information to aid in interpreting the existing groundwater conditions
- Review of the Aquifer interference policy (NOW, 2012), and development of a conceptual groundwater model
- Following a review of the existing literature, a conceptual groundwater model was produced to determine the potential impacts on groundwater. It was determined that the production of an analytic or numeric groundwater model was unnecessary because the regional unconfined groundwater table is likely well beneath the expected road cuttings. There are therefore no expected impacts on groundwater drawdown, groundwater take or changes to groundwater flow rates. A conceptual diagram was produced to demonstrate this

- Assessment of the groundwater impacts of the project during construction and operation including assessment of potential impact to groundwater levels, flows and connectivity, as well as potential impacts to groundwater quality and groundwater users.

The conceptual hydrogeological model was constructed using geospatial information obtained from public sources:

- DPI Water's Groundwater PINNEENA online database (accessed March 2016)
- DPI Water Groundwater Productivity Map (2013)
- Penrith 1:100,000 Geological Sheet 9030 (1991).

3.3 Surface Water Management

3.3.1 Desktop Assessment

The desktop assessment involved a review of the existing surface water environment across the study area to assess the likely and potential impacts of the project on surface water quality during construction and operation. The review of information has included:

Review of existing literature relating to the project, available water quality data and existing conditions using available non-project literature to obtain background information on catchment history and land use to aid in interpreting the existing conditions. Literature sources included:

- WSROC (2015) *Review of Western Sydney Airport Draft Environmental Impact Statement*. Prepared by Parsons Brinkerhoff Australia Pty. Ltd
- Commonwealth Department of Infrastructure and Regional Development (2015). *Western Sydney Airport – Draft Environmental Impact Statement. Volume 2, Stage 1 Development*
- SMEC (2014). *Environmental field survey of Commonwealth land at Badgerys Creek*. Report prepared for Western Sydney Unit, Commonwealth Department of Infrastructure and Regional Development. October 2014
- GHD (2015). *Western Sydney Airport EIS. Surface Water Quality Assessment*. A report for the Commonwealth Department of Infrastructure and Regional Development
- Raw water quality data collected by GHD as part of the Western Sydney Airport EIS
- The Northern Road Upgrade – Mersey Road, Bringelly to Glenmore Parkway, Glenmore Park *Biodiversity Assessment Report*
- The Northern Road Upgrade – Mersey Road, Bringelly to Glenmore Parkway, Glenmore Park *Hydrology and Flooding Report*.
- Assessment of the impact of construction activities on water quality with reference to the ANZECC/ARMCANZ (2000) water quality guidelines and the Healthy Rivers Commission Independent inquiry into the Hawkesbury Nepean (HRC 1998) with regard to the relevant environmental objectives of aquatic ecosystems and visual amenity
- Review of water quality treatment measures that could be used to mitigate the impact of construction on water quality, following the principles of *Managing Urban Stormwater – Soils and Construction Volume 1* (Landcom 2004) and *Volume 2D* (DECC 2008)
- Review of water quality treatment measures that could be used to mitigate the impact of the operation of the project on water quality following the principle of *Procedure for Selecting Treatment Strategies to Control Road Runoff* (RTA 2003), *Roads and Maritime Water Policy* (RTA, 1997) and *Roads and Maritime Code of Practice*, *Water Management* (RTA 1999).

There are a number of guidelines and management procedures relevant to the assessment of surface water quality. These guidelines and procedures have been used to determine existing water conditions along the project and identifying the appropriate water quality management and mitigations measures for implementation during the construction and operational phases of the project.

Water quality modelling using the eWater MUSIC was also undertaken to determine the pollutant load reductions that can be achieved by permanent water quality swales for Total Suspended Solids (TSS), Total Nitrogen (TN) and Total Phosphorus (TP).

The catchments draining to an individual control measure were identified by considering the formation of the proposed carriageway and the proposed pipe drainage network.

A water quality model was set up to represent proposed catchment conditions and models of the swales were created by adopting the sub-catchment areas estimated in the catchment analysis. Rock check dams were also added to the model.

3.3.2 Discharge Criteria

The NSW Healthy Rivers Commission has determined water quality objectives for the Hawkesbury-Nepean River (HRC 1998). The Australian and New Zealand Environment and Conservations Council (ANZECC/ARMCANZ 2000) also have guidelines for water quality. These objectives and guidelines provide benchmarks for assessment of the existing water quality of the river. The application of the criteria is dependent on the environmental values assigned to the waterway.

Environmental values are particular values or uses of the environment that are important for a healthy ecosystem or for public benefit or health. They are values that require protection from the effects of pollution and waste discharges and provide goals that help in the selection of the most appropriate management options (ANZECC/ARMCANZ 2000). Water quality objectives and environmental values were determined under the NSW Healthy Rivers Commission Inquiry into the Hawkesbury-Nepean system (HRC 1998). In 2001 the NSW Government agreed to these through a Statement of Joint Intent.

The project lies within the lower Hawkesbury Nepean Catchment. The nominated environmental values applying to waterways within this catchment are:

- Protection of aquatic ecosystems
- Visual amenity.

Aquatic Ecosystems

The most relevant environmental value for the purposes of this assessment is aquatic ecosystems. Aquatic ecosystems comprise the animals, plants and micro-organisms that live in water and the physical and chemical environment in which they interact. Aquatic ecosystems have historically been impacted upon by multiple pressures including changes in flow regime, modification and destruction of key habitats, development and poor water quality.

There are a number of naturally occurring physical and chemical stressors that can cause degradation of aquatic ecosystems and for the purposes of this assessment nutrients, dissolved oxygen, pH, salinity and turbidity (suspended solids) are discussed below. These have been considered in the assessment of existing water quality and potential impacts as a result of the project.

- **Nutrients** in aquatic environments promote the growth of algae and increase turbidity which in turn reduces light and may affect plant growth. Generally excessive nutrient inputs lead to excessive algal growth and formation of nuisance blooms. Nutrients consist of nitrogen (including total nitrogen, oxidised nitrogen and ammonia) and phosphorus (including total phosphorus and filterable reactive phosphorus (FRP)) including:
    - **Total Nitrogen** is a measure of all the nitrogen species found in a water body including oxidised nitrogen, ammonia and total organic nitrogen)
    - **Oxidised Nitrogen** represents the level of free nitrogen within the water column that is readily available to plants. Excessive concentrations of oxidised nitrogen concentrations can promote algal growth
    - **Ammonia** is the most reduced form of inorganic nitrogen available, and is preferentially utilised by plants and aquatic micro-organisms. The main sources of ammonia in aquatic ecosystems are from human and animal wastes and that which is released by bacteria during the decomposition of organic material

- **Total Phosphorus** is a measure of both biologically available species (known as filterable reactive phosphorus) and the unavailable species. There are two forms of dissolved phosphorus in the water body, organic phosphorus produced from the decay of plant and animal material and inorganic orthophosphates which are released through breakdown of rock and transported into the water body
- **Filterable Reactive Phosphorus** is a measure of orthophosphates which is the readily available biological component of total phosphorus. Concentrations of FRP within a water body can be influenced by variations in pH, oxygen levels and turbidity.

- **Dissolved oxygen** (per cent saturation and milligrams per litre (mg/L)) is a measure of the amount of oxygen dissolved in water. Dissolved oxygen is vital for many forms of estuarine biota including native fish and is also vital for the functioning of healthy aquatic ecosystems
- **pH** is a measure of the acidity or alkalinity of a water body. Changes in pH can impact the ability of aquatic organisms to maintain basic functions such as respiration. pH also controls the bioavailability of metals, nutrients and other organic molecules. Potential sources of changes to pH include changes in the level of organic matter within the system, agricultural runoff from low pH soils (e.g. acid sulphate soils (ASS)) and changes in salinity
- **Turbidity** is a measure of the optical clarity of a water body which is important in characterising the health of a water body. Changes in the availability of light can affect the distribution of animals and potentially alter the chemical characteristics of the water body. Suspended solids from runoff or land disturbance can result in increased turbidity, thereby reducing light penetration, modification of physical habitat and smothering of biota thereby impacting on aquatic ecosystems.

Visual Amenity

The aesthetic appearance of a waterbody is an important aspect with respect to recreation. As such the water should be free from noticeable pollution, floating debris, oil, scum and other matter. Substances that produce objectionable colour, odour, taste or turbidity and substances and conditions that produce undesirable aquatic life should not be apparent (NHMRC 2008). The key aesthetic indicators are transparency, odour and colour. These have been considered in the assessment of existing water quality and potential impacts as a result of the project.

The water quality guidelines and objectives applicable to the protection of the nominated environmental values that will be applied in the assessment of surface water quality are presented in **Table 3-1**. For the protection of aquatic ecosystems in this region, the ANZECC/ARMCANZ (2000) default trigger values for physical and chemical stressors for 'South-East Australian slightly to moderately disturbed lowland rivers' have been applied. The HRC nutrient guidelines (1998) listed are for mixed use rural areas. Recommended limits for metals are in accordance with ANZECC/ARMCANZ (2000) trigger values for toxicants for the protection of 95% of freshwater aquatic species. The NSW Healthy Rivers Commission Hawkesbury-Nepean River objectives have precedence where there is duplication.

Table 3-1 Guidelines for Protection of Aquatic Ecosystems

Indicator	ANZECC/ARMCANZ (2000)	HRC (1998)
1. Conductivity (µs/cm)	2. 125 - 2200	3.
4. pH	5. 6.5 - 8.5	6.
7. Dissolved oxygen (% saturation)	8. 85 - 110	9.
10. Turbidity (NTU)	11. 6 - 50	12.
13. Suspended Solids (mg/L)	14. < 40	15.
16. Ammonia (µg/L)	17. < 20	18.
19. Oxidised nitrogen (µg/L)	20. < 40	21.
22. Total nitrogen (µg/L)	23. < 350	24. 700
25. Total Phosphorus (µg/L)	26. < 25	27. 35
28. Chlorophyll-a (µg/L)	29. < 3	30.

Indicator	ANZECC/ARMCANZ (2000)	HRC (1998)
31.Arsenic (µg/L)	32.<13	33.
34.Cadmium (µg/L)	35.<0.2	36.
37.Chromium (µg/L)	38.<1	39.
40.Copper (µg/L)	41.<1.4	42.
43.Lead (µg/L)	44.<3.4	45.
46.Nickel (µg/L)	47.<11	48.
49.Zinc (µg/L)	50.<8	51.
52.Mercury (µg/L)	53.<0.6	54.

Water Quality Objectives

There is the potential for the current water quality to not meet the existing guidelines and trigger values for protecting nominated environmental values. Irrespective of the current condition of waterways, the project should not further degrade water quality. As such the key objective of the project is to minimise the potential impacts on downstream receiving waters, so that the project changes the existing water regime by the smallest amount practicable. This objective is consistent with *the Roads and Maritime's Water Policy 1997* (RTA, 1997) and *Code of Practice for Water Management 1999* (RTA, 1999).

3.3.3 Sensitive Receiving Environments

Sensitive receiving environments have been identified using aquatic habitat as an indicator which was assessed against the NSW *Department of Primary Industries Policy and Guidelines for Fish Habitat Conservation and Management* (2013) and Fish Passage Requirements for Waterway Crossings (Fairfull & Witheridge 2003) (see the Biodiversity Assessment Working Paper included in **Appendix I** of the EIS).

The five waterways listed as key fish habitats in the Biodiversity Assessment Working Paper are defined as sensitive receiving environments for the project, generally due to the presence of macrophytes and instream woody snags that could provide fish habitat, however protected or threatened fish species are unlikely to occur. The five sensitive receiving waterways are as follows:

1. Badgerys Creek (287912.65E / 6244897.30N)
2. Cosgroves Creek (287247.11E / 6249490.76N)
3. 'Site 29a' (286060.62 E / 6246544.14N), an intermittent stream
4. The large dam at 'Site 39' (286460.594 E, 6247352.348N), fed by several minor 1st and 2nd order streams. These streams are ephemeral with minimal channel definition, only flowing when the upstream dams overflow
5. Unnamed tributary of Surveyors Creek (286887.04E/6257728.90N).

The Nepean River is the downstream receiving environment to the project area; however, the project itself is located close to the catchment divide, just west of the eastern boundary. The Nepean River is significant both environmentally and economically and provides for a range of domestic and irrigation uses. Several threatened species including Macquarie Perch (Macquaria australasica), Australian Grayling (Prototroctes marena), Silver Perch (Bidyanus bidyanus), Murray Cod (Maccyllochella peelii peelii) and Trout Cod (Maccullochella macquariensis) have been recorded within the Hawkesbury-Nepean Catchment; however, habitat for these species is not present within the study area.

While the presence of macrophytes and instream woody snags provides fish habitat, no threatened or protected fish species were identified during the aquatic surveys and are not expected to occur within the waterways potentially impacted. Visual inspection sighted the invasive pest species, Gambusia (Gambusia holbrooki) within some of the waterways surveyed. Further information regarding the aquatic habitat assessment is provided in The Biodiversity Assessment Working Paper prepared for the EIS (**Appendix I** of the EIS).

4. Existing Environment

4.1 Landform and landscape

The project is located on the Cumberland Plain, a low lying and gently undulating subregion of the Sydney Basin. The Sydney Basin is a large geological feature stretching from Batemans Bay in the south to Newcastle in the north and Lithgow in the west. The formation of the basin began between 250 to 300 million years ago when river deltas gradually replaced the ocean that had extended as far west as Lithgow (Clark and Jones 1991).

The project area traverses a north-south oriented ridge that forms the watershed separating the catchment areas of South Creek in the east and the Nepean River in the west. The project itself is located close to the catchment divide, just west of the eastern boundary of the Nepean River catchment. The ridge is characterised by gentle to moderately inclined slopes with narrow to broad crests and drainage lines. The eastern side of the project area contains several north-east flowing creeks including Badgerys Creek, Cosgroves Creek and Oaky Creek which join South Creek approximately 7 km to the east. On the western side of the project area, several creeks including Duncan's Creek, Surveyors Creek, Mulgoa Creek flow north-west to join the Nepean River approximately 4.5 km to the west. To the southwest of Luddenham and the proposed new alignment of The Northern Road, undulating areas including creeks in gullies are present. There are a number of farm dams along the entire alignment.

East of the existing The Northern Road (which runs along a ridge line) the land is gently undulating with two ridgelines forming the main topographical features. One is located to the west of Luddenham Road and the other is in the Aldington Road / Mt Vernon Road areas.

Landscape character varies from generally semi-rural in the majority of the study area to occasional pockets of suburban areas including at Luddenham and Glenmore Park.

4.2 Regional geology

The Penrith 1:100,000 Geological Series Sheet 9030 (NSW Department of Mineral Resources, 1991) indicated that the project area is predominately underlain by Bringelly Shale (Rwb), Quaternary alluvium Qal) and Cranebrook Formation (Qpc). Bringelly Shale (Rwb) is composed of shale, carbonaceous claystone, claystone, laminate, fine to medium-grained lithic sandstone, rare coal and tuff (Clark and Jones 1991) and underlies the crests, slopes and drainage lines of the majority of the project area.

The Luddenham Dyke is located in the vicinity of the intersection of The Northern Road and Eaton Rd. The dyke consist consists of olivine basalt carrying analcite, the dyke intrudes the Bringelly shale and trends north-west to south-east

More recent Quaternary Alluvium (Qal) is present along the low lying areas adjacent to Badgerys Creek. Quaternary Alluvium (Qal) comprises fine-grained sand, silt and clay that deposited in association with fluvial activity along the various creek corridors. In the north of the project area, a small deposit of Cranebrook Formation geology (Qpc) is present adjacent to Surveyors Creek. Cranebrook Formation (Qpc) geology is characterised by a basal layer of pebble and cobble clast gravels below sand, silt and clay. Alluvium comprising of fine sands, silt and clay is likely to be deposited along the Cosgroves and Badgerys Creek systems. According to the *Western Sydney Airport Environmental Impact Statement* (Commonwealth Department of Infrastructure and Regional Development, 2016) the alluvium deposits can be up to five metres thick and are typically made up of fine sands, silts and clays with some areas of gravelly clay.

A description of the geological formations underlying the project area is provided in **Table 4-1** and outlined on **Figure 4-1**.

Table 4-1 Geological units underlying the project area

Unit	Description
Bringelly Shale (Rwb)	Shale, carbonaceous claystone, laminate, coal in parts
Luddenham Dyke	Basalt, dolerite
Cranebrook Formation (Qpc)	Pebbles and cobbles of quartz, quartzite, chert, porphyry, granite,

Unit	Description
	hornfels and silcrete
Quaternary Alluvium (Qal)	Fine grained sand, silt, clay

4.3 Soils

The Penrith 1:100,000 Soil Landscape sheet 9030 (Soil Conservation Service of NSW, 1990) indicated that the soil landscape groups within the project area consist three principal soil landscapes. These are erosional Luddenham (lu), residual Blacktown (bt) and fluvial South Creek (sc) soil landscape groups. **Table 4-2** describes the soil landscape groups within the project area.

The basal geology is overlain by South Creek soils within the immediate vicinity of major creeks, transitioning to Blacktown soils on crests and low rises and Luddenham soils on hills and ridge slopes (**Figure 4-2**). The alluvial South Creek soil landscape is characterised by flat landforms with incised channels that are subject to frequent episodes of inundation, erosion and aggradation.

Soil landscapes in the project area are shown on **Figure 4-2**.

Table 4-2 Soil units underlying the project area

Unit	Description
Luddenham (lu)	• Landscape – found on undulating to rolling hills on Wianamatta Shales, with slopes between 5-20 per cent and local relief between 50 and 80 m, narrow ridges, hills and valleys • Soils – shallow podzolic soils and massive clays on crests, moderately deep red podzolic soils on upper slopes and moderately deep yellow podzolic soils and prairie soils on lower slopes and drainage lines • Limitations – high soil erosion hazard, localised impermeable highly plastic subsoil, moderately reactive.
Blacktown (bt)	• Landscape - found on gently undulating rises on Wianamatta Group shales with local reliefs of up to 30 metres and slopes of less than 5 per cent • Soils - shallow to moderately deep hardsetting mottled texture contrast soils, red and brown podzolic soils on crests grading to yellow podzolic soils on lower slopes and in drainage lines • Limitations - moderately reactive, highly plastic subsoil, with low fertility and poor drainage.
South Creek (sc)	• Landscape - found on floodplains, valley flats and drainage depressions of the channels on the Cumberland Plain • Soils – deep layered sediments over bedrock or relic soils. Structured plastic slays and loams in and adjacent to drainage lines, red and yellow podzolic soils on terraces • Limitations – erosion hazard, frequent flooding.

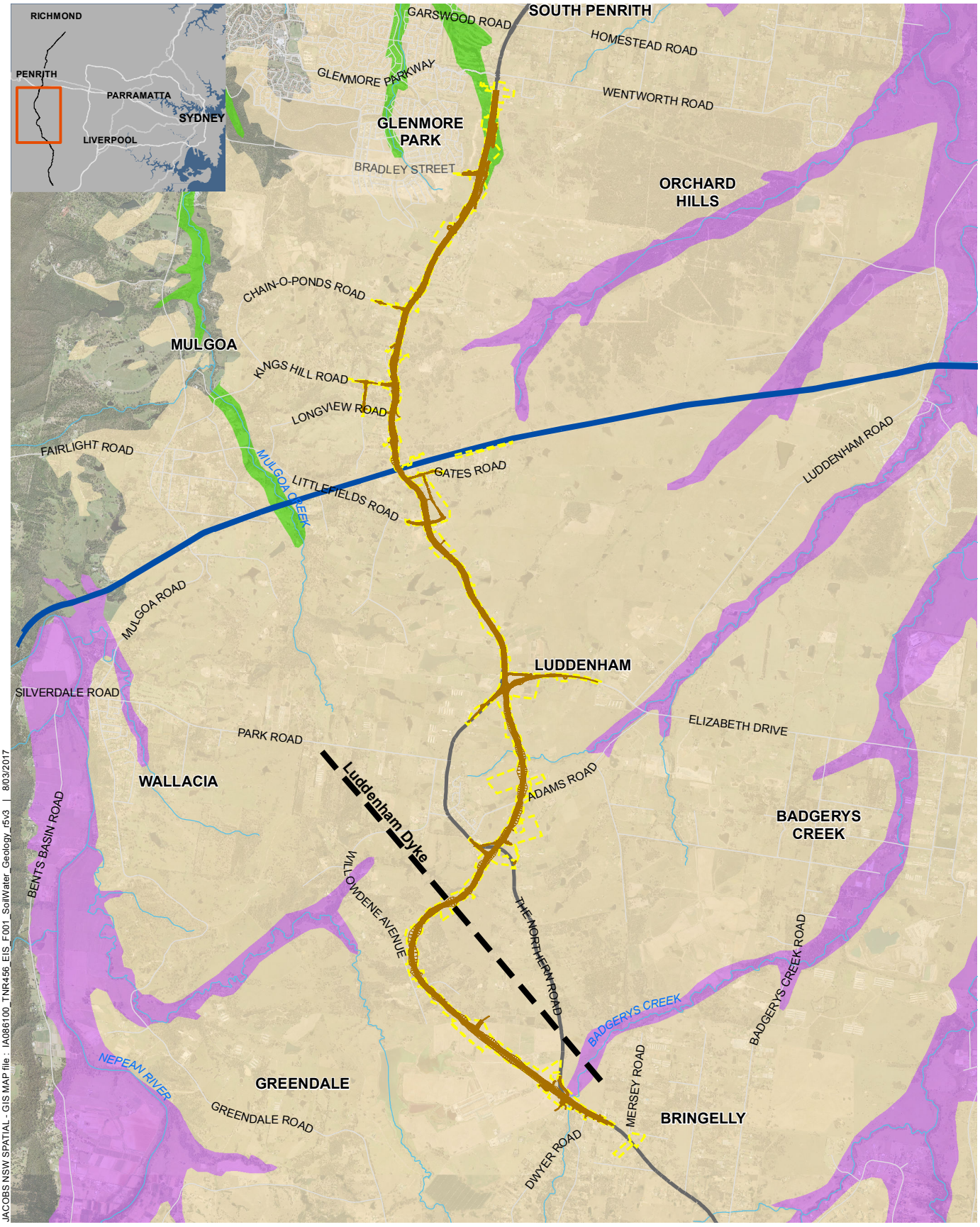
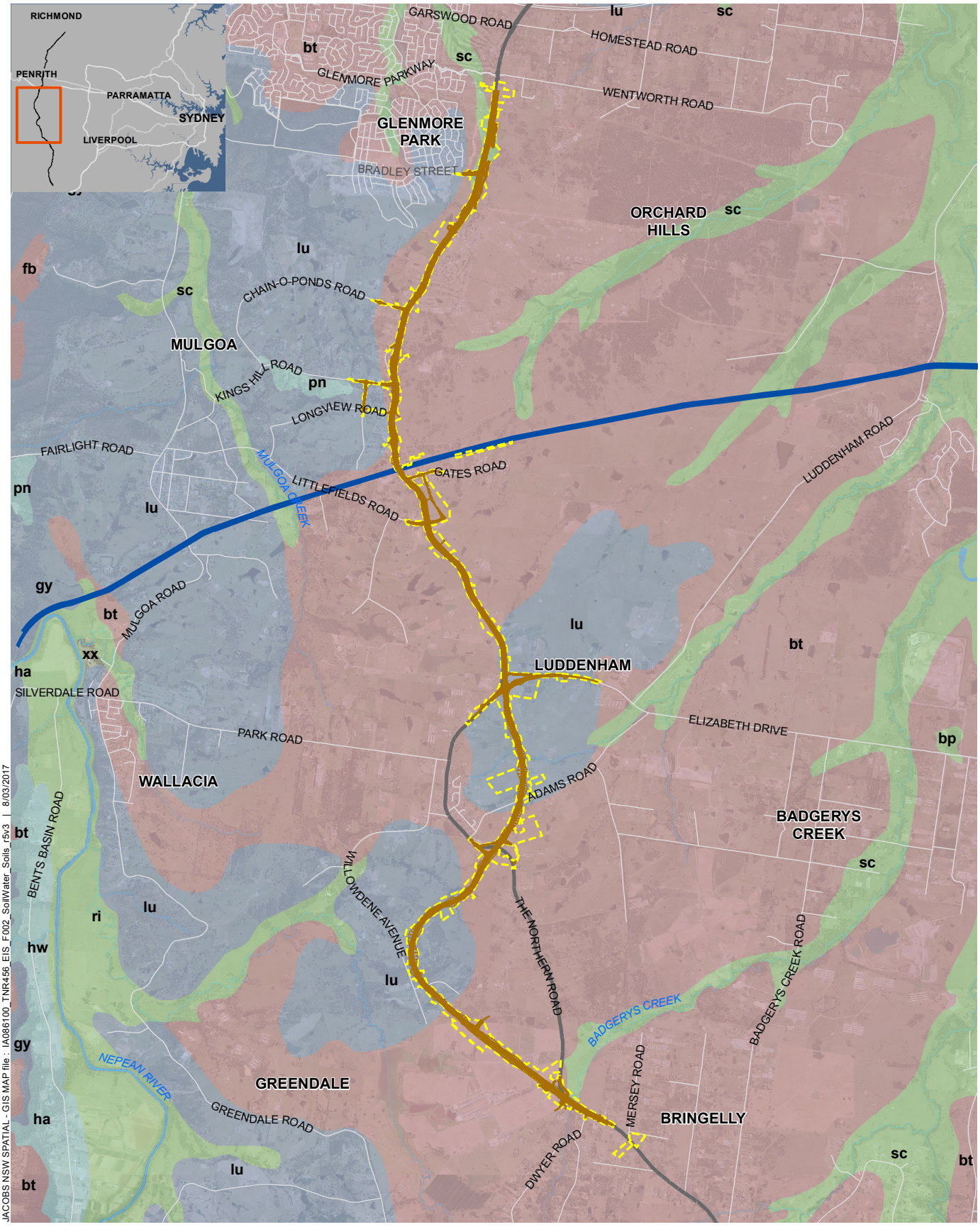


Figure 4-1 | Regional geology



JACOBS NSW SPATIAL - GIS MAP file : IA086100_TNR456_EIS_F002_SoilWater_Soils_r5v3 | 8/03/2017

The Northern Road upgrade - Mersey Road to Glenmore Parkway

The Northern Road (Existing)

WaterNSW supply pipelines

Project area

Soils

Alluvial

COLLUVIAL

Erosional

Residual

bt = Blacktown
lu= Luddenham
sc = South Creek
ri = Richmond

0 1 2 km

N

Figure 4-2 | Soil Landscapes

4.4 Acid Sulfate Soils (ASS)

Acid sulfate soils (ASS) are soils and sediments that contain iron sulfides that when disturbed to oxygen, generate sulphuric acid and toxic quantities of aluminium and other heavy metals. The sulfuric acid and heavy metals are produced in forms that can be readily released into the environment with potential adverse effects on the natural and built environment, as well as human health. The majority of ASS are formed by natural process under specific environmental conditions, which generally limits its occurrence in low lying sections of coastal floodplains, rivers and creeks where surface elevations are less than five metres AHD.

The Australian Soil Resource Information System (ASRIS, 2015) provides online access to the best publicly available information on soil and land resources across Australia. ASRIS provides a national map of available ASS mapping that is classified with a nationally consistent legend that includes risk assessment criteria and correlations between Australian and International Soil Classification Systems. The ASRIS ASS map was consulted to determine the presence and risk of ASS along the project alignment. The Acid Sulfate Soil Probability within the project alignment was classified as Extremely Low Probability of occurrence. ASS is therefore not considered to be a risk to the project.

4.5 Soil salinity

Surface water and groundwater can dissolve and mobilise salts and cause their accumulation in other areas. Excessive concentrations of salt in such areas can affect plant growth, soil chemistry and cause weakening and degradation of construction materials such as masonry, concrete and bitumen. The assessment of salinity potential along the alignment was undertaken using the map of the salinity potential in western Sydney (NSW Department of Infrastructure, Planning and Natural Resources 2002). The majority of the alignment occurs in areas of moderate salinity potential.

It is understood that durability and aggressivity samples of soil material will be collected and analysed prior to the construction phase, to determine potential impacts of soil salinity on pavement infrastructure.

Soil salinity potential for the project area is mapped on **Figure 4-3**.

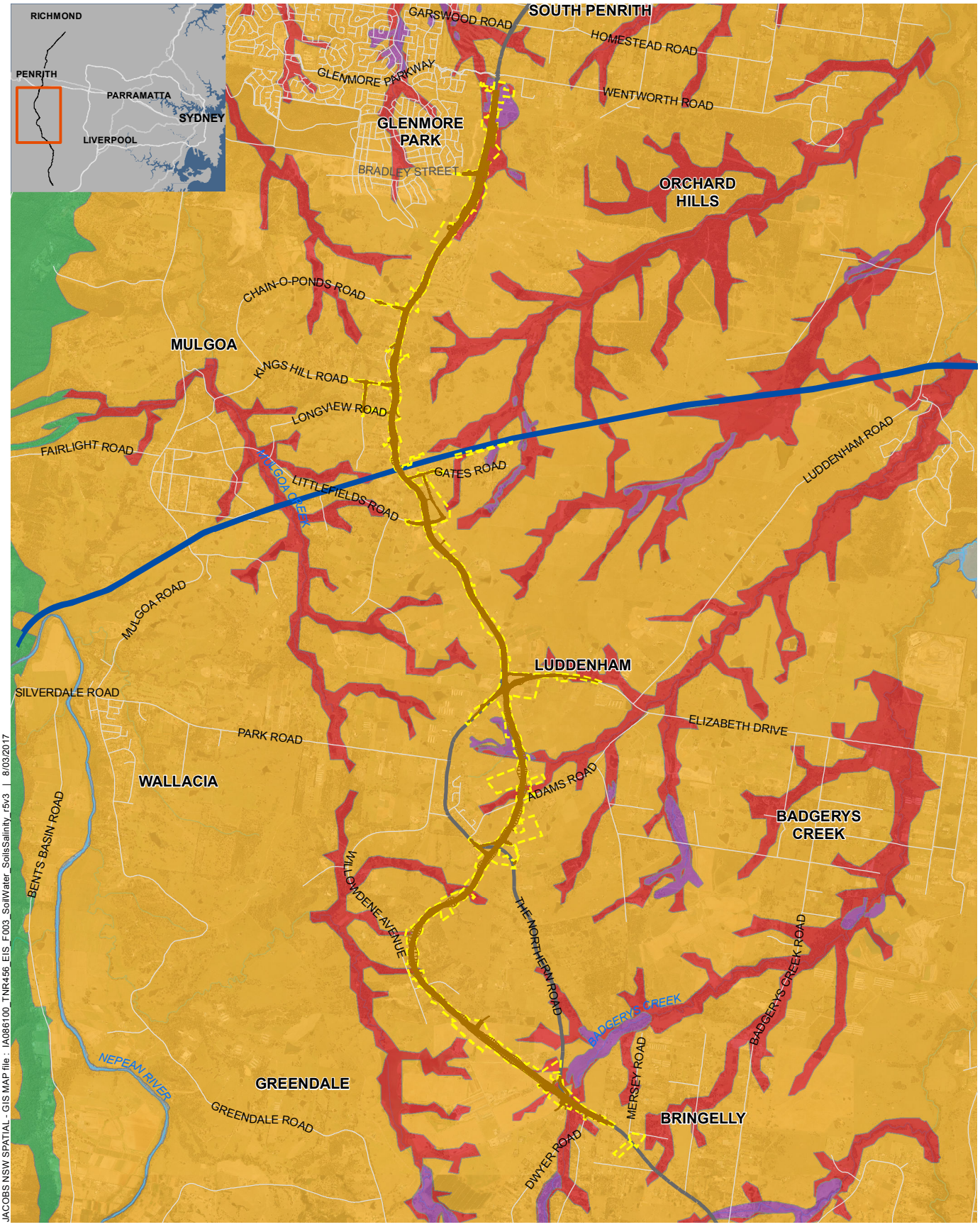


Figure 4-3 | Soil salinity potential

4.6 Contaminated land

4.6.1 NSW contaminated sites register

A search of the NSW EPA Contaminated Sites Register and Record of Notices (under Section 58 of the *Contaminated Land Management Act 1997*) was undertaken (November 2015) to ascertain the presence of registered sites that were either regulated or had been notified within the suburbs within the project area. The notified/regulated sites within one kilometre of the project area are summarised in **Table 4-3**.

Table 4-3 Notified sites within one kilometre of the project area

Suburb	Notified site address	Notified site activity	Contamination status	Location relative to Project
Luddenham	Caltex Service Station The Northern Road	Service Station	Under assessment	Outside project area (> 250m)

Based on the location of notified site relative to the project area, the Luddenham service station site is unlikely to be in the near vicinity of the construction footprint and as such is likely to pose a low contamination risk.

A search of areas of concern from the UXO website was undertaken (in March 2016). At the time of undertaking this assessment, no known areas of concern with respect to UXO were identified within or adjacent to the project area including Defence Establishment Orchard Hills.

4.6.2 Site inspection

A site inspection was conducted on 19 November 2015 by a Jacobs environmental scientist. The site inspection focussed on the Project area, as well as adjacent land uses and potential AEIs. The site inspection was only undertaken from areas which were accessible to the public.

At the time of the site inspection the project area consisted mostly of agricultural and rural residential land use, with low density residential land use in the suburbs of Glenmore Park and Mulgoa. The remaining areas generally comprised rural residential land use with more intensive agricultural land use within the southern portion of the project area (Greendale) and the Defence Establishment Orchard Hills. Roads were generally sealed.

A number of AEI were identified during the site inspection as detailed in **Table 4-4** and presented as **Figure 4-4.**