The Northern Road Upgrade, Glenmore Parkway, Glenmore Park to Jamison Road, South Penrith

Roads and Maritime Services

Soils & Water

Final

25 August 2016

Document history and status

Revision	Date	Description	By	Review	Approved
1	12/7/2016	Initial Review for client issue	JC/JRC/SD/MS/KB	TC	BL
2	1/8/2016	Final Draft REF Issue	JC/JRC/SD/MS/KB/ DL	JC	BL
3 (FINAL)	25/8/2016	Final issue	JC/JRC/SD/MS/KB/ DL	JC / TC	BL

Distribution of copies

Revision	Issue approved	Date issued	Issued to	Comments

Northern Road, Stage 3 REF

Project No:	IA086100
Document Title:	Soils & Water
Document No.:	FINAL
Revision:	3
Date:	25 August 2016
Client Name:	RMS
Client No:	Client Reference
Project Manager:	Tim Colman
Author:	Kate Byrnes, Jason Carr, John Constandopoulos, Michael Stacey, Sarah Douglass
File Name:	I:\NBIF\Projects\IA086100\Technical\REF_Stg3_North\Technical reports\Soils & Water\20160815 for REF Rev04 submission\20160825_TNR3 REF Soils Water quality_clean.docx

Jacobs Australia Pty Limited

100 Christie Street
St Leonards NSW 2065 Australia
PO Box 164 St Leonards NSW 2065 Australia
T +61 2 9928 2100
F +61 2 9928 2500
www.jacobs.com

Contents

1. Introduction

Roads and Maritime Services (Roads and Maritime) proposes to upgrade The Northern Road between Glenmore Parkway, Glenmore Park and Jamison Road, South Penrith ('the proposal'). The corridor is located about 47 kilometres west of the Sydney Central Business District (CBD). The proposal would upgrade The Northern Road to an eight-lane divided road, with three general traffic lanes and a kerbside bus lane in each direction, separated by a raised concrete median. Beyond Jamison Road, The Northern Road would continue as a six lane carriageway to the north.

The Northern Road is classified as a State Road and forms part of route A9, which connects Campbelltown to Windsor. The Northern Road also provides connections between the Western Sydney Priority Growth Area, the Western Sydney Employment Area, the M4 Motorway, and the site for the planned western Sydney airport at Badgerys Creek.

This section of The Northern Road is currently a four lane road, largely divided by a narrow median. Between 200 metres south of Smith Street and 200 metres north of Frogmore Road there is a 1.3 km section that is undivided. There are five signalised, and six unsignalised intersections, as well as various uncontrolled property accesses along this section of The Northern Road. At some unsignalised intersections and property accesses, right turn movements can be made across a painted median.

Roads and Maritime is upgrading The Northern Road as part of the Australian and NSW governments' Western Sydney Infrastructure Plan, which will deliver $3.6 billion in road infrastructure improvements over the next 10 years. The proposal was announced in April 2014 by the (then) Prime Minister as part of the Western Sydney Infrastructure Plan's program of work to support the planned western Sydney airport at Badgerys Creek.

It is anticipated that construction of the proposal would begin in mid-2017 and would be open to traffic by mid-2020.

This report has been prepared in support of the review of environmental factors (REF) for the proposed The Northern Road Upgrade between Glenmore Parkway, Glenmore Park and Jamison Road, South Penrith. The REF has been prepared under Part 5 of the NSW *Environmental Planning and Assessment Act 1979* (EP&A Act). This report provides an assessment of potential soils, surface water and groundwater impacts of the proposal. Mitigation measures and details of proposed water quality controls are also provided.

1.1 Description of the proposal

Roads and Maritime proposes to upgrade about four kilometres of The Northern Road between Glenmore Parkway, Glenmore Park and Jamison Road, South Penrith. The main features of the proposal are:

- An eight-lane divided road (three general traffic lanes and a kerbside bus lane in each direction) from just south of Glenmore Parkway, Glenmore Park to Jamison Road, South Penrith
- An upgrade to the M4 Motorway interchange, including:
  - Construction of a new two-span bridge over the M4 Motorway, located to the east of the existing bridge alignment
  - Replacement of the existing two sets of traffic lights at the M4 Motorway interchange, with a single set of traffic lights to control all movements at the interchange
  - Widening of ramps to accommodate future Smart Motorway requirements
  - Demolition of the existing bridge over the M4 Motorway
- New traffic lights on The Northern Road at:
  - The Glenmore Parkway and Wentworth Road intersection
  - The Frogmore Road and Tukara Road intersection
- Altered intersection arrangements at:
  - The Northern Road and Homestead Road (left-in, left-out only)
  - The Northern Road and Castle Road (left-in, left-out only)
- Upgrade of The Northern Road and Glenmore Parkway / Wentworth Road intersection, comprising:

  - Traffic lights to replace the existing roundabout, allowing all movements
  - Separate left-turn lanes on all approach roads to the intersection
  - Additional left-turn and right-turn capacity from both approach roads onto The Northern Road
  - A new dedicated access road into the Penrith Golf and Recreation Club, meeting Glenmore Parkway at a new T-intersection about 175 metres west of The Northern Road, with all left and right turn movements allowed
  - A new single-lane roundabout on Glenmore Parkway west of the proposed new Golf Club access road, to facilitate U-turn movements for traffic entering or leaving Fairwater Court and Garswood Road
- Changes to local roads, including:
  - Extension of Cross Road to provide a new local connection between Wentworth Road and Homestead Road
  - A new roundabout on Frogmore Road, west of the existing intersection with Simeon Road providing access to Penrith Christian School
  - Removal of the existing roundabout at Maxwell Street and Aspen Street, and replacement with a new four-leg roundabout realigned to include Hilliger Road, with traffic lights on the Aspen Street leg only
- New pedestrian and cyclist facilities, including:
  - A three-metre wide shared path along the western side of The Northern Road between Glenmore Parkway and Jamison Road
  - A three-metre wide shared path along the eastern side of The Northern Road between Wentworth Road and Bringelly Road
  - A 1.5 metre wide footpath on the eastern side of The Northern Road between Bringelly Road and Jamison Road
- New or additional pedestrian crossing signals at:
  - The Northern Road intersection with Glenmore Parkway and Wentworth Road
  - The M4 Motorway interchange
  - The Northern Road intersection with Frogmore Road and Tukara Road
  - The Northern Road intersection with Maxwell Street and Bringelly Road
  - The intersection of The Northern Road and Jamison Road
- New retaining walls along:
  - The eastern side of The Northern Road, south of Homestead Road
  - Both sides of the M4 Motorway beneath the proposed bridge (reinforced soil walls)
  - The northern side of the eastbound M4 on-ramp, towards the eastern end of the ramp
  - The western side of The Northern Road, south of Tukara Road
  - The eastern side of The Northern Road adjacent to the Flower Power Garden Centre, south of Castle Road
  - The eastern side of The Northern Road, south of Bringelly Road
  - The eastern and western side of The Northern Road at numerous locations between Maxwell Street / Bringelly Road and Smith Street
  - The southern side of Smith Street, west of the intersection with The Northern Road
  - The eastern and western side of The Northern Road at numerous locations between Smith Street and Jamison Road
- Upgrade of drainage infrastructure, including:
  - New or upgraded cross-drainage structures to replace existing cross-drainage where required
  - New longitudinal drainage including open concrete or grass-lined catch drains, grassed swales, pits and pipes
- New noise barriers at the following locations:
  - A noise mound along the northern side of the eastbound M4 Motorway off-ramp (the mound would be about 670 metres long and six metres high)
  - A noise wall along the eastbound M4 Motorway off-ramp from the end of the noise mound, continuing north along the western side of The Northern Road to Aspen Street (the wall would be about one kilometre long and up to 4.5 metres high)
  - A noise wall along the eastbound M4 Motorway on-ramp, between the motorway and the buildings at the Penrith Christian School (the wall would be about 325 metres long and up to 4.5 metres high)
- Two permanent variable message signs (VMS) on The Northern Road near the M4 Motorway interchange
- New street lighting
- New landscaping
- Relocation of utility services and construction/installation of new utility services

- Relocation of some bus stops and construction of new bus stops
- Changes to property accesses along The Northern Road to left-in, left-out only
- Adjustments to private properties to accommodate the proposal, including driveways, front yards, retaining walls, utility connections and fencing
- Establishment and use of temporary site compounds during construction.

It is anticipated that construction of the proposal would start during 2017 and is expected to be completed by mid-2020.

1.2 Location and context

For the purposes of this Soil and Water report, Jacobs has defined the “investigation area” which consists of land within the proposal footprint (ie. land that will be directly disturbed through the construction of the proposal) as well as a 500 metre buffer around this footprint. The 500 metre buffer was selected to identify potential sources of contamination that may present a risk to the proposal, receptors that may be impacted by the proposal and other conditions that may influence soil, surface water and groundwater characteristics within the proposal alignment.

The proposal is located in the Penrith local government area. The investigation area is mostly flat to undulating in topography.

The investigation area is generally divided into distinct geographies. To the east of The Northern Road and south of Bringelly Road, the investigation area is predominately semi-rural or rural residential in character. The remaining areas to the west of The Northern Road, and north of Bringelly Road are characterised by low density residential development comprising the southern suburbs of the City of Penrith. It also includes some commercial, educational, community and recreational land uses.

The Northern Road crosses the M4 Motorway about half way between Mulgoa Road and Mamre Road. The Northern Road is the main collector to and from the M4 Motorway through the area.

2. Methodology

The primary objective of this study was to assess the proposal's potential impact to soils, surface water and groundwater flow and quality, and to identify measures to avoid or minimise these impacts. In relation to land contamination, the study also aimed to identify potential risks to workers during the construction of the proposal and maintenance workers and users of the road once in operation.

As noted in **Section 1.1**, for the purposes of this Soil & Water report, the investigation area is defined as a 500 metre buffer around the proposal alignment as shown in **Figure 1-1**.

2.1 Surface water and groundwater

The general approach and methodology for the assessment of the proposal on water quality included:

1) Desktop review of existing information and relevant construction and operational water quality guidelines
2) Assessment of potential impacts from the construction and operation of the proposal to waterways including those waterways located downstream and outside the investigation area and the identification of appropriate safeguards and management measures
3) Assessment of potential impacts to groundwater and groundwater dependant ecosystems (including groundwater quality and hydrogeological conditions) and the identification of appropriate safeguards and management measures.

2.2 Soils and contaminated land

The soils assessment included an assessment of risks associated with acid sulphate soils, salinity and contamination.

In relation to acid sulphate soils, a review of the CSIRO ASRIS acid sulphate soils map was carried out to identify risks within the Investigation Area. Salinity risks were assessed through a review of the map of *Salinity Potential in Western Sydney* (Department of Infrastructure, Planning and Natural Resources, 2002).

A Stage 1 desktop contamination assessment was carried out for this Soil & Water study, and comprised a review of publically available information and project specific historical aerial photography, site inspection and identification of potential sources of contamination risk, referred to as Areas of Environmental Interest (AEIs).

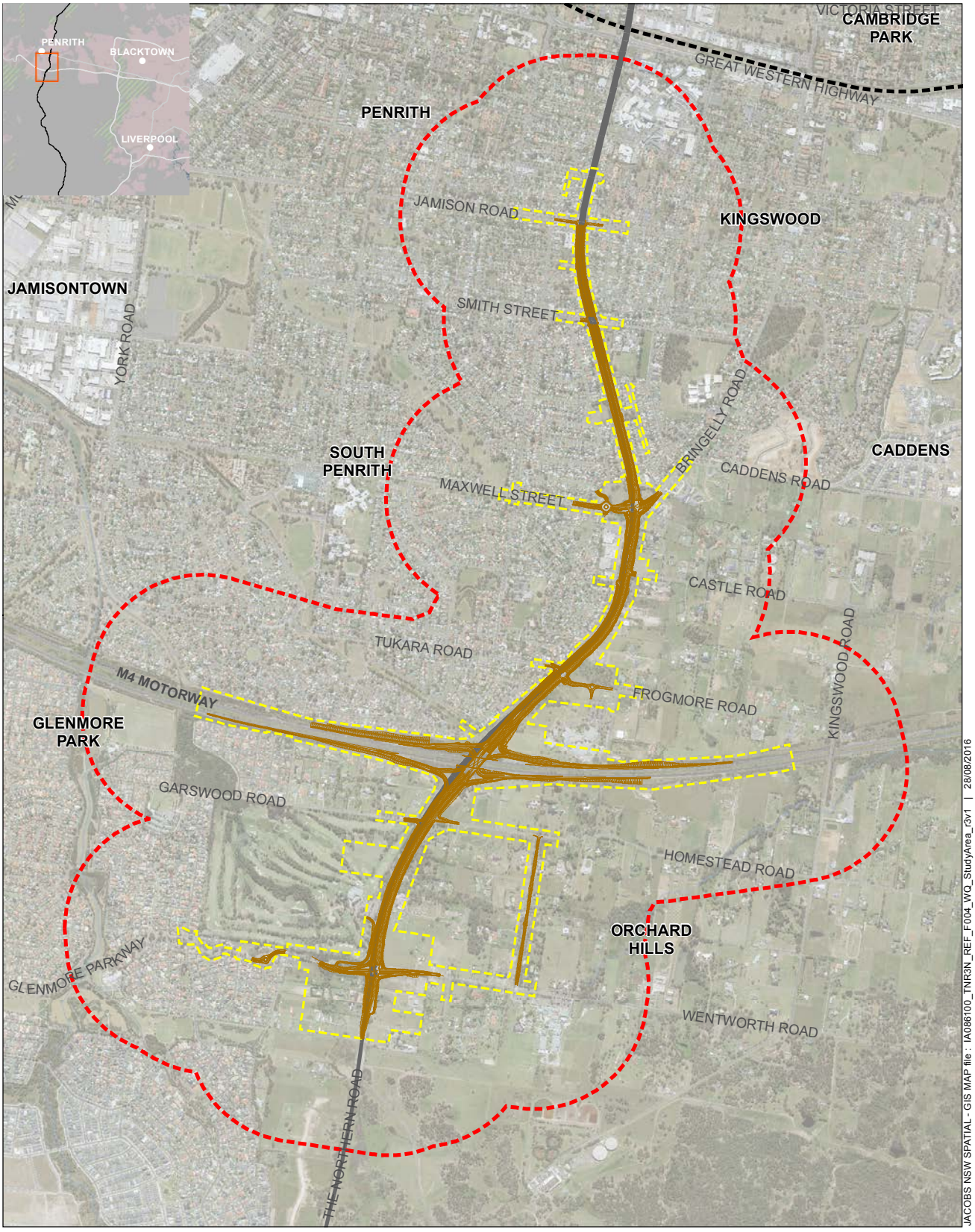
Public information sources in relation to land contamination include the NSW EPA contaminated land and Protection of the Environment Operations registers and the NSW Department of Primary Industries groundwater database.

The AEIs were considered to be those activities or sources that had the potential to cause soil, groundwater or vapour contamination which may be present as a result of historic and/or current activities carried out in the investigation area. In assessing potential risks associated with the AEIs, the potential source of contamination, potential ecological or human health receptors and potential pathways between the source and receptors were all considered.

A site inspection was carried out on 19 November 2015 by a Jacobs environmental scientist. The site inspection focussed on areas likely to affected by construction activities, as well as surrounding land uses and potential AEIs. The site inspection was only carried out from areas which were accessible to the public.

The Stage 1 assessment was carried out in accordance with relevant NSW EPA guidelines and did not include any ground investigations, sampling or testing of soils. The information in this report is based on the data obtained from the desktop background review and observations from the inspection of the investigation area.

The expected ground conditions are presented together with any contamination issues identified and recommendations for further investigations, if considered appropriate.



Legend

- The Northern Road Upgrade between Glenmore Parkway and Jamison Road
- The Northern Road (Existing)
- Study area
- Investigation area

0 0.5 1 km

N

Figure 1-1 | Study area

3. Existing environment and environmental values

3.1 Surface water

3.1.1 Catchment context

The proposal lies within the Lower Nepean River Management Zone of the Hawkesbury and Lower Nepean Rivers Water Source. The catchment is relatively flat with gently undulating hills. The proposal is largely an upgrade of the existing The Northern Road between just south of Glenmore Parkway to Jamison Road, South Penrith and passes through the suburbs of Glenmore Park, Orchard Hills and South Penrith.

The proposal directly traverses an eastern tributary of Surveyors Creek which flows into Peach Tree Creek and ultimately drains to the Nepean River at Penrith. There are a number of other unmapped, unnamed minor drainage lines/gullies traversed by the proposal. The predominant catchment land uses are residential, rural residential and defence force. The rural areas are predominantly agriculture including stone fruit and grapes.

3.1.2 Key fish habitat

One waterway, a tributary of Surveyors Creek at Glenmore Parkway, has been identified as Type 1 – Key Fish Habitats (DPI 2013), due to a combination of native aquatic plants and/or woody snags. This watercourse is an impacted, intermittent watercourse which is also identified as Class 2 – Moderate Fish Habitat (Fairfull & Witheridge, 2003) due to the presence of limited in stream aquatic vegetation. Another tributary of Surveyors Creek is potentially impacted by the proposal at the Northern Road at Penrith Golf and Recreation Club. **Figure 3-1** shows the Key Fish Habitats for the alignment. Several other minor, ephemeral gullies are present within the Investigation Area, however they are poorly defined, with no water and no aquatic habitat present.

Further information on potential fish habitat is provided in *The Northern Road Stage 3 North Biodiversity Assessment* (Jacobs, July 2016), and Chapter 6.3 of *The Northern Road Upgrade, Glenmore Parkway to Jamison Road Review of Environmental Factors* (Roads and Maritime, 2016).

3.1.3 Sensitive receiving environments

The Nepean River is the downstream receiving environment to the study area; however, the proposal itself is located close to the catchment divide, just west of the eastern boundary. The Nepean River is important to the region both environmentally and economically, and supports a range of domestic and irrigation uses.

Sensitive receiving environments have been identified using aquatic habitat as an indicator, as assessed by the aquatic ecologist. The tributary of Surveyors Creek at Glenmore Parkway is identified as key fish habitat and is therefore considered as a sensitive receiving environment for the proposal.

3.1.4 Existing water quality monitoring data

There is currently no water quality data available for Surveyors Creek or its tributaries. However, these waterways drain into Peach Tree Creek and some water quality data is available for Peach Tree Creek. The water quality within Peach Tree Creek reflects a highly degraded system and is identified as having poor water quality (SOE 2008-2009) largely due to the stormwater it receives from its immediate catchment and nearby urban creeks, including Surveyors Creek and its tributaries. As such the water quality in Surveyors Creek can be inferred from Peach Tree Creek as being likely to have elevated turbidity and nutrients, and elevated concentrations of indicators typically found in stormwater (Polycyclic Aromatic Hydrocarbons (PAHs), metals etc) (TfNSW 2014). This inference is based on Surveyors Creek and its tributaries having similar land uses and other influencing factors in its catchment, and the fact that nutrients and stormwater pollutants in Peach Tree Creek are likely to originate in upstream catchments.

3.1.5 Environmental values

Environmental values are particular values or uses of the environment that are important for a healthy ecosystem or for public benefit of health. They are values that require protection from the effects of pollution and waste discharges (ANZECC/ARMCANZ 2000). The Healthy Rivers Commission (HRC) nominated a number of environmental values and relevant indicators and guideline levels which are used in protecting the environmental value (HRC 1998).

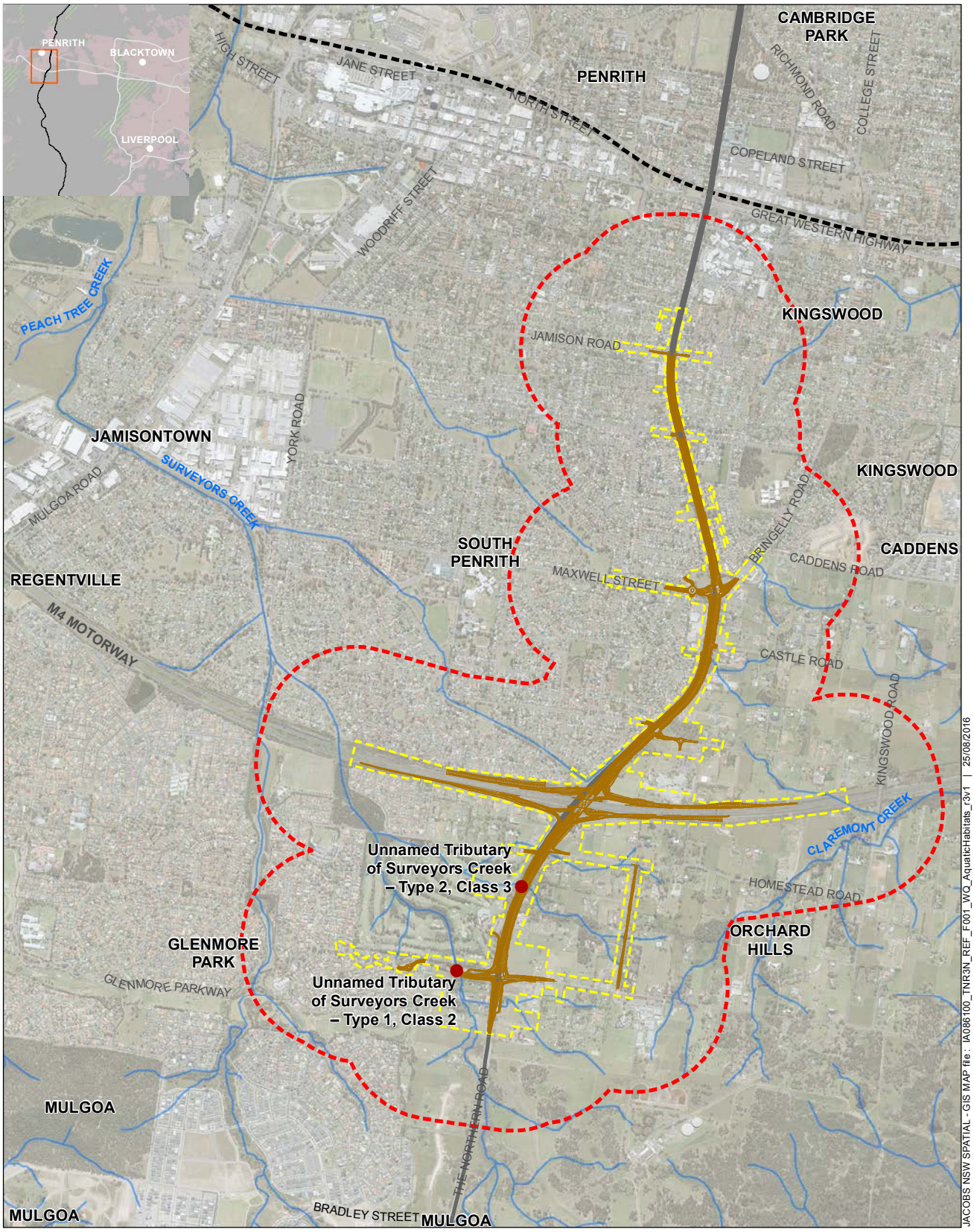
The relevant environmental value for the purposes of this assessment is aquatic ecosystems. Aquatic ecosystems can range from freshwater to marine and comprise the animals, plants and micro-organisms that live in water and the physical and chemical environment in which they interact. Aquatic ecosystems have 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 including nutrients, dissolved oxygen, pH, salinity and turbidity (suspended solids).

3.1.6 Water quality objectives

The water quality objective of the proposal is to minimise the potential impacts on downstream receiving waters, so that the proposal 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).

In order to meet this objective, water quality controls are needed upstream of receiving waterways that have been identified as environmentally sensitive using aquatic habitat as an indicator, as assessed by an aquatic ecologist. The results of this assessment indicated that one creek in the study area, a tributary of Surveyors Creek, is considered to be environmentally sensitive (refer to The Northern Road Upgrade Glenmore Parkway, Glenmore Park to Jamison Road, South Penrith Biodiversity Assessment (Jacobs, July 2016)). The tributary traverses the Penrith Golf and Recreation Club and would be potentially impacted by the proposal where it and its tributaries flow beneath Glenmore Parkway and the Northern Road at Penrith Golf and Recreation Club.

The aquatic ecology assessment was a desktop preliminary assessment and visual inspection only and a more comprehensive field assessment would need to be carried out to confirm the findings of the preliminary assessment.



Legend

- The Northern Road Upgrade between Glenmore Parkway and Jamison Road
- The Northern Road (Existing)
- Study area
- Aquatic habitats
- Investigation area

0 0.5 1 km

N

Figure 3-1 | Aquatic habitat

3.2 Soils and contaminated land

3.2.1 Regional geology

The proposal lies within the Penrith 1:100,000 geological map region (NSW Department of Mineral Resources, 1991). The dominant geological formation along the area of the study area is the Bringelly Shale. The Bringelly Shale belongs to the Wianamatta Group which is the uppermost geological unit of the Permo-Triassic sequence mainly comprising claystone and siltstone, with some areas of sandstone. It is interpreted as a coastal alluvial plain sequence that contains lagoonal – coastal marsh sequence at the base through to terrestrial, alluvial plain sediments at the top of the formation. The Minchinbury Sandstone (Rwm) and Ashfield Shale (Rwa) formations underlie the Bringelly Shale formation and make up the other formations of the Wianamatta Group.

The Hawkesbury Sandstone lies beneath the Wianamatta Group. The Hawkesbury Sandstone is a quartz sandstone containing detrital grains, rock fragments and clay pellets. The sandstone is dominantly medium to coarse grained, but varies from fine to very coarse grained. Iron-rich groundwater can be encountered in the Hawkesbury Sandstone.

Quaternary Alluvium comprised of fine sands, silts and clays is likely to be deposited along Surveyors Creek. The Cranebrook Formation comprising gravel, sand, silt and clay is also present along Surveyors Creek.

The Orchard Hills dyke (Jd), a basalt dolerite dyke is located to the east of the current Northern Road alignment and is intersected by the M4 Motorway. The dyke was exposed in a cutting for the M4 Motorway and is noted as highly weathered in the surface zone.

A description of the geological formations underlying the investigation area is provided in **Table 3-1** below.

Table 3-1 Geological units underlying the investigation area

Unit	*Description*
Quaternary Alluvium (Qal)	Fine grained sand, silt, clay
Cranebrook Formation (Qpc)	Gravel, sand, silt, clay.
Bringelly Shale (Rwb)	Shale, carbonaceous claystone, laminate, coal in parts
Minchinbury Sandstone (Rwm)	Fine to medium grained quartz-lithic sandstone
Ashfield Shale (Rwa)	Dark grey to black claystone-siltstone and fine sandstone-siltstone laminite
Hawksbury Sandstone (Rh)	Interbedded shale, laminate, and medium grained quartz sandstone
Orchard Hills Dyke (Jd)	Basalt, dolerite

3.2.2 Soils

The Penrith 1:100,000 Soil Landscape sheet 9030 (Soil Conservation Service of NSW, 1990) indicated that the soil landscape groups within the investigation area consist of erosional Luddenham (lu), residual Blacktown (bt) and fluvial South Creek (sc) soil landscape groups. **Table 3-2** describes the soil landscape groups within the investigation area.

Table 3-2 Soil units underlying the investigation 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 metres, 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 hard setting 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 next to drainage lines, red and yellow podzolic soils on terraces. • Limitations – erosion hazard, frequent flooding.

3.2.3 Acid sulphate soils (ASS)

ASS are soils and sediments that contain iron sulphides that when exposed to oxygen generate sulphuric acid and toxic quantities of aluminium and other heavy metals. The sulphuric 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 Australian Height Datum (AHD).

ASS includes Actual ASS, where oxidation has occurred, and Potential ASS, soils which contain iron sulfides or sulfidic material which has not been exposed to air and oxidised.

The Australian Soil Resource Information System (ASRIS, 2015) provides online access to 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 proposal alignment. The Acid Sulphate Soil Probability within the proposal alignment was classified as “Extremely Low Probability” of occurrence. ASS is therefore not considered to be a risk to the proposal.

3.2.4 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 and soil chemistry, and cause weakening and degradation of construction materials such as masonry, concrete and bitumen.

Clause 7.6 of the Penrith Local Environmental Plan 2010 states that:

“Development consent must not be granted to any development unless the consent authority has considered:

a) whether or not the proposed development is likely to have an impact on salinity processes, and

b) whether or not salinity is likely to have an impact on the proposed development, and

c) appropriate measures that can be taken to avoid or reduce any undesirable effects that may result from the impacts referred to in paragraphs (a) and (b).”

Part C4, Section 4.5 of the Penrith Development Control Plan 2014 states that "a detailed salinity analysis will be necessary if:

i. The site of the proposed development has been identified as being subject to a potential risk of salinity (refer to the map Salinity Potential in Western Sydney 2002),or

ii. An initial investigation shows the site is saline or affected by salinity."

An assessment of the salinity potential within the investigation area was carried out using the map of *Salinity Potential in Western Sydney* (Department of Infrastructure, Planning and Natural Resources, 2002). The majority of the investigation area occurs in areas of moderate salinity potential with isolated areas of high salinity potential.

3.2.5 Historical aerial photography

Historical aerial photographs of the investigation area from the NSW Land and Property Management Authority, Land and Property Information Division were examined for the years: 1947, 1955, 1965, 1975, 1986, 1994 and 2005. The purpose of this review was to identify indicators of activities with the potential to have caused contamination. The findings of the historical aerial photograph review are described in **Table 3-3**.

Table 3-3 Historical aerial photograph review

Date of aerial photography	Proposal footprint	Surrounding area
1947	The Northern Road is visible in the photograph. Land around the road generally comprised agricultural land. Agricultural land use appeared to be small scale cropping, orchards (generally in areas north of Orchard Hills) and grazing in other parts of the proposal area. There were a small number of buildings/structures (houses, sheds) likely to be associated with the agricultural activities.	Surrounding land use consisted of rural residential land use to the north of the investigation area (Penrith, Kingswood) and agricultural land in other areas. Small scale cropping and orchards were also present in the investigation area.
1955	Generally, as per observations in the 1947 photograph.	The surrounding area remained largely the same with increased structures observed within the Orchard Hills Defence Facility.
1965	Generally, as per observations in the 1955 photograph with construction of the Penrith Golf Course, There appeared to be a general reduction in agricultural activities (small scale cropping, orchards) within the proposal area.	The surrounding area remained largely the same, with increased low density residential development within the proposal area, construction of Sydney Water reservoirs (Orchard Hills) and increased structures within the Orchard Hills Defence Facility. There appeared to be a general reduction in agricultural activities (small scale cropping, orchards) within the proposal area.
1975	Generally, as per observations in the 1965 photograph with increased low density residential development in South Penrith, construction of the M4 Western Motorway, increased rural residential properties, less agricultural activities within the proposal area, Penrith golf course has been constructed.	The surrounding area remained largely the same, with increased low density residential development (Penrith and Kingswood) and rural residential properties, less agricultural activities (Orchard Hills) within the proposal area.
1986	Generally, as per observations in the 1975 photograph with low density residential development in South Penrith extending south to the M4 Western Motorway.	The surrounding land use remained largely unchanged. Quarrying activities were observed in Glenmore Park located to the south west of the proposal area. A waste water treatment facility had been constructed at the Sydney Water reservoir site in Orchard Hills.
1994	Generally, as per observations in the 1986 photograph.	The surrounding land use remained largely unchanged. The waste water treatment facility at Orchard Hills had been re-configured.

Date of aerial photography	Proposal footprint	Surrounding area
2005	Generally, as per observations in the 1994 photograph with increased low density residential development occurring in Glenmore Park (adjacent to Penrith Golf Course) and quarrying activities have ceased in Glenmore Park.	The surrounding land use remained largely unchanged with increased residential development around Glenmore Park adjacent to the south western portion of the proposal area.

3.2.6 NSW EPA contaminated sites register

At the time of preparing this Soil & Water report, 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 to ascertain the presence of registered sites that were either regulated or had been notified in the suburbs within the proposal area. The notified/regulated sites within one kilometre of the proposal area are summarised in **Table 3-4**.

Table 3-4 Contaminated sites notified to the NSW EPA within the investigation area

Suburb	Notified site address	Notified site activity	Contamination status
South Penrith	7-Eleven Service Station 45 Aspen Street	Service Station	Regulation under CLM Act not required

3.2.7 Interactive crash statistics

At the time of preparing this Soil & Water report, a search of the Transport for NSW Interactive Crash Statistics was undertaken to ascertain the potential for localised contamination associated with vehicle accidents to be present within the proposal area.

The database indicated that vehicle accidents have been recorded on The Northern Road and most of the local roads within the proposal area. The majority of accidents appeared to have occurred on the on and off ramps to The Northern Road from the M4 Western Motorway and areas around Glenmore Park. The database did not provide information with respect to potential contamination including fuel release, fires etc.

3.2.8 Previous site investigations

At the time of preparing this Soil & Water report, no previous contamination investigations were known to have been undertaken across the proposal area or were made available for review.

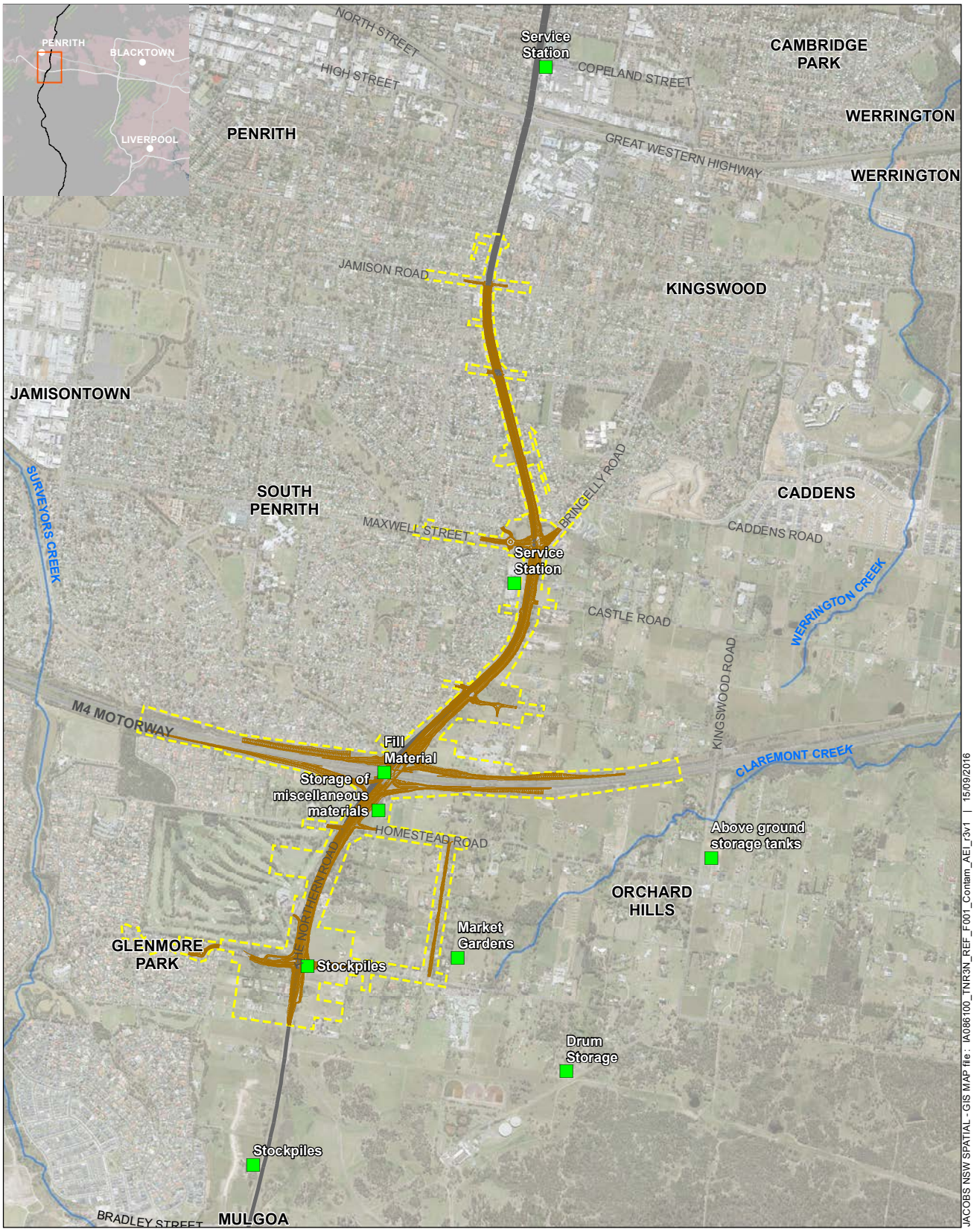
3.2.9 Areas of environmental interest

Areas of Environmental Interest (AEI) have been identified based on the desktop information review and site inspection. It is noted that the scope of work for this assessment did not include entry to private property and so all observations made during the site inspection were from publicly accessible areas. In many cases, it was not possible to make close inspection of AEI within private property and only general observations were able to be noted. The identified AEI are presented in **Table 3-5** and shown in **Figure 3-2**.

Table 3-5 Areas of environmental interest

AEI	Location	Description
Service station	Aspen Street, South Penrith	Operational service station site, storage of dangerous goods in underground systems

AEI	Location	Description
Filling	On and off ramps – Great Western Motorway and Northern Road intersection	Fill of unknown quality used for the on and off ramps
Storage of miscellaneous materials	Private property, Homestead Road, Orchard Hills	Miscellaneous storage of building and construction materials. Shipping containers of unknown content
Above ground storage tanks	Private property, Homestead Road, Orchard Hills	Possible storage of dangerous goods (petroleum)
Market gardens	Private property, Homestead Road, Orchard Hills	General agricultural activities, possible chemical storage and pesticide use
Market gardens	Private property, Wentworth Road, Orchard Hills	General agricultural activities, possible chemical storage and pesticide use
Stockpiles	Corner of Wentworth Street and The Northern Road, Orchard Hills	Fill of unknown quality. Close proximity to The Northern Road
Septic systems	Numerous tanks and pump out points observed (within investigation area)	Human wastes



Legend

- The Northern Road Upgrade between Glenmore Parkway and Jamison Road
- The Northern Road (Existing)
- Study area
- AEI contamination sites

0 0.5 1 km

N

Figure 3-2 | AEI contamination sites

3.3 Groundwater

3.3.1 Overview

It is expected that a shallow and a deep groundwater system exists in the investigation area. The shallow groundwater system is likely comprised of regolith (weathered Wianamatta Shale) through to unweathered shale. The depth of the shale layer is about 35 metres below ground level as indicated by works summaries obtained from the Department of Primary Industries NSW office of Water (DPI Water). The shallow water table, if present, is expected to range from two to 30 metres below ground level.

The Wianamatta Shale is a low permeability formation and therefore the contribution of this to baseflow in surface water courses is expected to be minor to negligible.

The deep groundwater system comprises the Hawkesbury Sandstone. Recharge to the Hawkesbury Sandstone is expected to occur from rainfall and surface water interaction along the Lapstone Monocline along the far eastern edge of the Blue Mountains (west of the proposal alignment) and to a minor extent vertical percolation from the overlying Wianamatta Shale. Groundwater flow direction is expected to be north-easterly within the Hawkesbury Sandstone. There are some faults in the area that could indicate enhanced connectivity between the shallow and deeper groundwater systems.

As noted in Section 3.2.1, the Orchard Hills dyke is located to the east of the current Northern Road alignment and is intersected by the M4 Motorway. This is expected to be weathered in the surface zone and unlikely to influence shallow groundwater. The dyke may have some influence in the deeper groundwater system in terms of preferential pathways and / or barriers for groundwater flow. However it is noted that the geological map indicates that the dyke is less extensive than other dykes in the region and therefore may not have a significant influence on deep groundwater.

3.3.2 Conceptual Hydrogeological Model

The conceptualised hydrogeological model for the site is presented in **Figure 3-3**. The model depicts the idealised key interactions between the surface water, regional shallow aquifer and regional deep aquifer systems.

The conceptual model consists of three groundwater systems:

1. Localised perched aquifer systems located in the shallow weathered shale and clay. Road cuttings are not expected to exceed 10m across the project. It is possible that the road cuttings will intercept incidental perched aquifers. The flow from these pockets is expected to be minor to negligible due to the low hydraulic conductivity of weathered shales and clays. These aquifers are likely to recharge and discharge during rainfall events. The Sydney Basin Central Groundwater Source is defined as a less productive groundwater source.

2. The Bringelly Shale represents the regional shallow aquifer system. The depth to the groundwater table is expected to vary across the investigation area. However because the proposal is largely centred on a topographic ridge, the depth to water is expected to be approximately 30mbgl. The water quality in this aquifer unit is expected to be of poor quality (high Total Dissolved Solids) and low hydraulic conductivity. This unit is generally of limited beneficial use for potable or domestic use. As noted above, the Sydney Basin Central Groundwater Source is defined as a less productive groundwater source.

3. The Hawkesbury Sandstone represents the deeper semi-confined regional aquifer. The Hawkesbury sandstone is generally of better quality than the shallow groundwater system. Local water supplies tend to be screened in this unit as it is more suitable for stock and domestic uses. This unit has a low primary hydraulic conductivity. The depth to this unit varies from 100 to 130mbgl.

Groundwater in the shallow groundwater table is expected to generally flow north-east, down hydraulic gradient towards the Nepean River.

This 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)

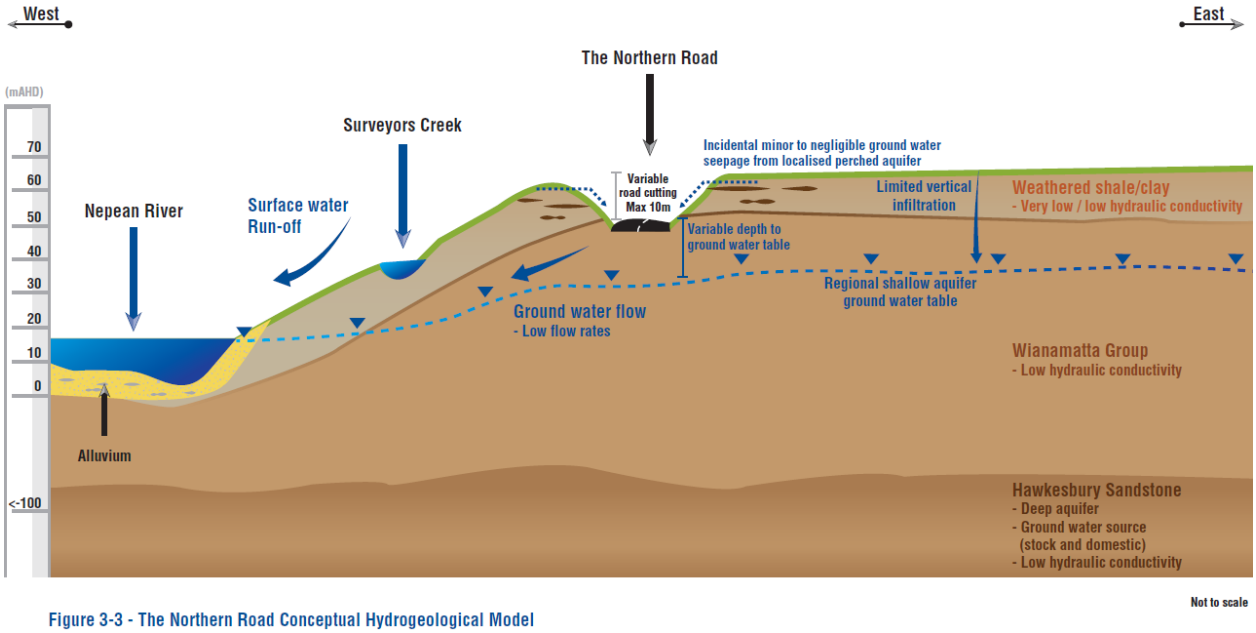


Figure 3-3 - The Northern Road Conceptual Hydrogeological Model

3.3.3 Surrounding groundwater work

There is limited groundwater use near the proposal due to the geological environment comprising low permeability shale, siltstone and sandstone. Six registered groundwater works were identified during a review of the DPI Water's Groundwater PINNEENA online database (accessed March 2016), which provides current groundwater works data across NSW. All groundwater works within a 500 metre buffer (excluding monitoring bores) that are considered to extract groundwater were assessed as potential groundwater receptors for the proposal (refer to **Figure 3-4**).

One test bore (GW108906) was identified within the investigation area (**Table 3-6**). This bore was drilled into unweathered shale and sandstone. Data obtained from PINNEENA indicates the groundwater work (GW108906) is currently inactive.

Other groundwater works within the investigation area are listed in PINNEENA as monitoring piezometers installed into the Wianamatta Shale. It is likely these monitoring piezometers refer to local, site specific investigations for geotechnical or due diligence purposes. No other information on the purpose of these wells is provided in the PINEENA database.

Table 3-6 : Groundwater work

Groundwater Works ID	Easting	Northing	Depth (mBGL)*	Screen (mBGL)	Formation	SWL (mBMP)**	Use	Lot/DP
GW108906	287656	6259328	186	48.9	Sandstone/Shale	30	test bore	11/831409

** mBGL: metres below ground level*

*** SWL (mBMP): Standing Water Level (metres below measuring point)*

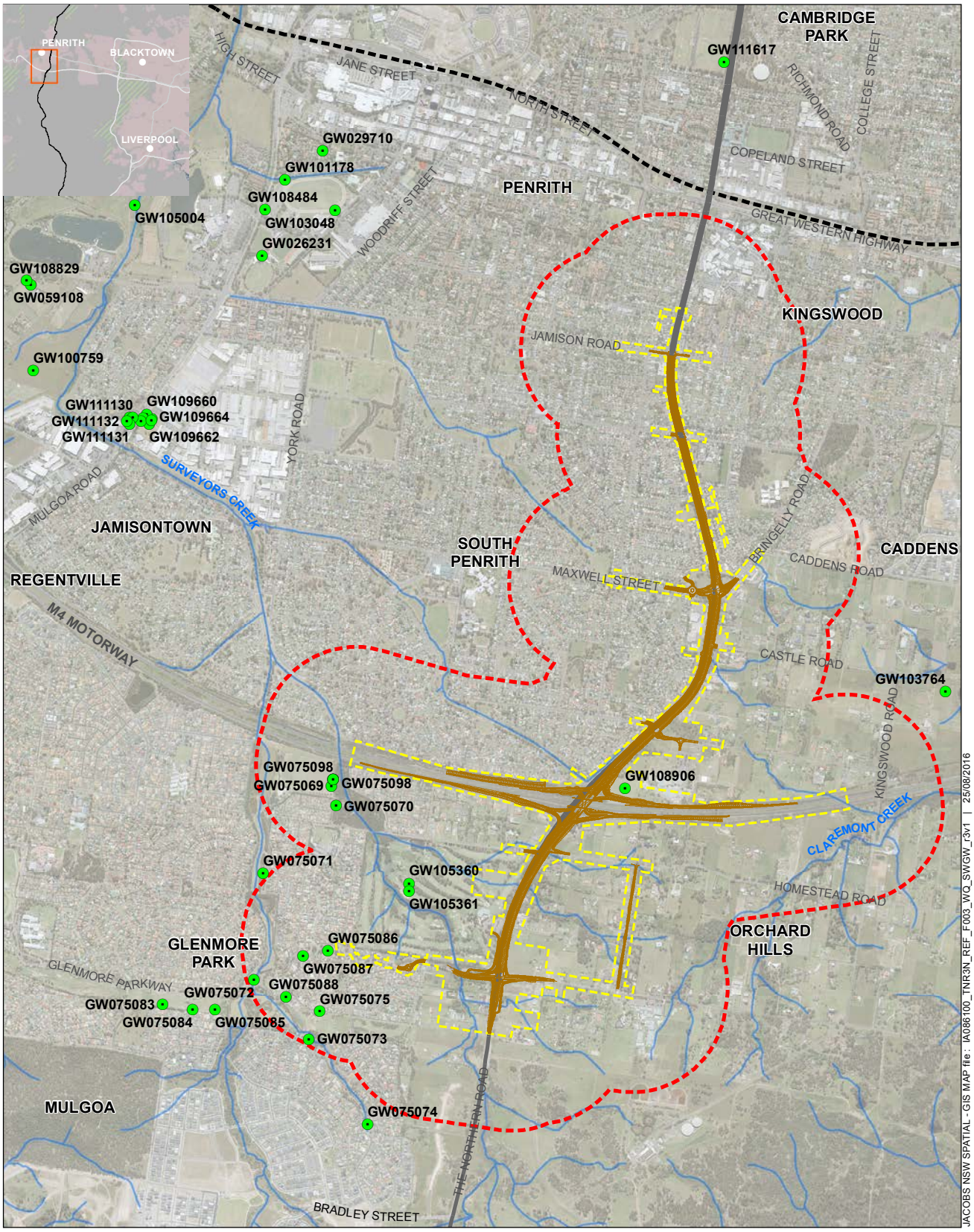
3.3.4 Surrounding water access licences

There are no active Water Access Licences within the study area.

3.3.5 Groundwater dependant ecosystems

A review of the *Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011* indicates there are no listed high priority groundwater dependent ecosystems (GDE) located in the investigation area.

Similarly, a review of the Bureau of Meteorology Groundwater Dependent Ecosystems Atlas did not indicate the presence of other GDEs.



Legend

- The Northern Road Upgrade between Glenmore Parkway and Jamison Road
- The Northern Road (Existing)
- Study area
- Groundwater bore (GW Work)
- Investigation area

Figure 3-4 | Groundwater bore locations

4. Assessment of potential impacts

4.1 Surface water

4.1.1 Potential construction impacts

Construction of the proposal presents risk to downstream water quality if management measures are not implemented, monitored and maintained. If unmitigated, the highest risk to water quality would occur through the following construction activities:

- Construction upstream of waterways such as the tributaries of Surveyors Creek as well as other unnamed tributaries located within the investigation area
- Construction of in-stream structures in watercourses. This includes potential construction of new or extended culverts in a tributary of Surveyors Creek at the Glenmore Parkway intersection and unnamed tributaries and the replacement of existing culverts at the unnamed tributaries at Cross Road. Drainage works including drainage pits at two locations in the investigation area also present risks to water quality
- General earthworks, including stripping of topsoil, excavation or filling particularly when these sites are located close to waterways. Minor cutting is proposed near tributaries of Surveyors Creek near the Glenmore Parkway interchange and Homestead Road. Minor cutting is also proposed at unnamed tributaries near The Northern Road and M4 Motorway interchange, near Castle Road and near Bringelly Road. Filling would only occur in close proximity to an unnamed tributary of Claremont Creek on the M4 Motorway east of The Northern Road
- Removal of vegetation where vegetation exists along the length of the proposal, particularly at the cut locations mentioned above
- Temporary sites and work areas located near waterways including those used for stockpiling of excavated materials, in particular those south of the M4 Motorway which is where the majority of waterways (unnamed tributaries of Surveyors Creek) are located
- Transportation of cut and/or fill materials throughout the study area
- Movement of heavy vehicles across exposed earth.

The introduction of pollutants from construction of the proposal into the surrounding environment, if uncontrolled could potentially impact on the water quality of receiving surface waters including tributaries of Surveyors Creek in the following ways:

- Increased sediment loads and organic matter causing elevated turbidity levels and increased levels of nutrients, metals and other pollutants in nominated waterways in the study area from exposed soil during site disturbance and movement of construction vehicles, particularly following rainfall events. Increased sedimentation has the potential to smother aquatic life and affect the ecosystems of downstream waterways. Provided safeguards and management measures are implemented, the proposal would be unlikely to contribute significant amounts of sediment and organic matter to the immediate waterways. Given that the waterways are generally disconnected pools which would likely only flow under high flow conditions the impacts on downstream receiving environments of Peach Tree Creek and the Nepean River is likely to be negligible.
- Increased levels of litter from construction activities and ancillary sites polluting downstream watercourses
- Chemical, heavy metal, oil and grease, and petroleum hydrocarbon spills from construction machinery directly contaminating downstream waterways

Construction activities could introduce additional materials to local drainage lines, particularly during high rainfall events. Contaminants could include those from construction materials, rubbish, fuel and chemicals from accidental spills. A Soil and Water Management Plan would be prepared as part of the construction environmental management plan prior to the commencement of construction. The plan would detail measures for reducing the incidence of sediment, litter of chemical pollution reaching tributaries of Surveyors Creek and other nearby waterways within the study area during the construction phase.

4.1.2 Potential operational impacts

The proposal has the potential to affect existing local water quality due to the generation of additional pollutants directly attributable to the widened road and associated increased vehicle traffic in the future. The most important pollutants of concern relating to road runoff are:

1) Sediments from the paved surface from pavement wear and atmospheric deposition
2) Heavy metals attached to particles washed off the paved surface
3) Oil and grease and other hydrocarbon products.

The emphasis in stormwater quality management for road runoff is that of managing the export of suspended solids and associated contaminants – namely heavy metals, nutrients and organic compounds (Austroads, 2001). Pollutants such as nutrients, heavy metals and hydrocarbons are usually attached to fine sediments (RTA, 2003). Therefore, trapping suspended solids is the primary focus of the water quality management strategy for the operational phase of the proposal.

Accidental spills could occur on any highway; however the improved horizontal and vertical geometry of the upgrade and the improved layout of the signalised interchanges would reduce the current risk of accidental spills.

4.2 Groundwater

4.2.1 Potential construction impacts

Construction projects can have an impact on groundwater systems where excavations or structures intersect these systems or dewatering is carried out or caused. Construction projects can also have an impact on groundwater quality where contamination from construction activities enters the sub-surface and reaches groundwater.

No significant groundwater impacts are expected during the construction phase of the proposal as the cuttings would be relatively shallow and located above the regional shallow groundwater table. There would be 15 cuttings within the study area. The proposed depths of cuttings are less than 2 metres below ground level along the proposal alignment with the exception of the cutting located at the cross section of The Northern Road and M4 Motorway, which would have a maximum depth of 9.604 meters below ground level. It is understood the closest groundwater bore is GW108906, located 170 metres east of this cutting. The historic standing water level in this groundwater bore is 30 mbgl. Therefore impacts on the regional shallow groundwater system are not expected.

A perched shallow water table may be encountered. The magnitude of seepage through the road cuttings is expected to be negligible, that is less than 0.1 L/s/km (litres per second per kilometre) based on the permeability of weathered shales and clays. Any dewatering that may be required is likely to be superficial and associated with managing local and recent rainfall.

Other potential impacts upon groundwater may include:

- Oil and grease contamination to the shallow aquifer. Any petroleum hydrocarbon spill from construction machinery would have the potential to seep into the shallow groundwater system
- Soil salinity, although it is not anticipated that soil salinity would be a particularly significant issue with respect to road design as Roads and Maritime have developed specific procedures for managing potentially saline and sodic soils. The potential for salinity to damage infrastructure and the suitability of excavated material for reuse as fill would be considered during detailed design.

It is noted that piling will likely be required for the replacement of the M4 Motorway bridge. This is considered unlikely to have a significant impact on groundwater as the piles are unlikely to create a barrier to groundwater flow or extend deep enough to create pathways between the shallow and deep aquifers.

4.2.2 Potential operational impacts

No significant impacts on groundwater flow conditions or groundwater quality are expected as a result of the operation of the proposal, primarily as the road alignment will be located well above the main groundwater systems. Minor seepage from local perched groundwater into the cuttings may occur and this seepage water would be managed with surface water runoff. Contaminants from the road are unlikely to enter the sub-surface and leach to groundwater due to the low permeability of the soils.

4.3 Soils

4.3.1 Potential construction impacts

4.3.1.1 Erosion

Erosion of soil could occur from disturbed areas and material stockpiles during construction of the proposal. This would mainly occur due to surface water runoff and movement of vehicles across disturbed areas. The main impact of this erosion is the potential impact on downstream water quality as discussed in **Section 4.2**.

4.3.1.2 Salinity

As discussed in Section 3.2.4, the majority of the investigation area occurs in areas of moderate salinity potential with isolated areas of high salinity potential.

Saline soils can impact on sub-surface structures constructed for the proposal, impact on vegetation growth and make reuse of soil excavated for the proposal unsuitable.

Soil salinity testing will need to be carried out prior to construction to further assess these risks and implement appropriate controls.

4.3.1.3 Existing contamination

In relation to existing contamination, an assessment of qualitative health risk to construction workers for the proposal associated with each of the AEIs identified in **Section 3.2.9** has been undertaken. This is presented in **Table 4-1**.

Table 4-1 : Qualitative contamination risk assessment of AEIs

AEI	Location	Potential Contaminants of Concern	Potential Contamination Distribution	Exposure Risk
Service Station	Aspen Street, South Penrith	Heavy metals, hydrocarbons	Deeper soils, groundwater and soil vapour	Moderate – Site likely to be in the near vicinity of the construction footprint. Risk increased if deep excavations occur in the vicinity of the site.
Filling	On and off ramps – Great Western Motorway and The Northern Road intersection	Heavy metals, hydrocarbons, pesticides, polychlorinated biphenyls, asbestos	Surface and shallow soils	Moderate – Fill likely to be exposed during construction activities
Storage of miscellaneous materials	Private property, Homestead Road, Orchard Hills	Heavy metals, hydrocarbons, pesticides, polychlorinated biphenyls, asbestos	Soils, groundwater and soil vapour	Low – Contamination (if present) likely to be localised and substantial construction activities are unlikely on the site.
Above ground storage tanks	Private property, Homestead Road, Orchard Hills	Heavy metals, hydrocarbons	Surface and shallow soils	Low – Contamination (if present) likely to be localised and substantial construction activities are unlikely on the site.
Market Gardens	Private property, Homestead Road, Orchard Hills	Heavy metals, hydrocarbons, pesticides, nutrients	Soils and groundwater	Low – Contamination (if present) likely to be localised and substantial construction activities are unlikely on the site.
Market Gardens	Private property, Wentworth Road, Orchard Hills	Heavy metals, hydrocarbons, pesticides, nutrients	Soils and groundwater	Low – Contamination (if present) likely to be localised and substantial construction activities are unlikely on the site.
Stockpiles	Corner of Wentworth Road and The Northern Road, Orchard Hills	Heavy metals, hydrocarbons, pesticides, polychlorinated biphenyls, asbestos	Surface and shallow soils	Moderate – Stockpiles may need to be removed during construction activities.
Drum Storage	Private property, The Chase, Orchard Hills	Heavy metals, hydrocarbons	Surface and shallow soils	Low – Contamination (if present) likely to be localised and substantial construction activities are unlikely on the site.
Stockpiles	Private Property, western side of The Northern Road between Glenmore Parkway and Bradley Street, Glenmore Park	Heavy metals, hydrocarbons, pesticides, polychlorinated biphenyls, asbestos	Surface and shallow soils	Moderate – Stockpiles may need to be removed during construction activities.
Septic Systems	Numerous tanks and pump out points observed within the investigation area	Heavy metals, nutrients, biological	Deeper soils and groundwater	Low – Contamination source likely to be highly degraded.

The majority of AEIs identified are likely to pose a low risk of exposure to site users and environmental receptors to contamination during construction of the proposal.

The following information summarises the AEIs assessed as moderate risk in **Table 4-1**:

- The service station located at Aspen Street, South Penrith represents a potential source of contamination associated with leaks and spills from fuel storage infrastructure (i.e. hydrocarbons and heavy metals). The location of the service station in the near vicinity of the construction footprint of the proposed upgrade poses an increased risk of exposure to contamination (if present) especially associated with deeper excavations.

- The abutments of the on and off ramps from the M4 Western Motorway to The Northern Road appear to have been filled to facilitate construction of the existing interchange. The quality of the fill material used in the abutments is unknown and it is likely that some of this fill material would be exposed during the construction of the upgrade.

- The stockpiles located at the corner of Wentworth Road and The Northern Road, Orchard Hills are located close to the current road verge and could be disturbed as part of construction activities. The quality of the material within the stockpiles is unknown.

- The stockpiles located on the western side of The Northern Road between Glenmore Parkway and Bradley Street, Glenmore Park are located close to the current road verge and could be disturbed as part of construction activities. The quality of the material within the stockpiles is unknown.

Contamination within the disturbed area during construction of the proposal associated with these AEIs, if any, could present a health risk to construction workers. It is also noted that contamination will also need to be considered in classifying waste soil for off-site disposal.

No high risk AEIs have been identified and the moderate risks are not considered to present a material constraint to the proposal. Further investigation and assessment will be required in order to implement appropriate risk management measures.

4.3.1.4 Contamination caused by construction

The storage and use of fuel and other chemicals during construction presents a risk of land contamination due to leaks or spills. Appropriate controls and management measures will need to be implemented as part of the Construction Environmental Management Plan.

4.3.2 Potential operational Impact

Following the construction of the proposal, the disturbed surfaces will be re-surfaced or revegetated. Therefore erosion and salinity risks will be minimal. Risks to site users (maintenance workers and road users) from existing contamination will be lower than those during construction. If contamination is encountered during construction then this would be remediated, removed or appropriate management measures to reduce future risk would be put in place.

In relation to contamination caused by the operation of the proposal, this could occur through vehicle accidents which result in spills of fuel or chemicals to the roadway and surrounding land. Fire-fighting activities following accidents may also result in contamination impacts. The design of the proposal aims to minimise accidents and no further safeguards are considered necessary. Appropriate investigation and clean-up of any accident will occur as part of RMS standard processes.

5. Proposed mitigation measures

5.1 Water quality

The potential impacts on water quality as a result of the proposal are to be minimised by implementing adequate temporary and permanent water quality controls for the construction and operational phases respectively. For the construction phase, erosion and sediment controls including sediment basins would be designed and sized in accordance with the requirements of the Blue Book (Soils and Construction, 2008 Volume 2D Main Road). For the operational phase, water quality treatment would be provided through vegetated swales with rock check dams. Permanent water quality ponds would not be necessary.

5.1.1 Construction

Techniques to reduce potential water quality impacts and prevent degradation of downstream waterways include the use of temporary sedimentation basins, onsite and offsite diversion drains, sediment fences and erosion controls at the source. The design criteria for the construction phase water quality sedimentation basins are defined in the Blue Book (Soils and Construction, 2008 Volume 2D Main Road Construction) which requires that temporary sediment basins be designed for the 85th percentile, five day rainfall depth for basins located near sensitive receiving environments, and for the 80th percentile for non-sensitive receiving environments.

In addition, consideration needs to be given to the following relevant documents in the design of temporary sediment basins:

1) Managing Urban Stormwater: Soils and Construction, Volume 2D Main Road Construction (DECC, 2008);
2) Managing Urban Stormwater – Soils and Construction, Volume 1 4th Edition, March 2004; and
3) Roads and Maritime General Specifications G36 and G38.

The temporary sediment basins would need to provide sufficient volume for settling and storage of sediments. The settling zone volume would be estimated using the appropriate design rainfall depth and catchment areas. The storage zone is estimated using the Revised Universal Soil Loss Equation (RUSLE).

The temporary sediment basins for the proposal would be designed as Type D or F, as per the Blue Book classifications and the assumed soil parameters. Some localised pockets of Type C soils exist; however these are small and isolated, therefore Type D soils have been adopted for the design.

The three key design elements used in the individual sizing of each temporary sediment basin are:

1) Catchment areas contributing to the sediment basins (disturbed and undisturbed areas)
2) The percentage of the total contributing catchment area that is either “cut” or “fill” (and hence which would generate greater soil losses). These are batters/embankment areas that would generally be in the order of less than 25 per cent of the total catchment area for this proposal
3) Whether the basin is located in a “sensitive” environment, thus requiring the 85th percentile, five day rainfall depth design criteria.

Other design input parameters include soil type, rainfall erosivity (which is a function of local rainfall intensity), soil hydrologic group, volumetric runoff coefficients and soil erodibility. From these key elements and the Blue Book design methodology, the temporary sediment basin volumes have been derived.

Assessments of the construction phase catchments and the selected temporary sediment basin locations have been carried out to confirm all (temporary) sediment basin locations. The locations of sediment basins have been selected to provide the maximum runoff capture from catchments throughout the construction process using gravity driven diversion drains to divert runoff to the basins. The required volume of each temporary sediment basin has been determined according to an estimate of the maximum disturbed catchment area that drains to the basin during various stages of the construction.

After the ideal temporary sediment basin locations were identified, basins were modelled in 12D to ensure the space requirements for the construction phase sediment basins was adequate, to determine or confirm that they could be built within the boundary requirements.

Temporary sediment basin design

The site topography and the number of cross drainage culverts is such that a large number of temporary basins would be required to treat every section of the construction area throughout all stages of the work. In order to minimise the number of temporary sediment basins, and the impact of the construction of these basins on the local natural environment, the Blue Book criteria of 'Minimum 150m^3' of annual sediment loss has been adopted. This criteria indicates that if the estimated annual soil losses from a disturbed catchment is less than 150m^3, then a sediment basin may not be required subject to other erosion and sediment controls being implemented as described in the following two Blue Book extracts:

- "...the average annual soil loss from the total area of land disturbance can be estimated (Appendix A). Where this is less than 150 cubic metres per year, the building of a sediment retention basin can be considered unnecessary. In such circumstances, alternate measures may be employed to protect the receiving waters" (Blue Book Section 6.3.2, Clause (d))
- "Sediment basin(s) must be constructed where the calculated total annual soil loss from the disturbed lands is more than 150 cubic metres. Where the calculated basin size is less than 150 cubic metres, other erosion and sediment control devices can be installed instead" (Blue Book, Appendix M, Clause (54)).

It was estimated that a contributing disturbed area exceeding 1.0 hectare on this site would generate 150 m^3 of annual soil loss. Therefore for catchments less than about 1.0 hectare, a temporary sediment basin has not been proposed. This is about the equivalent of a surface area of 50 metres wide and 200 metres long. If 50 metres is assumed to be an average width of disturbance, then lengths of about 200 metres or less would not require a temporary sediment basin. These dimensions represent an approximation only as catchments widths and shapes vary.

The required volume of each temporary sediment basin with a catchment area larger than 1.0 hectare was determined according to the maximum catchment area that would drain to the basin during the various stages of the construction and the design parameters identified in Section 2.4 of this report. At locations where temporary sediment basins cannot be provided, the Erosion and Sediment Control Plan should include additional controls and small sediment traps (typically less than 5 m^3 each) where possible.

The proposed locations and sizes of 12 temporary sedimentation basins for the construction phase of the proposal are presented in **Table 5-1**.

Sediment basins that would be required for the site compound areas for sites that exceed a 1 ha surface area of disturbed soils will need to be identified by the contractor once the details of the site compound layouts and areas is available.

The design and the location of the road would have a significant effect on the size and location of the temporary basins. Changes to the road design in the future may result in changes to basin locations or addition of new basins, resulting in an adjustment of the construction boundary identified for the proposed basins.

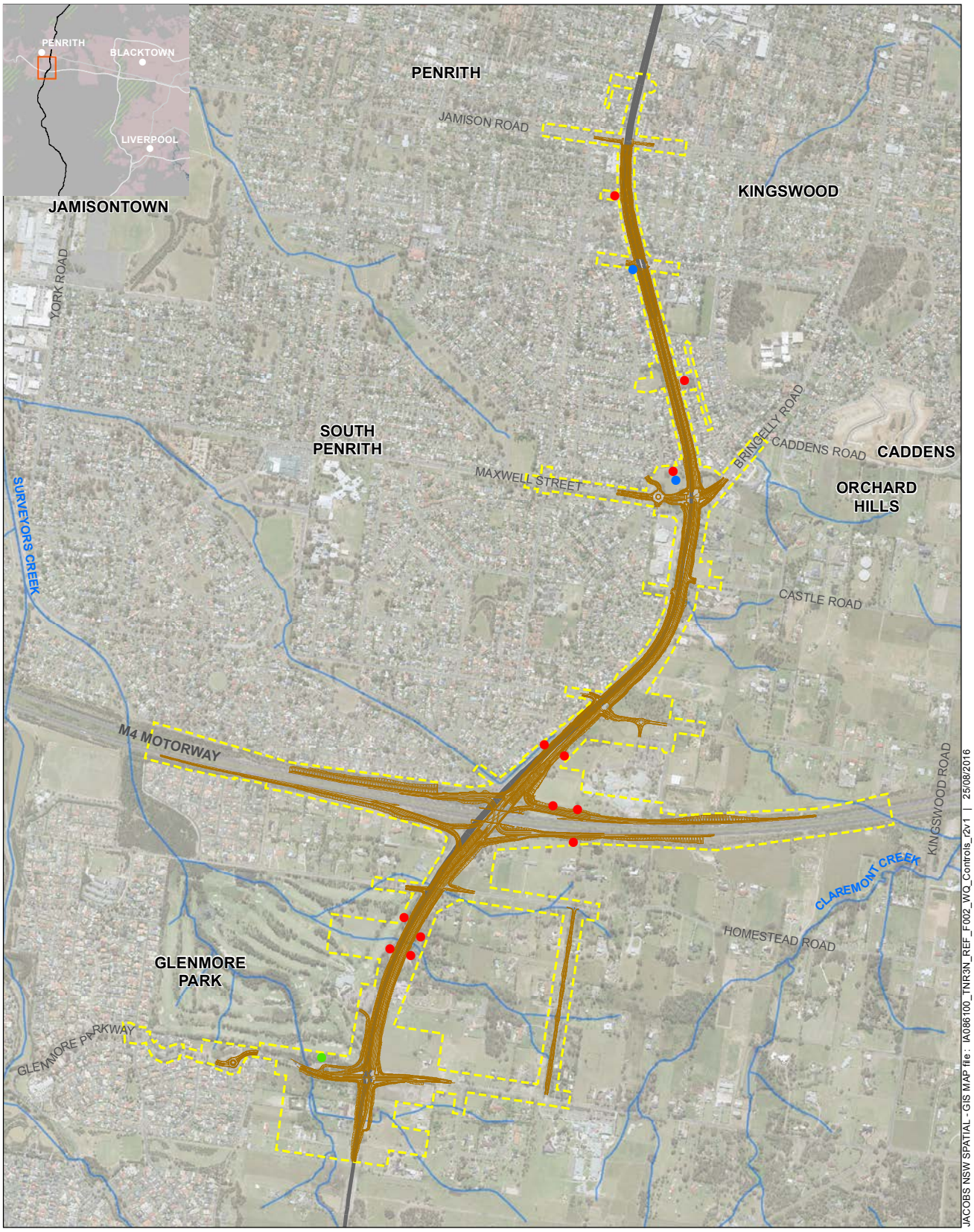
The indicative temporary sediment basin locations are shown on **Figure 5-1**. Temporary fencing should be required around all sediment basins for public safety.

Table 5-1 : Temporary sediment basins for the concept design of The Northern Road upgrade

*Basin name**	*Min basin volume required (m3)*	*Receiving Creek*	*Sensitive Y/N?*	*Comment*
B680L	403	Surveyors Creek	Y	
B680R	323	Surveyors Creek	Y	

Basin name*	Min basin volume required (m3)	Receiving Creek	Sensitive Y/N?	Comment
B720L	507	Surveyors Creek	Y	
B720R	641	Surveyors Creek	Y	
B1280R	323	Surveyors Creek	N	There is an existing basin at the proposed location, which can be used during the construction phase.
B1400R	311	Surveyors Creek	N	
B1440R	305	Surveyors Creek	N	
B1540L	461	Surveyors Creek	N	
B1540R	368	Surveyors Creek	N	
B2700L	830	Peach Tree Creek	N	
B3060R	731	Werrington Creek	N	
B3740L	275	Peach Tree Creek	N	

* B3740L denotes that the sediment basin is at approx. Chainage 3740 (Based upon tender design), and L indicates that it is on the Left hand side, looking at increasing chainages.



Legend

- The Northern Road Upgrade between Glenmore Parkway and Jamison Road
- The Northern Road (Existing)
- Study area
- Temporary sediment basin
- Gross pollutant traps
- Biofilteration basin

0 0.5 1 km

N

Figure 5-1 | Water quality controls

5.1.2 Operation

This section of the report focuses on the proposed water quality controls for the operational phase of the proposal. It provides a description of the proposed permanent water quality control measures.

An assessment of the drainage design indicated that a water quality treatment control would be required upstream of the sensitive receiving waterway that has been identified by the aquatic ecologist. It is proposed to provide a biofiltration basin at the location shown on Figure 5-1. This basin would treat road pavement runoff before it discharges into the Golf course area and before entering the tributary of Surveyor's Creek at Glenmore Parkway.

Two additional Gross Pollutant Traps (GPTs) have been recommended upstream of the proposed detention basins as shown on Figure 5-1. These GPTs have been recommended by Roads and Maritime following a request from Penrith City Council at a coordination meeting with Council on 30 November 2015.

Spill basins are normally provided at locations where two key factors are identified. The first factor is the risk of accidents occurring due to the road horizontal and vertical geometry, and the second factor is the existence of a sensitive receiving waterway as identified by an aquatic ecology assessment. When both factors occur at any one location along the road upgrade, a spill basin would be required.

One sensitive waterway has been identified along the road upgrade which meets one of the two conditions for providing spill basins; however the improved horizontal and vertical geometry of the upgrade and the improved layout of the road has reduced the risk of accidental spills along the upgraded road. It has therefore been decided that spill basins would not be required.

5.2 Groundwater controls

It is not expected that specific controls for groundwater will be required. This is primarily due to the low to very low permeability of Wianamatta Shale, and expected low or negligible groundwater drawdown and seepage rates through identified road cuttings.

5.3 Soils controls

As noted in **Section 3.2.4**, the majority of the investigation area occurs in areas of moderate salinity potential with isolated areas of high salinity potential. Soil salinity testing will be required prior to commencement of construction in order to assess potential risks to sub-surface structures for the proposal, appropriate vegetation selection for vegetated areas and appropriate re-use of excavated soil.

The qualitative contamination risk assessment presented in Section 4.3 identified four AEIs with a moderate risk for health impact to construction workers. These AEIs also present a risk for soil contamination that may affect the classification of any waste soil to be disposed during the construction phase. Further contamination investigation is therefore recommended for these AEIs prior to the commencement of construction.

The proposed safeguards and management measures are set out in **Table 5-5** below.

5.4 Safeguards and management

Safeguards and management measures will be implemented to minimise and manage the impacts of the proposal on surface water, groundwater and soils throughout construction and operation. These measures are presented in **Table 5-5**.

Table 5-5: Safeguards and management measures

Impact	*Environmental safeguards*	*Responsibility*	*Timing*
General Construction Impacts	A soil and water management plan (SWMP) would be developed in accordance with the Roads and Maritime specification G38 – Soil and Water Management and the Blue Book – Soils and Construction – Managing Urban Stormwater Volume 1 (Landcom 2004) and Volume 2D (DEC 2008a). The SWMP would include but not be limited to: • An erosion and sedimentation control plan and maintenance schedule for ongoing maintenance of temporary erosion and sediment controls. • A sediment basin management plan to guide appropriate management of runoff during construction and operation. • An incident emergency spill plan which will include measures to avoid spillages of fuels, chemicals and fluids onto any surfaces or into any nearby waterways.	Project Manager and Contractor	Pre-construction and construction
Sedimentation and Erosion	• Erosion and sediment controls would be implemented before any construction starts. • Sediment basins will be regularly serviced and maintained to comply with water quality and capacity requirements. • Clearing of vegetation and site stabilisation of disturbed areas would be progressively carried out to limit the time disturbed areas are exposed to erosion processes. • High risk soil and erosion activities such as earthworks will not be carried out immediately before or during high rainfall or wind events. • Stockpiling of topsoil separately for potential reuse in landscaping and rehabilitation work. • Permanent catch drains will be installed behind cut faces to act as diversion drains during the construction phase. • Erosion and sediment control measures will be maintained until the work are complete and areas are stabilised by revegetation.	Project Manager and Contractor	Pre-construction and construction
Impacts to water pollution (surface water and groundwater)	• All fuels, chemicals, and liquids would be stored at least 50 metres away from the existing stormwater drainage system and would be stored in an impervious bunded area within the compound site. • The refuelling of plant and maintenance machinery would be carried out in impervious bunded areas in the designated compound area. • Vehicle wash downs and/or concrete truck washouts would be carried out within a designated bunded area of an impervious surface or carried out off-site.	Project Manager and Contractor	Pre-construction and construction

Impact	Environmental safeguards	Responsibility	Timing
Potential impacts associated with saline soils	Salinity testing of soil within the proposed construction work footprint.	Construction contractor	Pre-construction
Potential exposure of construction workers to existing contamination associated with the identified Areas of Environmental Interest	Sampling and analysis of soil within the proposed construction work footprint that is within or adjacent to the respective AEIs, to the maximum depth of excavation planned within these areas.	Construction contractor	Pre-construction
Potential impacts associated with inappropriate disposal of waste soil	Any spoil material generated during construction work must be assessed and disposed in accordance with the requirements (where applicable) of the NSW EPA (2014) *Waste Classification Guidelines* and the *Protection of the Environment Operations (Waste) Regulations 2014.* Potential contaminants associated with the identified Areas of Environmental Interest should be considered in classifying spoil excavated from these areas.	Construction contractor	Construction
Potential exposure of contamination to site workers, public and environmental receptors	If potentially contaminated materials are suspected and/or encountered during construction activities, these should be managed by an unexpected finds protocol incorporated in the construction environmental management plan	Construction contractor	Construction

References

Australian Soil Resource Information System (CSIRO) Acid Sulphate Soils (ASS) Map.

ANZECC/ARMCANZ (2000) *National Water Quality Management Strategy Australian and New Zealand Guidelines for Fresh and Marine Water Quality*. Australian and New Zealand Environment and Conservation Council, Agriculture and Resource Management Council of Australia and New Zealand.

Clark N.R. and Jones D.C., 1991, Penrith 1:100 000 Geological Sheet 9030, 1st edition. Geological Survey of New South Wales, Sydney.

Department of Infrastructure, Planning and Natural Resources, (2002). *Salinity Potential in Western Sydney.*

Department of Primary Industries 2013, *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (2013 upate)*, Department of Primary Industries

Fairfull, S. and Witheridge, G. (2003) Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings. NSW Fisheries, Cronulla, 16 pp.

HRC (1998) *Independent inquiry into the Hawkesbury Nepean River System*. Healthy Rivers Commission of New South Wales, August 1998.

Transport for NSW (2014) *Power Supply Upgrade Penrith Feeder Project Review of Environmental Factors*. June 2014

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.

Soil Conservation Service of NSW (1990). 1:100 000 Penrith Soil Landscape sheet.