



## Chapter 8.0 - Topography, Geology and Soils

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## 8.0 Topography, Geology and Soils

### 8.1 Overview

This chapter aims to identify existing environmental conditions, potential impacts from the construction and operation of the KBP along the preferred alignment and to recommend suitable mitigation measures where warranted.

### 8.2 Approach and Methodology

The impact assessment for topography, geology, soils (including contaminated land) has been undertaken as a desktop study of available information. The approach and methodology included:

- Review of published geological maps and memoirs, to establish the geological setting of the scheme;
- Collation and review of relevant geotechnical data from previous studies of the area;
- Review of current land uses within the study area for potential contaminating activities;
- Search of registered service station location databases;
- Review of the Department of Defence (DoD) Unexploded Ordnance (UXO) mapping;
- Review of the EPA Environmental Management Register (EMR) and Contaminated Land Register (CLR); and
- Inputs from geotechnical work undertaken as part of this design options phase of the project (AECOM, 2009).

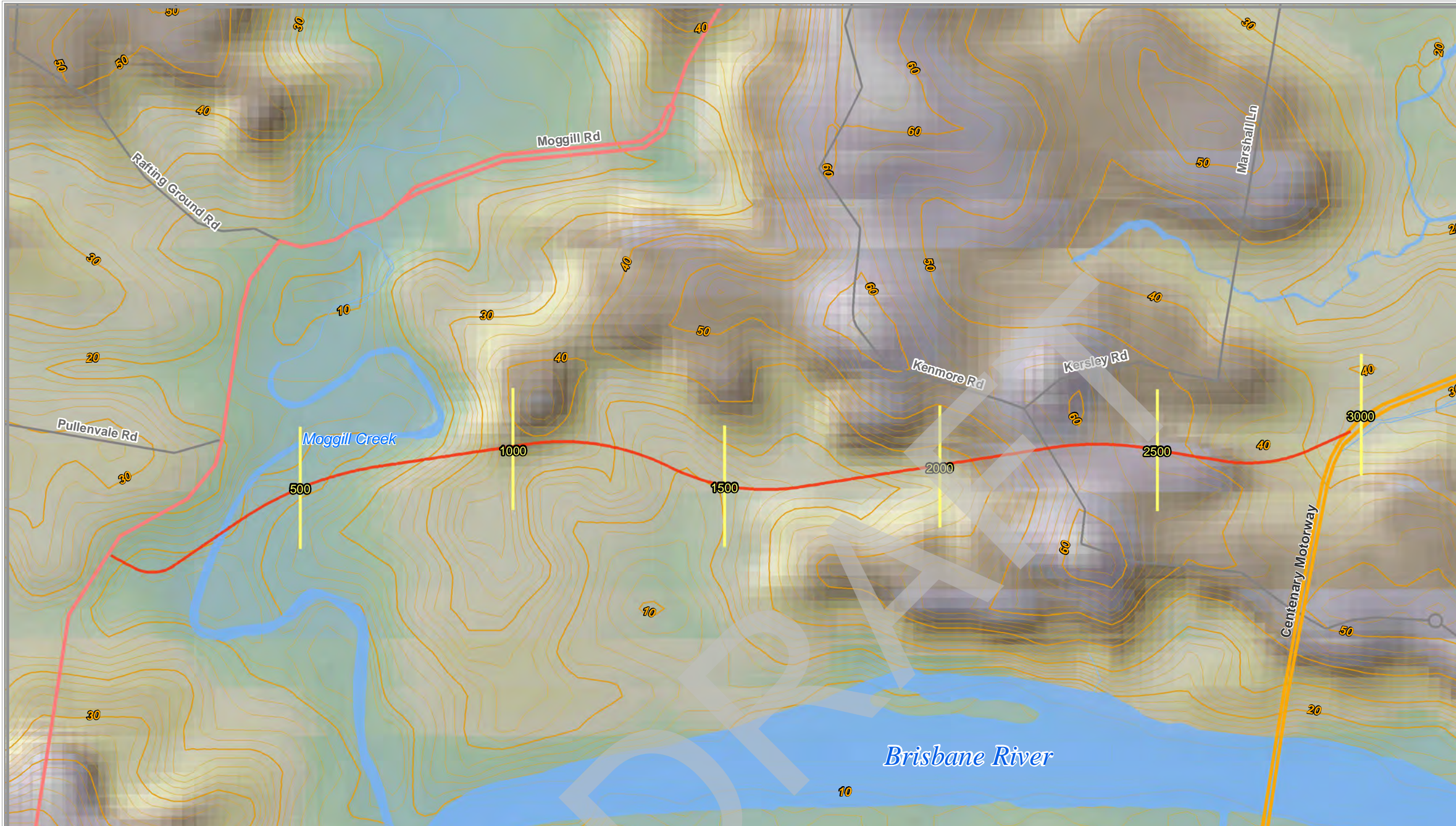
### 8.3 Existing Environment

#### 8.3.1 Topography

Topography within the study area exhibits a combination of gentle to moderate slopes contributing to a rolling to hilly terrain. Topographic highs along the proposed alignment are marked by Plumeria Close (58 metres) and Summerfield Place (38 metres), whilst Moggill Creek (10 metres), Cubberla Creek (16 metres) and Sunset Road (18 metres) represent the lowest points of the three notable valleys along the corridor.

The close proximity of such topographical variance to the Brisbane River is not unusual, with the study area focussed on the outside of a meander, where fluvial erosion processes dominate.

A map showing topographical features within the study area and showing the approximate profile of the alignment is illustrated in Figure 8.1.



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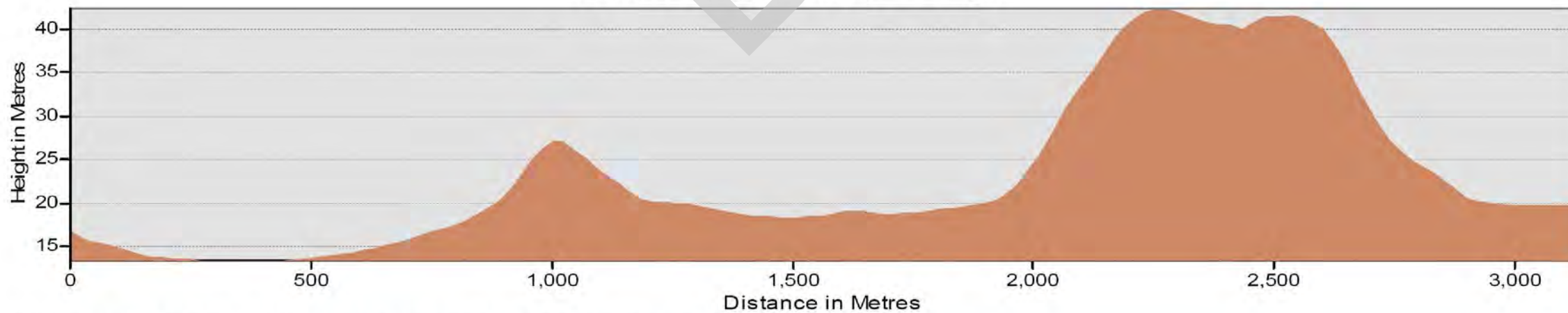
Date - 13 May 2009



**Legend**

- Centenary Motorway
- Kenmore Bypass
- Moggill Road
- River/creek
- Distance References
- Contour 2m Intervals

**Kenmore Bypass Profile Graph**



Data sources:  
Roads, railway, rivers etc - Copyright 2006, MapData Sciences PTY LTD, PSMA  
DEM and Contour data derived from NASA Satellite Radar Topography Mission (SRTM) Version 2 data (c) NASA  
This spatial information has been derived from the NASA Satellite Radar Topography Mission (SRTM) digital elevation model (DEM) data, obtained from the NASA Space Shuttle missions. This data belongs to NASA, and is free on the web.  
The data in Australia is based on a 25 metre grid network, and contours may be generated from this XYZ data at a realistic useable minimum of 2 metre contour interval.  
All data are referenced to the WGS84 in latitude and longitude, the heights are referenced to the Earth Gravity Model 96 (EGM96), which is the most common global gravity model. Therefore, please note that the vertical datum for this data IS NOT AHD, and therefore will not necessarily match up with other local surveys or council data.  
Because the DEM grid is 25m and therefore fairly coarse, please use it with extreme care, and any data or maps should carry warnings as to the data's datum, source and (in)accuracy. The data should never be used for any building, civil, or engineering design work, and should only be used for broad planning studies.

**KENMORE BYPASS TOPOGRAPHY, GEOLOGY & SOILS**

**Topology**

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## 8.3.2 Geology

### General

Review of the DNRW SEQ Region Geoscience data set (2002) indicates that the study area consists primarily of the Neranleigh-Fernvale Beds (NFB) as shown in Figure 8.2. This unit has been formed, for the most part, from medium to fine-grained sediments (now greywacke and argillite) deposited in sub-marine fans, but also includes some patches of chert (now mostly quartzite) and bands of basalt (now greenstone).

In stratigraphic sequence, the NFB are underlain by the Bunya Phyllite and Rocksberg Greenstone, all three of which are grouped together as the Brisbane Metamorphics (Bryan & Jones 1951).

### Neranleigh-Fernvale Beds

The oldest bedrock of the Brisbane area is the NFB formation of Devonian to Carboniferous age (420-350 million years old). This formation underlies an extensive area in Brisbane, the south of Redland City Local Government Area and in the hinterland of the Gold Coast. In Brisbane it outcrops to the west of the Bunya Phyllite in a broad band north of the Brisbane River from Mt Crosby through to Kenmore and extends north-west forming the D'Aguilar Range. It also outcrops in another band from Enoggera to Chermside and extends through the City to Mt.Gravatt, then south into Logan Shire (SKM-CW JV 2007).

This formation consists of metamorphosed sediments, sandstones and shales (Table 8.1). The sediments have lost their intrinsic porosity, but as much of the rock is siliceous, fractures are not as in-filled with clay as in the Bunya Phyllite or Rocksburg Greenstone. Fractures occur at depths down to >60 metres, mostly close to drainage lines, but quite often they appear unrelated to topographic features. The fractures are unpredictable, and many dry bores have been drilled into the hard rock of this formation.

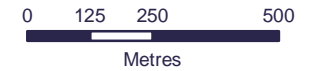
Table 8.1: Component rock types of the Neranleigh-Fernvale Beds

Principle Rock Types	Characteristics
Argillite	Closely fractured in many exposures. Gives shallow pale soils.
Greywacke	Forms thick bands with few traces of individual beds and, where exposed, has a blocky appearance. Gives shallow, pale, rocky soils. Important source of crushed rock aggregate for construction use.
Quartzite	Closely fractured. Gives a reddish soil. Worked in quarries for road gravel.
Jasper	Red variety of chert with iron oxide impurities. Occurs mainly NW of Ipswich. Less recrystallised than other cherts/quartzites. Generally banded.
Greenstone	Gives rise to chocolate soils when weathered. Can be used for aggregate when fresh.

(Willmott & Stevens 1992)

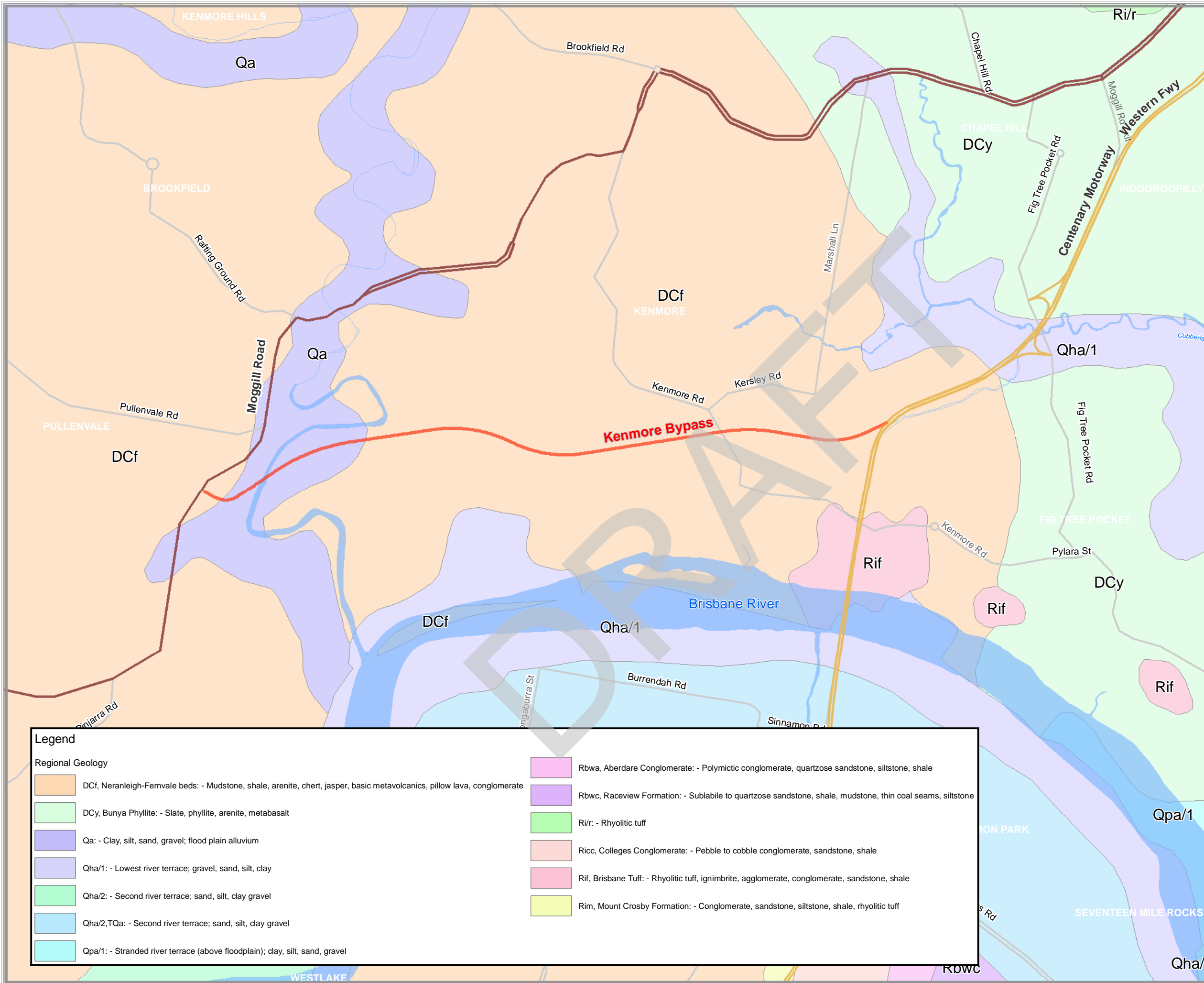
### Tertiary-Quaternary Alluvium

Alluvial deposits along the alignment are associated with Moggill Creek at the western end of the corridor. The alluvium consists of a combination of gravel, sand, clay and silt.



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**Legend**

- Centenary Motorway
- Kenmore Bypass
- Moggill Road
- River/creek

**Legend**

**Regional Geology**

- |   |   |
|---|---|
| <ul style="list-style-type: none"> <li> DCf, Neranleigh-Fernvale beds: - Mudstone, shale, arenite, chert, jasper, basic metavolcanics, pillow lava, conglomerate</li> <li> DCy, Bunya Phyllite: - Slate, phyllite, arenite, metabasalt</li> <li> Qa: - Clay, silt, sand, gravel; flood plain alluvium</li> <li> Qha/1: - Lowest river terrace; gravel, sand, silt, clay</li> <li> Qha/2: - Second river terrace; sand, silt, clay gravel</li> <li> Qha/2,TQa: - Second river terrace; sand, silt, clay gravel</li> <li> Qpa/1: - Stranded river terrace (above floodplain); clay, silt, sand, gravel</li> </ul> | <ul style="list-style-type: none"> <li> Rbwa, Aberdare Conglomerate: - Polymictic conglomerate, quartzose sandstone, siltstone, shale</li> <li> Rbwc, Raceview Formation: - Sublabile to quartzose sandstone, shale, mudstone, thin coal seams, siltstone</li> <li> Ri/r: - Rhyolitic tuff</li> <li> Ricc, Colleges Conglomerate: - Pebble to cobble conglomerate, sandstone, shale</li> <li> Rif, Brisbane Tuff: - Rhyolitic tuff, ignimbrite, agglomerate, conglomerate, sandstone, shale</li> <li> Rim, Mount Crosby Formation: - Conglomerate, sandstone, siltstone, shale, rhyolitic tuff</li> </ul> |
|---|---|

Data sources:  
Roads, railway, rivers etc - Copyright 2006, MapData Sciences  
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Aerial Imagery:  
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Air Quality Information provided by ENSR Australia,  
Brisbane for the Kenmore Bypass Environmental Study.

**KENMORE BYPASS  
TOPOGRAPHY, GEOLOGY &  
SOILS**

**Geology**

Figure 8.2

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## 8.3.3 Soils

### General

A desktop soils assessment was undertaken with a review of the Project Environmental Assessment (PEA) (GHD 2007), in reference to the Australian Soils Classification, the Soil Landscapes of Brisbane and South-eastern Environs (Beckman 1987) and the CSIRO Digital Atlas of Australian Soils. Soil units within the study area have been mapped and are provided as Figure 8.3.

The Digital Atlas of Australian Soils identifies soils within the study area as being typical of rolling to hilly terrain with gentle to moderate slopes. Chief soils are hard acidic yellow and red mottled soils. Associated soils are hard alkaline yellow and red mottled soils; sandy acidic yellow mottled soils and leached sands, all containing large amounts of nodular ironstone material, also with mottled clays, at depth.

Beckman (1987) identifies specific soil orders within the study area. Tenosols, with generally only weak pedological organisation apart from the A horizons, dominate the majority of the proposed alignment. Dermosols, with structured B2 horizons and lacking strong texture contrast between A and B horizons, are recognised as being closely associated with Moggill Creek.

### Acid Sulfate Soils

Acid Sulfate Soils (ASS) commonly occur on coastal wetlands (<5 metres AHD) as layers of Holocene marine muds and sands deposited in protected low-energy environments such as barrier estuaries and coastal lakes. ASS are formed when seawater or sulfate-rich water mixes with land sediments containing iron oxides and organic matter in a waterlogged situation.

As shown in Figure 8.4, DNRW ASS mapping indicates that soils associated with Moggill Creek and the resultant Quaternary alluvial deposits, at the western end of the proposed alignment, are known to contain at least one horizon of potential acid sulfate soils (PASS). Such deposits are mapped as land where ASS occurs within 5 metres of the surface. Virtually all land in this category has at least one PASS soil horizon and some of this land will have an ASS layer.

ASS are soils which have been at least partially oxidised and therefore comprise of soluble and exchangeable acidity, readily available for reaction. In contrast, PASS are non-oxidised in situ (and therefore non-acidic), soils with significant amounts of oxidisable iron sulfides present.

The 1:100 000 DNRW 2003 *Special Acid Sulfate Soils Map* of Tweed Heads to Redcliffe shown as an overlay in Figure 8.4, shows the terrain adjacent to the Moggill Creek (at TP1 & BH101) to be land where ASS is likely to occur within 5 metres of the surface (denoted as S on the map).

As part of the Geotechnical assessment of the corridor an analysis for ASS was undertaken at a borehole on the Moggill Creek Floodplain (BH 101). ASS were not found; however, PASS were confirmed from a depth of around 2.4 – 7 meters. This reinforces the need to undertake further assessment for PASS for any excavations on the floodplain, and the necessity to be prepared for treatment and stabilisation of spoil.

## 8.3.4 Contaminated Land

The *Environmental Protection Act 1994 (EP Act)* identifies Lots based on the risk of contamination to exist. The EMR lists Lots which have been used for a notifiable activity (Schedule 3 of the *EP Act*) and/or land that has been identified to contain a degree of contamination through a preliminary site investigation as detailed in Appendix 5, *Draft Guidelines for the Assessment and Management of Contaminated Land in Queensland* (Draft Guidelines). As such, land listed on the EMR is considered to pose a low risk to human health or the environment under the current land use.

Land is recorded on the CLR when the extent of contamination following site investigation is deemed by the EPA to require remediation or management. Remedial action is required to reduce risk to human health and the environment, thereby preventing potential harm.

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Digital Cadastral Database (DCDB) mapping of the study area was overlain with current concept design plans to provide a focus area for the review. All Lots situated wholly or partially within the corridor were identified and marked for search on the EPA's EMR/CLR databases. Two hundred and fifty nine (259) Lots were identified in this manner. Of the Lots identified, two hundred and fifty four (254) had previously been searched on the EMR/CLR database as part of the PEA. None of the search Lots were found to be listed on the EMR or CLR.

Five (5) additional Lots, contained within the corridor but omitted from the PEA, were searched on the EMR/CLR database maintained by the EPA for public access.

None of the five additional Lots searched on the EMR/CLR database were listed. Certificates of these database searches are provided in Appendix 8-A. A summary of these searches is included in Table 8.2.

**Table 8.2: Summary of EMR/CLR Database Search**

Lot	Plan	On EMR/CLR?	Likely Land Use*
2	RP180004	No	Residential
2	RP223382	No	Light Industry
1	RP202557	No	Equestrian School
24	RP76432	No	Small residence at the front of the Lot, but largely undeveloped with a cover of mature vegetation
1	RP105922	No	Thin strip of undeveloped land between this property and the Centenary Motorway.

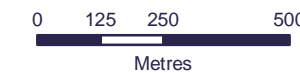
\* Land uses have been determined from a review of 2008 aerial photography.

An aerial photography assessment of these newly searched Lots was conducted to identify possible land uses and to assess the likelihood of on-site contamination despite not being registered on either the EMR or CLR.

Only one of the Lots, Lot 2 RP223382, appeared to have a use consistent with a potentially contaminating activity. The apparent use of this Lot for light industrial purposes may be a source of generation for on-site contamination. However, current on-site structures, a likely source of contamination, appear to be well removed from the scheduled extent of any disruption to this site during the construction phase of the project. Despite this, a preliminary investigation is suggested into the existing and historical use of this site, any chemicals that may be stored or used on-site, as well as any previously recorded contaminating events. This preliminary investigation will further clarify the contamination potential of the area of Lot 2 RP223382 due to be disturbed during construction.

Further investigation should be conducted prior to the commencement of any construction works on the property.





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**Legend**

- Centenary Motorway
- Kenmore Bypass
- Moggill Road
- River/creek

**Acid Sulphate Soil**

- S:** Land where ASS occurs within 5m of the surface. Virtually all land in this category has at least one potential ASS soil layer and some of this land will have an actual acid sulphate layer.
- SLA:** Limited field assessment but occurs in a landscape position where there is a reasonable probability of ASS occurrence. This is usually land where the present use precludes any disturbance e.g. National Parks, Reserves etc., or land where accessibility is severely restricted.
- LP:** Land between the 5m Australian Height Datum (AHD) contour and the outer limit of Holocene, estuarine ASS (land <5m AHD) as mapped at this scale, with low probability of ASS occurrence. Limited field investigation.

**Soils Atlas**

- TB64:** Rolling to hilly terrain with gentle to moderate slopes: chief soils are hard acidic yellow (Dy3.41) and red (Dr3.41) mottled soils. Associated are hard alkaline yellow (Dy3.43) and red (Dr3.43) mottled soils; sandy acidic yellow mottled soils (Dy5.41), (Dy5.31), and (Dy5.81) and leached sands (Uc2.2), all containing large amounts of nodular ironstone material, also with mottled clays, at depth, below the (Uc2) soils. As mapped, small areas of adjoining units are included

Data sources:  
Roads, railway, rivers etc - Copyright 2006, MapData Sciences PTY LTD, PSMIA

Aerial Imagery:  
Copyright Qasco Surveys Pty Limited (2005).

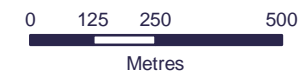
Air Quality Information provided by ENSR Australia, Brisbane for the Kenmore Bypass Environmental Study.

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**Soils**



Figure 8.3



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**Legend**

- Centenary Motorway
- Kenmore Bypass
- Moggill Road
- River/creek

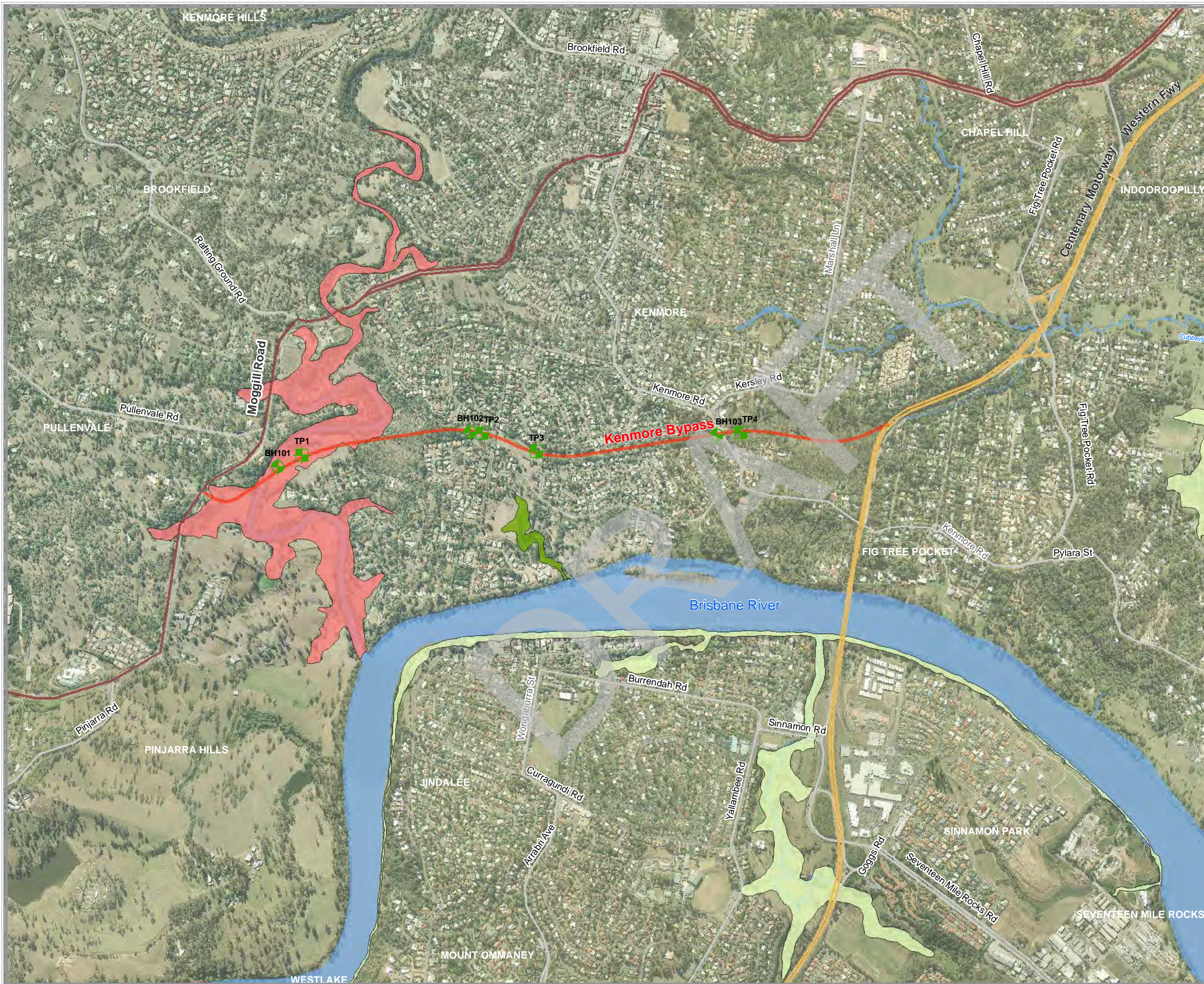
**Acid Sulphate Soils**

- S
- SLA
- LP
- Boreholes
- Test Pits

Data sources:  
Roads, railway, rivers etc - Copyright 2006, MapData Sciences PTY LTD, PSMA

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Air Quality Information provided by ENSR Australia, Brisbane for the Kenmore Bypass Environmental Study.



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Indicative Acid Sulphate Soils

Figure 8.4

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## Operational Service Station Search

A search was conducted of online service station location databases for all known operational service stations within the corridor. The purpose of the search was to locate any service stations within the corridor that were not identified from aerial photography. No operational service stations are situated within the corridor.

## Unexploded Ordnance Mapping

A review of DoD UXO mapping shows that the proposed alignment does not traverse any lots of known UXO potential.

## 8.4 Potential Impacts and Mitigation Measures

### 8.4.1 Potential Impacts

#### 8.4.1.1 Construction

The hazards posed to or by topography, geology and soils are primarily during the construction phase of the project, as this is when the frequency and total number of hazards is highest.

Potential construction phase impacts identified here are based upon construction activities commonly undertaken on road construction projects of a similar nature.

#### Acid Sulfate Soils

If ASS or PASS are disturbed by excavation during works, then acid and metal-rich runoff can be generated from stockpiles or from in situ disturbed ASS.

Filling activities over ASS can also have impacts via:

- short-medium term raising of groundwater levels and contact with ASS horizons;
- shear failure causing extrusion of ASS; and
- extrusion of acidic groundwater during pre-loading with wick drains.

Soils overlying the Quaternary alluvial deposits associated with Moggill Creek have been identified as having at least one PASS layer, with some of this land also expected to exhibit an actual ASS layer.

Site works in this area may involve excavations for piled foundations, culverts and filling.

#### Contaminated Land

Contaminated land is not likely to impact on this project. However, if any suspected or known contaminated land is discovered during any phase of the project, then further assessment by personnel qualified in contaminated land management will be required.

#### Erosion and Sediment Control

Table 8.3 shows the general erosion hazard of the alignment soils. However, site disturbances during construction have a high risk of causing erosion if not mitigated.

Table 8.3: Erosion Hazard and Drainage Characteristics of Soils within the Study Area

Order	Erosion Hazard	Drainage
Tenosols	Susceptible to wind erosion on bare surface soils.	Highly permeable and well drained.
Dermosols	Susceptible to surface slaking upon rapid wetting, resulting in hard setting if organic matter content is low.	Relatively well drained due to well developed soil structure.

(Australian Agricultural Assessment, 2001)

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## Earthquake

The earthquake hazard in SEQ is low, with relatively minor historical seismicity and its correspondingly minor impact on human activity. However, the short historical record and the consequences of a rare, damaging earthquake need to be considered.

## Slope Stability

A search of the Geoscience Australia's Australian Landslide Database has indicated that no landslides or other significant slope instability events have occurred along the proposed alignment within the last 50 years. Landslide events included in this database have been sourced from reportings by local media and members of the public. Hence, not all landslip events are included in the database and gaps in information are prevalent. As such, consideration must also be given to the local environment to determine the likelihood of future landslide or other slope instability events.

Steep to moderate slopes on unconsolidated Tertiary sediments are susceptible to landslides when cleared of original vegetation or where drainage patterns have been disrupted. The risk of potential slope instability is expected to be increased where loose hillside debris has accumulated around gully heads or concave slopes. In such environments, footings may be required to extend down into the underlying bedrock.

Red and brown soils on bands of greenstone and quartzite, within the NFB or Bunya Phyllite, are susceptible to slope instability due to significant soil depth. As a result, an investigation into soil stability will be necessary where foundations are required on steep sloping areas of these geological formations.

Corridor width constraints dictate that only to the east of Kenmore Road will there be sufficient land available to batter back deeper cuts. Over this section of the corridor, the undulating terrain and sidelong sloping ground will require cuts up to around seven (7) metres deep. Although no ground investigation was possible over this section of the corridor, findings of the walkover survey suggest that residually weathered soils are likely to be present over weathered NFB. Unsupported cut slopes at 1:1 in rock, laid back at 1:2 in the overlying clay material should be achievable for the long term condition.

It is possible that these geometries may also be suitable for some of the shallower cut profiles along other sections of the corridor. Further investigation will be required to support this.

Cut slopes are not anticipated within the alluvium of the Moggil Creek floodplain, but shallow cuts may be required within the fill/alluvium that is present beneath Kingfisher Park. Unsupported 1V:3H batter slopes may be applicable in this instance.

The stability of cuts within the NFB will be controlled by joint strength and orientation. This will require assessment during the detailed site investigation stage. Cuts in rock exhibiting favourable jointing will remain stable at steeper angles, whereas adverse jointing will likely require positive support. Support and rock fall prevention measures could comprise:

- rock fall netting and rock trap fences;
- shotcrete and mesh (with or without dowels/nails); and
- spot dowels/anchors (tensioned or passive).

The erosion potential of soils should be investigated during future stages of investigation.

## Geotechnical Soil Issues

Issues that may influence the construction of the project include the competency of founding and sub-grade soils, shrink/swell clays, ease of excavation and soil aggressivity.

Argillite, greywacke and bands of greenstone within the NFB provide for good footings and can be excavated without much difficulty. However, detailed investigation of foliation direction, joint orientations and small fault zones will be required to identify possible planes of weakness which could lead to block or wedge failures into excavations.

Ignimbrite (Brisbane Tuff), near the eastern end of the KBP, is also expected to provide a good foundation for footings, although hardness is known to vary significantly. As such, the extent of excavation work into this formation, if deemed necessary at the northern bridging point of the Centenary Motorway, needs to be determined in consultation with outcomes of the geotechnical test pitting investigation.

The alignment is classified as having a low salinity hazard (DNRW 2006). Soils along the alignment are thus not expected to pose unusually high chloride aggressivity to structural foundations.

The preliminary Geotechnical Investigation completed by AECOM as part of this design options analysis stage has made a number of recommendations with respect to considerations for civil design, which are beyond the scope of this environmental assessment. Refer to the '*Kenmore Bypass Geotechnical Assessment Report*' (AECOM, 2009) for further information.

## 8.4.1.2 Operation

Hazards posed to or by topography, geology and soils during operation include:

### Erosion and sediment control

Poorly designed or maintained erosion and water quality structures can contribute to erosion.

### Slope stability

As per Section 8.4.1.1, slope instability can also pose a risk to the operation of a road.

### Contaminated land

Major spillages of fuel or chemicals caused by accidents can contaminate land adjacent to the road.

## 8.4.2 Mitigation Measures

A summary of the potential impacts and proposed mitigation measures can be found in Table 8.4.

### 8.4.2.1 Design

Potential impacts on or by topography, geology and soil could be mitigated through design by:

- Undertaking a geotechnical investigation of the alignment prior to design (including ASS assessment);
- Avoiding disturbance of ASS;
- Where disturbance of ASS cannot be avoided, develop an ASS management plan as per the *Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines v 3.8* and the *State Planning Policy 2.02 Planning and Managing Development involving Acid Sulfate Soils* (SPP 2.02).

The following issues should be considered when formulating an ASS management plan:

- The sensitivity and environmental values of the receiving environment;
- The direct or indirect affect on local groundwaters and/or surface waters;
- The heterogeneity, geochemical and textural properties of soils on-site; and
- The management and planning strategies of both Queensland and local governments.
  - Ensuring the design of significant filling over ASS allows for the potential capture of porewater;
  - Ensuring that if alterations are made to the alignment then the new lots are assessed for contaminated land potential;
  - Consider *AS1170.4-1993 and AS 1170.4-2007: Structural design actions - Earthquake actions in Australia* for the road design;
  - Ensure erosion and sediment control measures as outlined in publications such as *Soil Erosion and Sediment Control, Engineering Guidelines for Queensland Construction Sites*, 1996. Engineers Australia. This includes:
    - Keeping land clearance to a minimum within the narrow corridor available;

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- Avoid wherever possible clearing areas of highly erodible soils and steep slopes which are prone to water and wind erosion; and
- Design the slope of a cut to minimise the angle of incline.

## 8.4.2.2 Construction

Most of the construction phase impacts, particularly impacts by topography, geology and soils, can be mitigated through design, as per Section 8.4.2.1. All other construction phase impacts can be mitigated by ensuring that site practices follow an Environmental Management Plan (Construction) (EMP (C)). With relevance to topography, geology and soils, the EMP (C) should address the following issues relevant to general road construction:

### Erosion and Sediment Control

- Develop and implement an Erosion and Sediment Control Plan (ESCP) for any surface works, embankments and excavation work, water crossings and stormwater pathways;
- Allow for regular review and updating of the ESCP on a temporal basis and in reflection of stages of progress during construction;
- Minimise disturbance and controlling run-off from construction areas;
- Revegetate and mulch progressively as each section of works is completed. The interval between clearing and revegetation should be kept to an absolute minimum;
- Coordinate work schedules, if more than one contractor is working on a site, so that there are no delays in construction activities resulting in disturbed land remaining destabilised;
- Program construction activities so that the area of exposed soil is minimised during times of the year when the potential for erosion is high, for example during summer when intense rainstorms are common;
- Stabilise the site and install and maintain erosion controls so that they remain effective during any pause in construction. This is particularly important if a project stops during the wetter months;
- Keep vehicles to well-defined haul roads, and keep haul roads off sloping terrain wherever practical;
- Installation of shake down grids at each site entry/exit point; and
- Cultivate the cut surface to increase infiltration of rainfall and decrease the velocity of water across the slope during rain and therefore reduce erosion.

### Acid Sulfate Soils

- Address ASS management and verification of any ASS management (e.g.: liming on treatment pads);

### Avoid Causing Land Contamination

- Ensuring good vehicle maintenance; and
- Appropriate design of storage, stockpiling and refuelling areas and temporary drainage systems.

The EMP (C) must acknowledge all identified sensitive receptors within the construction corridor and include a suitable Emergency Spill Containment Plan.

- Hazardous Materials - The nature, quantity and location of all hazardous material on site should be recorded in a manifest, which is to be maintained on site and updated regularly. Such materials should be stored in clearly designated areas as far as practicable from residences and water courses. Storage areas will consist of a compacted base and bunding to contain spillages and roofing to prevent contamination and infiltration of stormwater.

The Construction Contractor shall nominate a Site Safety Officer and provide an Emergency Response Plan, along with prescribed placarding, hazchem cards and fire extinguishers. Where onsite storage exceeds minor storage limits a permit shall be obtained from the appropriate authority for bulk storage of chemicals, oils and/or petroleum products.

Guidelines on the storage requirements and the adequacy of bunding around stores are provided in Australian Standards AS1940: *Storage and Handling of Flammable and Combustible Liquids*,

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and AS3780: *The Storage and Handling of Corrosive Substances*.

Residual stocks of hazardous materials will be removed from the construction site and returned to an appropriate storage area or disposed of at an appropriate waste facility at the end of construction.

- Fill Material - All fill material imported from offsite is to be procured from a licensed quarrying facility and accompanied by relevant documentation to verify it is contaminant and ASS free.

All onsite fill material is to be cleared for contamination prior to disturbance and stockpiled in separate, banded and lined treatment areas where it is to be analysed for contaminants and ASS prior to being reused onsite. All documentation related to fill shall be retained on file by the Construction Contractor.

### 8.4.2.3 Operation

Slope stability can be mitigated through design. Other soil mitigation measures for the road operational phase include:

- Response plans to deal with any spillages; and
- Maintenance of WSUD/anti-erosion infrastructure.

Table 8.4: Potential Impacts and Mitigation Measures

Reference Code	Project Phase	Potential Impact	Potential Mitigation Measures	
TGS 01	Construction	If ASS or PASS are disturbed by excavation during works, then acid and metal-rich runoff can be generated from stockpiles or from in situ disturbed ASS.	Undertake a geotechnical investigation of the alignment prior to design (including ASS assessment).	
TGS 02			Avoiding disturbance of ASS.	
TGS 03			Where disturbance of ASS cannot be avoided, develop an ASS management plan as per the <i>Queensland Acid Sulfate Soil Technical Manual, Soil Management Guidelines v 3.8</i> and the SPP 2.02.	
TGS 04			Address ASS management and verification of any ASS management (e.g.: liming on treatment pads).	
TGS 05		Suspected or known contaminated land is discovered during any phase of the project.	Further assessment by personnel qualified in contaminated land management will be required.	
TGS 06			Fill Material - All fill material imported from offsite is to be procured from a licensed quarrying facility and accompanied by relevant documentation to verify it is contaminant and ASS free.	
			All onsite fill material is to be cleared for contamination prior to disturbance and stockpiled in separate, bunded and lined treatment areas where it is to be analysed for contaminants and ASS prior to being reused onsite. All documentation related to fill shall be retained on file by the Construction Contractor.	
TGS 07			Construction works causing land contamination.	Ensure good vehicle maintenance.
TGS 08				Appropriate design of storage, stockpiling and refuelling areas and temporary drainage systems. Guidelines on the storage requirements and the adequacy of bunding around stores are provided in Australian Standards AS1940: <i>Storage and Handling of Flammable and Combustible Liquids</i> , and AS3780: <i>The Storage and Handling of Corrosive Substances</i> .
TGS 09	The EMP (C) must acknowledge all identified sensitive receptors within the construction corridor and include a suitable Emergency Spill Containment Plan.			



Reference Code	Project Phase	Potential Impact	Potential Mitigation Measures
TGS 10			Hazardous Materials - The nature, quantity and location of all hazardous material on site should be recorded in a manifest, which is to be maintained on site and updated regularly. Such materials should be stored in clearly designated areas as far as practicable from residences and water courses. Storage areas will consist of a compacted base and bunding to contain spillages and roofing to prevent contamination and infiltration of stormwater.
TGS 11			The Construction Contractor shall nominate a Site Safety Officer and provide an Emergency Response Plan, along with prescribed placarding, hazchem cards and fire extinguishers. Where onsite storage exceeds minor storage limits a permit shall be obtained from the appropriate authority for bulk storage of chemicals, oils and/or petroleum products.
TGS 12			Residual stocks of hazardous materials will be removed from the construction site and returned to an appropriate storage area or disposed of at an appropriate waste facility at the end of construction.
TGS 13		Site disturbances during construction have a high risk of causing erosion.	Develop and implement an ESCP for any surface works, embankments and excavation work, water crossings and stormwater pathways.
TGS 14			Allow for regular review and updating of the ESCP on a temporal basis and in reflection of stages of progress during construction.
TGS 15			Minimise disturbance and controlling run-off from construction areas.
TGS 16			Revegetate and mulch progressively as each section of works is completed. The interval between clearing and revegetation should be kept to an absolute minimum.
TGS 17			Coordinate work schedules, if more than one contractor is working on a site, so that there are no delays in construction activities resulting in disturbed land remaining destabilised.
TGS 18			Program construction activities so that the area of exposed soil is minimised during times of the year when the potential for erosion is high, for example during summer when intense rainstorms are common.
TGS 19			Stabilise the site and install and maintain erosion controls so that they remain effective during any pause in construction. This is particularly important if a project stops during the wetter months.

Reference Code	Project Phase	Potential Impact	Potential Mitigation Measures
TGS 20			Keep vehicles to well-defined haul roads, and keep haul roads off sloping terrain wherever practical.
TGS 21			Installation of shake down grids at each site entry/exit point.
TGS 22			Cultivate the cut surface to increase infiltration of rainfall and decrease the velocity of water across the slope during rain and therefore reduce erosion.
TGS 23			Issues that may influence the construction of the project include the competency of founding and sub-grade soils, shrink/swell clays, ease of excavation and soil aggressivity.
TGS 24	Operation	Poorly designed or maintained erosion and water quality structures can contribute to erosion.	Maintenance of WSUD/anti-erosion infrastructure.
TGS 25		As per Section 8.2.1, slope instability can also pose a risk to the operation of a road.	Slope stability can be mitigated through design.
TGS 26		Major spillages of fuel or chemicals caused by accidents can contaminate land adjacent to the road.	Response plans to deal with any spillages.