

This chapter presents findings of geological investigations within the study area and includes a description of the geology and soils, the potential for contamination and acid sulfate soils, discussion of the groundwater regime, impacts of the Proposal and mitigation measures as required.

8.1 Method of assessment

The assessment of the soils and geotechnical conditions along the route of the Proposal involved:

- a desktop study of the available information including geological mapping and published literature for the area, interpretation of aerial photographs, and reviews of existing reports
- site investigations to provide broad information on the ground conditions
- a review of soil and soil contamination issues, including potential acid sulfate soils (PASS)
- an assessment of probable methods of excavation, suitability of cut materials for use as fill, likely slope angles in cuttings and batter angles for fill slopes and suitable foundation types for bridges.

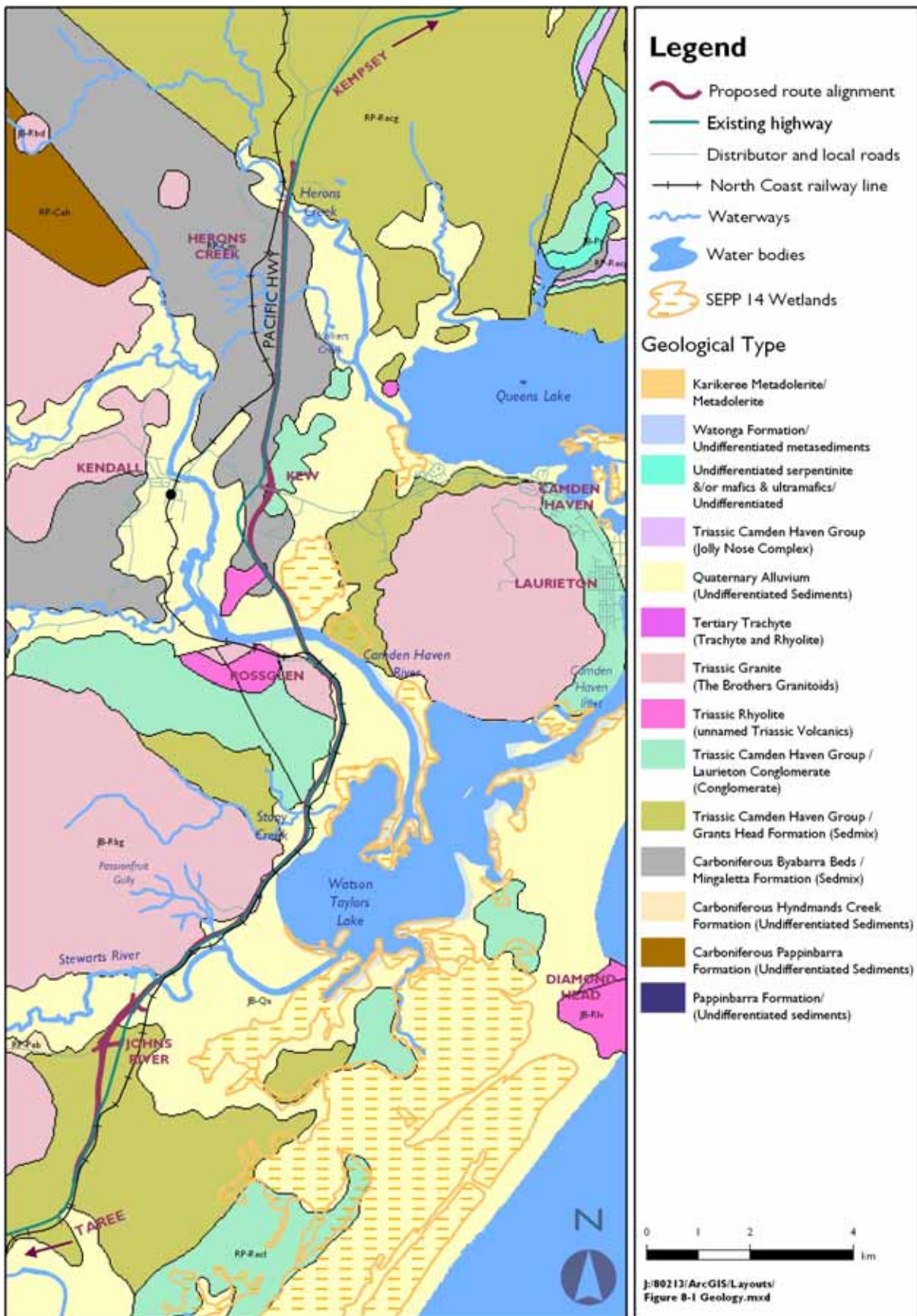
Understanding the geotechnical and site conditions is integral to the development of the engineering concept design (see Chapter 6). The results of the preliminary geotechnical investigations are presented in Working Paper No. 8.

8.2 Topography

The topography along the route of the Proposal is characterised by gentle undulations to the south of Stewarts River and to the north of Camden Haven River, interspersed with elevated ground in the central section on the footslopes of Middle Brother Mountain. Immediately to the east of the highway, and north of the Camden Haven River is an area of wetlands protected under SEPP 14. The topography in this area is flat and low-lying, forming part of the Camden Haven River floodplain.

Terrain along the route of the Proposal is generally below 30 m AHD with slope angles rarely exceeding 20% except on the fringes of Middle Brother Mountain. Between Stewarts River and the Camden Haven River, and to the west of the existing highway, the terrain is generally rugged with rocky outcrops rising to approximately 558 m AHD at the summit of Middle Brother Mountain.

The local catchments drain eastwards via the Stewarts River, Passionfruit Gully, Stony Creek, and the Camden Haven River into Watson Taylors Lake, which is located immediately adjacent to the east of the central section of the highway (refer to Figure 8-1), or via Herons Creek and Walkers Creek into Queens Lake. Ultimately, all the waterways within the study area discharge into the Pacific Ocean via the Camden Haven Inlet at North Haven.



8.3 Geology

The regional geology of the study area is shown in Figure 8-1.

The study area lies predominantly within the Lorne Basin and partly within the Hastings Block, both of which are part of the New England Fold Belt.

Triassic sediments and volcanics in the Lorne Basin are exposed in the southern part of the study area. These comprise red and grey mudstones, lithic sandstones and conglomerates, tuffaceous sandstones, felsic volcanic and minor coal units that form part of the Camden Haven Group. Additional unnamed rhyolite and rhyolitic volcanics also exist within the study area.

Tertiary granites of the Middle Brother Granite are exposed in the central section.

The Hastings Block underlies the northern section of the Proposal between the Camden Haven River and Herons Creek. This section contains the Carboniferous era Byabbara Beds, comprising low strength shale, siltstone and tuff, lithic sandstones, siltstones, pebbly sandstone and conglomeratic units.

Quaternary alluvial sediments are present in the low-lying floodplains of the Stewarts River, Passionfruit Gully and the Camden Haven River. These recent deposits reach a thickness of approximately 20 m in the area of the Camden Haven River.

The regional fault trend within the area is towards the northwest, with minor conjugate faults towards the southwest. The sedimentary and volcanic sequences are gently folded with a typically north to south synclinal fold axis. Dip angles are typically less than 50°.

Information provided by the former Department of Mineral Resources (now part of DPI) indicates that there are five industrial mineral borrow areas or quarries within the study area (one of which is operational) and no proposed mines in the area. A summary of these quarries is presented in Table 8-1.

Table 8-1 Existing aggregate sources

Name/location	Operator/operational status	Product/material
Boral Quarry, Johns River	Boral Resources Pty Ltd - operational	Hard rock aggregate/granite
Stoney Creek Road	State Forests of NSW – not operated	Road materials/granite
Rossglen	RailCorp – not operated	Railway ballast/granite
Bethesda Quarry	NSW RTA – not operated	Road materials/shale
Taylor's Pit, Ocean Drive	Hurd Haulage – not operated	Road materials/conglomerate

Source: based on information provided by DPI (formerly Mineral Resources)

8.4 Ground conditions

8.4.1 Soils

The solid geology and topography of the study area has given rise to varied ground conditions along the route of the Proposal, particularly the floodplain areas of Stewarts River, Passionfruit Gully and Stony Creek, the Camden Haven River, Herons Creek, and the footslopes of Middle Brother Mountain. This results in a mosaic of soil landscapes through which the Proposal will pass (see Figure 8-2). Detailed descriptions of the soil landscape types are provided in Working Paper No. 8. The investigation of the engineering limitations of these soils and their successful management are also discussed in the Working Paper.

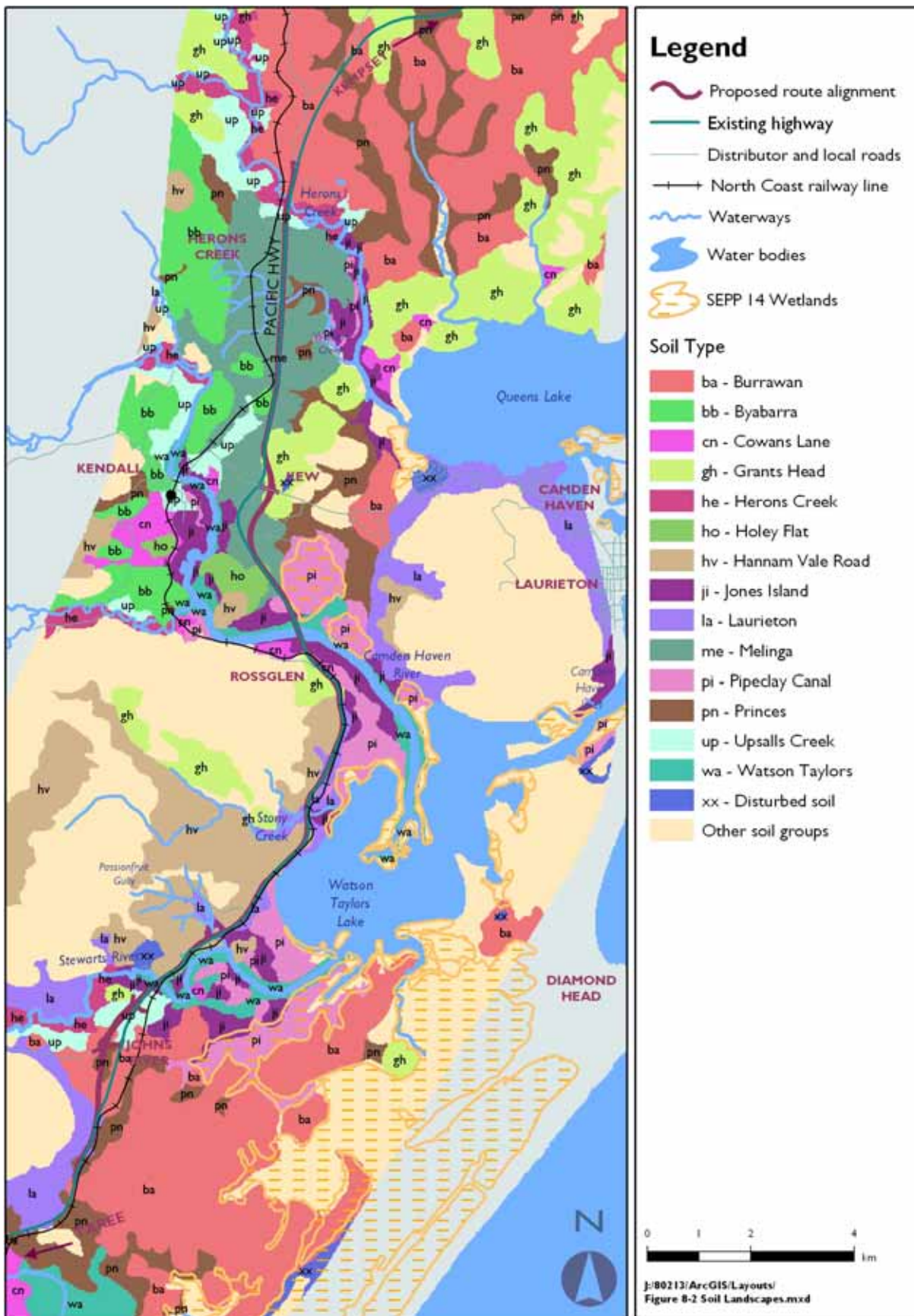


Figure 8-2 Soil landscapes

The soil types found along the route of the Proposal vary, with silty, sandy, gravely and organic clays; sandy silts; and clayey, silty and gravely sands. These soils were found to be susceptible to waterlogging during the initial ground investigation carried out in 2001. Topsoil depths also vary along the route, ranging in depth from around 0.25 m to 0.40 m. The depth to bedrock also varies considerably, ranging from 0.3 m on the Kew bypass to 24.6 m on the flood plain just south of the Camden Haven River.

8.4.2 Potential for soil erosion and reactive and expansive soils

Soil erodibility

Soil erodibility is the susceptibility of a soil to the detachment and transport of soil particles by wind and water. Dispersivity is closely linked to erodibility and is a measure of the instability upon wetting of a soil. Dispersive soils are those which become unstable upon wetting and as a result are susceptible to gully erosion and tunnelling of earthworks. Results from the samples taken from the preliminary ground investigations indicate that soils along the route of the Proposal are generally non-dispersive (low dispersivity).

Soil erosion hazard

DIPNR's method of soil erosion hazard assessment for major road construction was used to assess the proposed route. Erosion hazard is defined by Houghton and Charman (1986) as the 'susceptibility of a parcel of land to erosion to prevailing agents of erosion if the soil is left exposed and no erosion control management is employed'. Based on the results of soil tests conducted in the preliminary ground investigations and the soil erosion classifications recommended by Charman and Murphy (2000), soils in the study area fall into medium to low erosion hazard classes.

The potential for soil erosion has the ability to strongly affect activities and techniques required for construction of the Proposal. It is fortunate that soils along the Proposal route are generally of low dispersivity with medium to low erosion hazard characteristics. These soils and the slightly reactive soils at the Stewarts River and Camden Haven River crossings, as well as the Kew and Herons Creek sections, can be managed during construction through the application of appropriate soil and water management measures.

Reactive and expansive soils

Reactive soils swell when they become wet and shrink on drying out, which can lead to significant damage to structures built on them, including bridges. The results of soil movement estimates calculated on soil samples collected during the preliminary ground investigations indicate:

- Soil landscapes (wa, ho, cn and, in part, me) are classed under AS 2870 Residential Slabs and Footings Construction as 'slightly reactive clays with only slight ground movement from moisture changes'. These soil landscapes predominate at the Stewarts River and Camden Haven River crossings, and along the majority of the Kew and Herons Creek sections.
- Soil landscapes (bb, ba, la, pi, pn and, in part, up) are classed as 'highly reactive clays, which can experience high ground movement from moisture changes'. These soil landscapes are mostly found in the Johns River and Lake sections, and the final section of the Proposal north of Herons Creek.

The highly reactive clays found in the Johns River, Lake and northern Herons Creek sections of the Proposal would require attention to prevent ground movements arising from moisture changes. These soils can also be managed by appropriate techniques such as control of moisture content through water application, installation of drains to divert runoff around and away from construction areas, and stabilisation of banks and stockpiles. A range of appropriate mitigation measures for erosion and sediment control are provided in Chapters 9 and 21.

8.4.3 Slopes

Cut slopes

Suitable batter angles for cut slopes in soil and rock have been suggested based upon information from the ground investigation, geological mapping, kinematic stability analysis and observation of the performance of existing slopes in the study area. It is recommended that batters of 3H:1V be used for soil slopes due to the potential erodibility of the soils in the study area. Cut slopes in soils of 2H:1V could be achieved with surface protection. It is also recommended that benches be installed at approximately 7 m to 10 m intervals in the deeper cuts, depending on the rock stability, and at the rock/soil interface. Provision of benches is consistent with standard RTA practice to improve stability and reduce long-term maintenance.

Existing and recommended rock cut batters are generally flatter than 1H:1V due to the fractured nature of rock in many instances and adverse jointing present in rock masses. The recommendations are based on slope stability and erodibility criteria and the slope batters could be flattened further for maintenance or environmental reasons.

Fill slopes

A number of new embankments would be constructed as part of the Proposal and the suitability of the material won from excavation for use as fill would depend on the type of material and method of excavation used. Fine-grained material of shale or mudstone origin would generally be low strength but would generally be suitable for use in the base of embankments or in other non-critical areas provided that suitable excavation processes and stockpiling methods are used to reduce the moisture content.

Suitable batters recommended for the new fill slopes are based upon information from ground investigations and maximum fill slopes should not exceed 2H:1V. If slopes are not grassed or do not have surface protection measures employed it is recommended that fill slopes should be flattened to 3H:1V due to the potential for erosion and the dispersivity of the soil identified within the study area. If constraints exist, steeper batters of 1.5H:1V could be achieved if crushed rock is used and the embankment is founded on competent soil or rock. This would require laboratory testing to confirm that suitable strength parameters are achievable and quality testing should be undertaken throughout construction.

Soft, alluvial soils exist at a number of locations along the Proposal route (e.g. the southern approach of the Camden Haven Bridge crossing and the southern approach to the Stewarts River) and stability and settlement is likely to be an issue at these points. It is recommended that flatter slopes or stabilising berms be provided at these locations.

8.5 Potential acid sulfate materials

8.5.1 Location of ASS and PASS

Acid sulfate soils (ASS) comprise sediments and soils containing iron sulphate minerals such as pyrite which become extremely acidic when drained and exposed to oxygen, and may generate acidic leachate following the oxidation of iron sulphide layers. This acid leachate can pose a threat to the water quality of local waterways once mobilised in runoff and can lead to 'fish kills' and a degradation of other aquatic biota. Typically, ASS are found in low-lying areas of coastal floodplains such as swamps, rivers, creeks, lakes and mangroves in coastal creeks and rivers below 5 m AHD.

An investigation of the likelihood and location of any potential acid sulfate soils (PASS) along the proposed route was undertaken (refer to Working Paper No. 8). This included desktop studies of existing published and unpublished information, aerial photograph interpretation, field sampling with subsequent laboratory PASS testing, and field sampling for acid sulfate rock (ASR).

Figure 8-3 shows the locations of both low and high probability ASS areas along the route of the Proposal. PASS have been identified in the flood plain areas north and south of Stewarts River and north and south of the Camden Haven River. The existing highway passes across a 270 m section of the Stewarts River flood plain, which is considered to have a low probability for ASS, despite containing organic acidity. The highway passes across an 870 m section of the Camden Haven River flood plain, which is considered to have a high probability for ASS. In all, approximately 7% of the proposed route is susceptible to a high probability of ASS. In these areas, special precautions would be taken to ensure construction activities such as excavations and piling activities associated with bridge construction, and other forms of ground disturbance do not generate acid sulfates.

At the locations of the two major bridge crossings (Stewarts River and Camden Haven River) where the probability of encountering ASS ranges from low to high respectively, the recommended option for founding the bridge structures based on the results of the geotechnical investigations is that driven piles should be used. Driven hollow steel tubes or driven precast concrete piles reduce the disturbance to PASS and the riverbed during construction compared to other pile systems involving bored piles. Driven piles avoid or minimise excavating soil from beneath the water table with the exception of the pile caps. If steel piles are proposed, the selection of steel type should take into account the acidic nature of the soils near the ground surface and should allow for corrosion. Driven piles would result in the lateral displacement only of iron sulphide layers and would therefore minimise the potential with other piling systems for subsequent exposure of ASS or PASS to oxidising processes and the generation of acid leachate into the local receiving waters.

8.5.2 Management measures for ASS or PASS

Prior to the commencement of construction activities, a detailed acid sulfate soil management plan (ASSMP) would be prepared by the construction contractor(s) in accordance with the *Acid Sulfate Soil Manual* (Stone et. al. 1998) to cover all the proposed excavations, management and disposal of ASS or PASS materials. The ASSMP would include both pre-construction testing protocols: monitoring of both ASS/PASS during site preparation and excavation works (for liming rate control); and water quality monitoring of selected local waterways, leachates and groundwater both prior to and during construction. ASS management techniques and measures include the need to:

- avoid disturbance of areas containing soils with high levels of oxidisable sulphur, including minimising the extent of lowering of the water table
- control surface water drainage and where necessary provide aggregate in drains to capture fines and or limestone to buffer acid runoff - consideration should also be given to the use of silt and vegetation sediment fences
- reduce oxidation of ASS material by placing the material below the water table
- neutralise ASS material with calculated quantities of lime
- remove pyritic material via techniques such as sluicing
- develop and implement containment strategies to ensure that all acidic leachate associated with the oxidation of ASS is contained for treatment or removal and is prevented from entering downstream watercourses.

For areas subject to small amounts of ASS disturbance (i.e. less than 1000 m³) such as excavations associated with pile caps on the bridge abutments over a relatively short time frame (i.e. over a few months), a management strategy comprising ASS avoidance, neutralisation of any disturbed ASS material with lime at a specified rate, and burial of the material onsite or disposal offsite could be implemented.

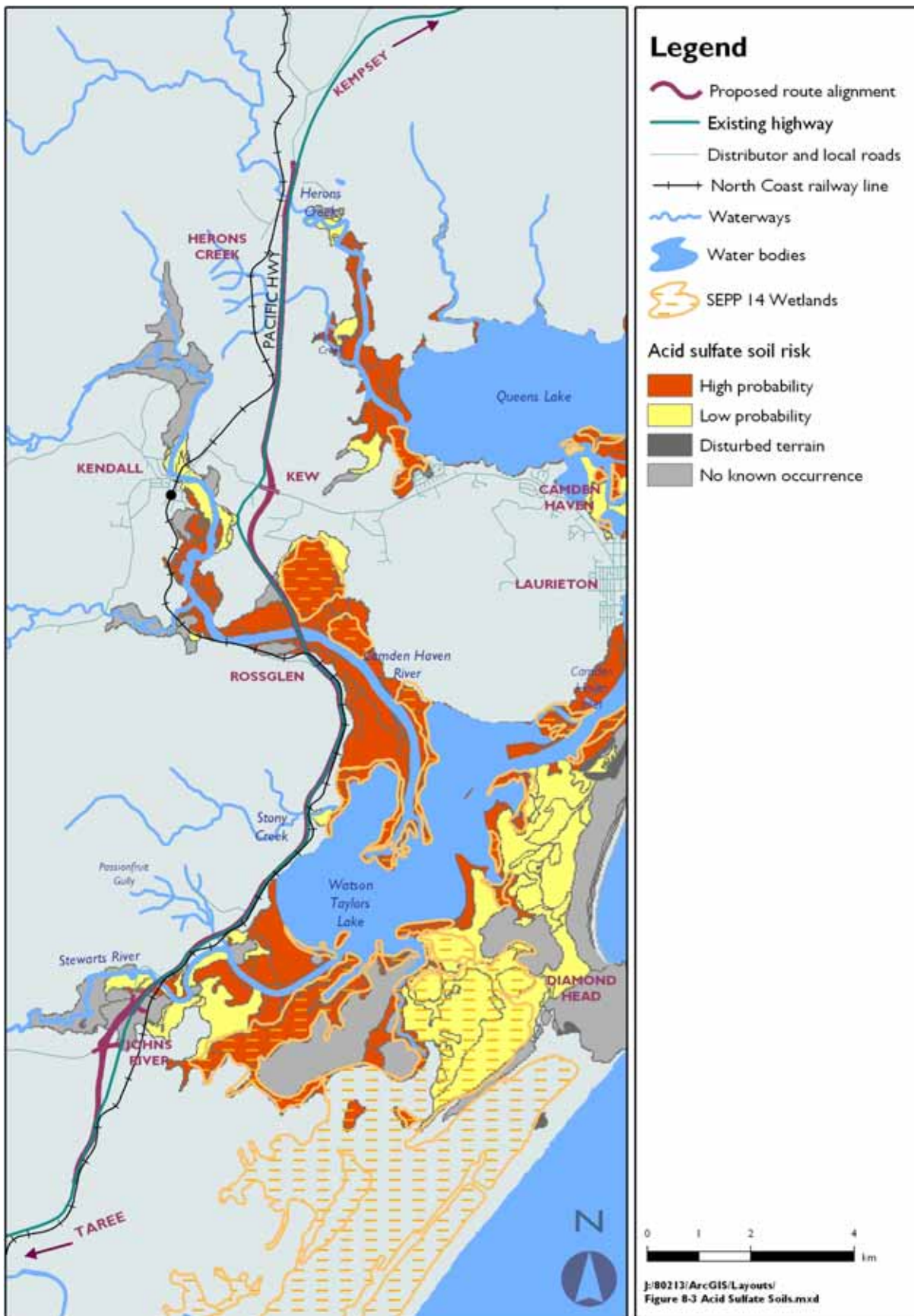


Figure 8-3 Distribution of potential acid sulfate soils

Detailed design solutions proposed for the Proposal should minimise the likelihood of significant quantities of ASS material being disturbed during construction. However, if for any reason significant volumes of ASS material were likely to be disturbed over a relatively long construction period, a staged ASS management approach would be required that considers the variable periods and locations of construction activity. In addition, due to the heterogeneity of ASS material identified, the treatment strategy would need to consider the following to provide a solution that can be effectively implemented on:

- visual identification of ASS strata within soil profiles (using investigation results and bore log information)
- treatment locations
- testing and validation work.

8.5.3 Acid sulfate rock

The tests carried out for ASR indicated the total sulphur percentage levels were below the threshold (0.1%) at which acid generating potential is likely to become an issue. On this basis, it can be reasonably concluded that ASR would not pose any potential problems for the proposed road works planned along the Proposal corridor.

8.6 Potential contaminated areas

A review of past and current land use activities identified the locations of potentially contaminated sites within the study area. Land use activities identified include agricultural usage, garden nurseries, and a service station site at Herons Creek.

In total, fifteen trial pits were excavated at selected locations along the route of the Proposal and soil samples were tested for potential contaminants. All the results tested were below the required Soil Investigation Levels (SILs) adopted for this assessment and almost all, with the exception of some of the heavy metals, were below the limit of recording (LOR) for the laboratory test methods used. SILs are published in the *Contaminated Sites: Guidelines for the NSW site auditor scheme* (NSW DEC 1998) and the *NEPM (Assessment of Contamination) Measure 1999 Schedule B(1) Guidelines on the Investigation Levels for Soil & Groundwater* (EPHC 1999).

Four boreholes were drilled to test groundwater in the vicinity of the main watercourses in the area. Contamination of the groundwater was identified near the former service station adjacent to the highway immediately north of Herons Creek.

Details relating to the sampling and testing of soils and groundwater within the study area are presented in Working Paper No. 8.

8.6.1 Site of former Herons Creek service station

Soil samples collected in 2002 at the site of the former service station immediately adjacent to the western side of the existing highway just to the north of Herons Creek indicated no contamination. However, the groundwater results from borehole number BH214 indicated the presence of hydrocarbons. Elevated total petroleum hydrocarbons (TPH) and polynuclear aromatic hydrocarbons (PAHs) at levels exceeding the site criteria for total TPH and total PAHs were recorded.

More detailed investigations of this site were carried out in 2003. The groundwater and soils were tested for TPH, benzene, toluene, ethyl benzene and xylene (BTEX), PAHs, phenol compounds and heavy metals. Analysis of soil samples taken across the site did not detect TPH, BTEX, PAHs or phenols. The heavy metal concentrations within fill and natural soils were all below the site criteria and are likely to be typical of natural levels.

Testing of the groundwater at this site showed concentrations of TPH compounds at levels between a third and half of the site criteria guidelines from DEC (formerly EPA) and *Australian Water Quality Guidelines for Fresh and Marine Waters* (ANZECC 2000), and any groundwater PAHs that may have been present were in concentrations below detection limits. A groundwater chromatograph for the sample from this location shows some resemblance to weathered kerosene, mixed with a small amount of weathered diesel. Toluene was also encountered, and was in concentrations exceeding DEC (formerly EPA) criteria for protection of freshwater ecosystems (ANZECC 2000). This indicated that the contamination might be a result of former service station operations.

A geophysical survey was also carried out in 2003 to investigate the possibility that an underground fuel storage tank existed at the site. This survey identified an anomaly in the ground that was thought to have been caused by the presence of a tank. However, test pits excavated in April 2004 found no tank, but encountered pieces of iron pipe. The cause of this groundwater contamination is not fully understood, but it is likely to be associated with the site's former use as a service station.

Monitoring of groundwater over a period of about one year showed a general attenuation of hydrocarbon levels in the groundwater. However, the levels remain elevated.

The concept design includes construction of the new northbound carriageway and a sediment basin above the contaminated area but all works are on fill and would generally not otherwise require excavation of the contaminated material.

It is proposed that further testing should be carried out prior to construction to determine the most appropriate treatment at the time. The EPA would be consulted regarding the form of treatment. Options considered would depend on any remaining level of contamination encountered at the time but could include:

- filling above the material
- encapsulation of contaminated material
- removal from the site for treatment and/or disposal at an approved facility
- removal of contaminated material followed by site treatment and replacement.

8.7 Groundwater

Groundwater was encountered at a number of locations along the Proposal route at depths ranging from 0.0 m (at surface) at the Camden Haven River crossing to 7.45 m in the Lake section. The Kew bypass section was the only area where groundwater was not encountered. Test pits dug at Stewarts River, along the Lake section and Camden Haven River areas also indicated seepage at depths ranging from 0.6 m to 2.8 m. Table 8–2 profiles the groundwater depths found.

Table 8–2 Groundwater depths

Location	Depth to groundwater (m)
Johns River	1 m to 3.0 m
Stewarts River	0.6 m to 2.8 m
Lake section	0.6 m to 7.5 m
Camden Haven River	0.0 m to 2.5 m
Kew section	no ground water encountered
North of Kew to Herons Creek	2.5 m to 5.0 m

Twenty-two existing groundwater abstraction wells are registered by DIPNR within a 1 km distance of the proposed route (see Figure 8-4). Details of these wells are provided in Working Paper No. 8. Abstraction from these wells is primarily for domestic, stock and irrigation purposes. Well yields are all low, generally less than 2 litres per second.

The only likely effect of the Proposal on the existing groundwater could be drawdown of the groundwater table around major cuttings (see Chapter 6). Given the depth of the proposed cuts and the depth to the water table, this is only likely to occur in the vicinity of Ocean Drive, in Kew. However, this is unlikely to have an effect on any existing abstraction given the distance to the nearest registered abstraction wells which are located approximately 0.5 km to 1.2 km to the east of the Proposal.

Localised drawdown of very shallow water perched within residual soils could occur. The effects however, would be very localised and would be expected to not extend more than about 10 m from the cut.

8.8 Further geotechnical investigations

8.8.1 Scope of further investigations

Should the Proposal proceed, the following additional field investigations would be required for the detailed geotechnical investigation phase of the Proposal. These investigations would be carried out as part of the detailed design phase of the highway upgrade, following approval but prior to construction.

As noted in Section 6.19.1, the detailed design may vary from the concept design described in this EIS and the further geotechnical investigations described below could be subject to adjustment if necessary due to design modifications.

- **Boreholes**
Boreholes would be required at bridge sites, pier locations and abutments, cuttings and in soft soil areas. Overwater boreholes would be required at pier locations for river crossings. Boreholes may be required within the rail reserve for the bridge over the Main Northern Railway line.
- **Test pits**
Test pits would be required at regular intervals along the proposed route to characterise the soil for general earthworks, subgrade and pavements, and to assess acid sulfate potential in the river flood plains. Test pits would be from 2 m to 4 m deep.
- **Seismic refraction surveys**
Seismic refraction surveys would be required in cuts to assess the rock depth and degree of difficulty of rock excavation and to assess sources of construction materials in the cuttings. Seismic refraction surveys may also be required on the riverbeds at bridge sites to confirm bridge geometry (span lengths and pier locations) before overwater holes are drilled.
- **Continuous sampling**
Continuous sampling of soils would be required for boreholes in the Camden Haven and Stewarts River flood plains to determine subsoil conditions at embankment locations and to further assess the extent of acid sulfate soils.
- **Cone penetrometer tests**
Cone penetrometer tests (CPTs) would be required in the Camden Haven and Stewarts River flood plains to determine the subsoil profile below embankments and at bridge sites.

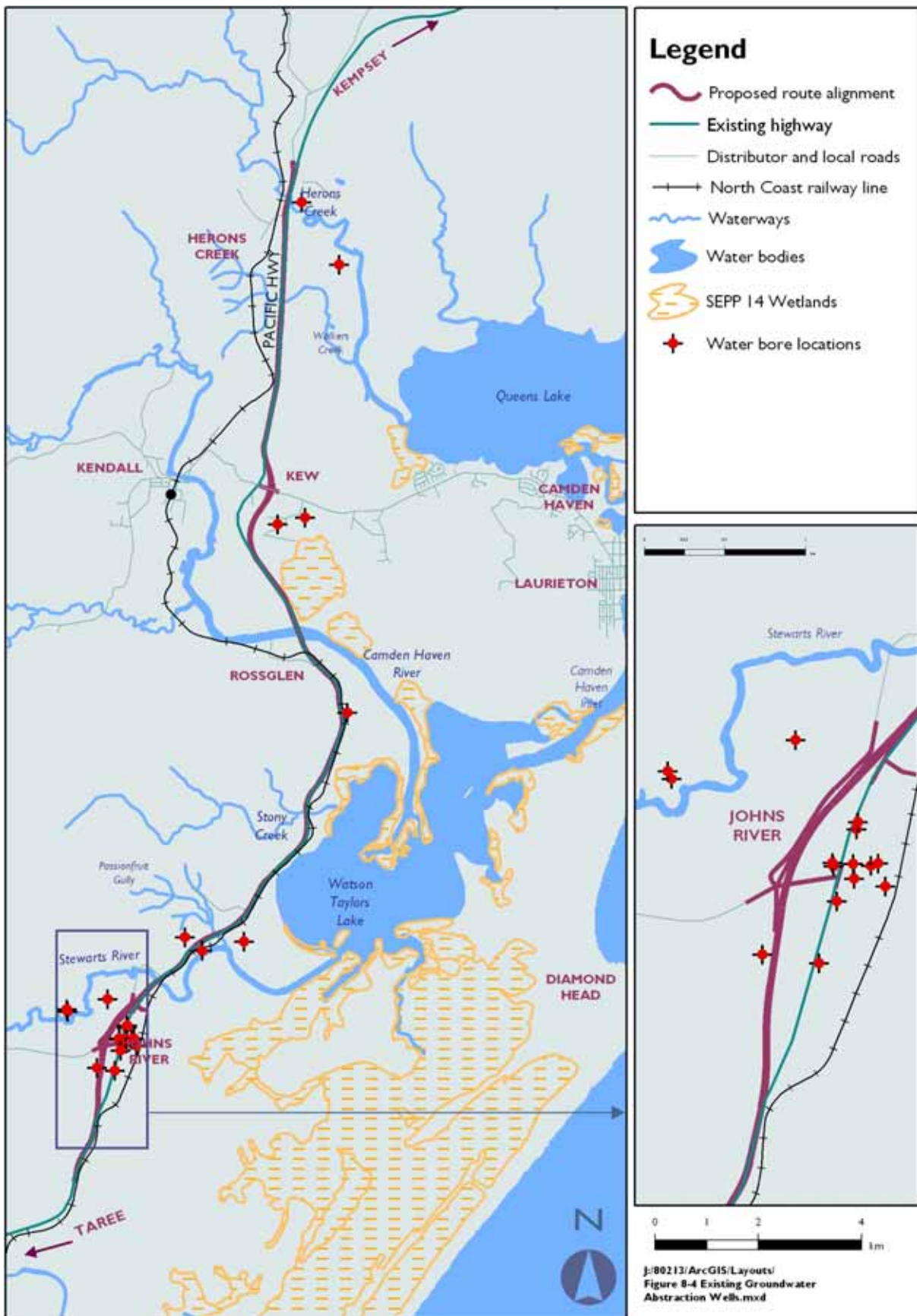


Figure 8-4 Existing groundwater abstraction wells

- Trial embankments
Due to the relatively low consolidation settlements predicted in the investigations to date it is considered that a trial embankment would not be required for the detailed geotechnical investigations. However, the need for trial embankments should be reviewed following the detailed geotechnical investigation and would also depend on the type of technology or construction methodology proposed at the detailed design stage.
- Pavement condition assessment
A detailed pavement condition assessment may be required in those sections where retention or rehabilitation rather than replacement of existing pavements could be possible.
- Access tracks
Tracks would be required for vehicles to access sites for various boreholes, test pits, CPTs, continuous samples and seismic refraction surveys. Provision of access may require some clearing of vegetation, depending on the location of the test positions.
- Piezometers
Piezometers would be required at various boreholes to monitor water levels and water quality. These piezometers would be monitored at regular intervals during the detailed geotechnical investigation.
- Site of former Herons Creek service station
As noted in Section 8.6.1 above, it is proposed that further testing should be carried out at this site prior to construction. The most appropriate treatment and/or the need for further monitoring during construction would depend on any remaining level of contamination encountered at that time, and would be agreed in consultation with RTA and the EPA.

8.8.2 Potential impacts and mitigation

The additional geotechnical investigations as described above would be limited to within the proposed road reserve boundaries shown in Figures 6-1A to 6-1N and would involve small scale impacts. Generally sites which are already cleared and for which access tracks already exist would be chosen, but in some cases where alternative cleared investigation sites with existing access are unavailable, there may be a need to remove some vegetation. In these cases, consideration would be given to the type and extent of existing vegetation in determining alternative sites, and adoption of best practice and application of the relevant mitigation measures described elsewhere in this EIS would be applied.

On the Camden Haven River, drilling from a barge may be required. Disturbance to riparian vegetation would be addressed as described in Section 7.2.5 for construction of the Camden Haven Bridge. Consultation with DPI (NSW Fisheries) and DEC would be required for any investigation works in watercourses.

Additional mitigation measures that would be adopted to reduce impacts include:

- preparation of an EMP for these investigation activities, incorporating effective mitigation measures to reduce environmental impacts - a copy of this EMP would be forwarded to relevant agencies
- consultation in advance with all affected parties, including agencies and landholders prior to works
- any works in waterways would involve preparation of a waterway method statements to minimise impacts
- other measures described elsewhere in this EIS as appropriate, depending on location and sensitivity.

8.9 Implications for ESD

8.9.1 Precautionary principle

The assessment of geotechnical and soil conditions identifies possible constraints for the Proposal. These include the likelihood of ASS and erosion. By adhering to the 'best practice' construction management measures, as identified in Chapter 21, environmental impacts would be appropriately mitigated during the construction of the Proposal. Monitoring throughout and following the construction phase would ensure that mitigation measures put in place are as effective as possible in mitigating environmental impacts.

8.9.2 Intergenerational equity

The 'best practice' construction methods to be implemented with the construction of the Proposal would prevent and/or mitigate the potential environmental impacts to soils and geology. This includes practice in relation to soil erosion and sedimentation; significant ground movements in reactive soils; disturbance to PASS and ASS (including subsequent impacts in the medium and long term); and the exhaustion of mineral resources in local quarries. These measures would ensure that any reduction in the quality or quantity of the soil and geological resources available to users in the future would be minimised.

This approach to the Proposal design, construction and monitoring is consistent with the principle of maintaining social equity including intergenerational equity.

8.9.3 Conservation of biological diversity and maintenance of ecological integrity

The use of 'best practice' construction methods and proposed mitigation techniques would conserve biological diversity and maintain ecological integrity in ways that include the following:

- Preventing the erosion of topsoil would ensure suitable soils exist in the future for the continued propagation of vegetation. This would help to maintain the biological diversity of flora and fauna (through the provision of food supplies and habitat).
- Stabilising of soil stockpiles so as to control erosion would minimise the possibility of sedimentation from stockpiles contaminating local waterways and assist in maintaining their biological diversity and ecological integrity.
- Correct management of PASS and ASS would ensure acid leachate is not mobilised in runoff and therefore would assist with the maintenance of ecological integrity and biological diversity through the avoidance of fish kills.

8.9.4 Improved valuation and pricing of environmental resources

The importance of considering soil types, their potential for erosion, location of ASS, PASS, potential contaminated areas and geological resources has been explicitly recognised in the route selection, concept design and environmental assessment phases of the Proposal. While a specific economic valuation has not been made for these areas, their importance from an environmental perspective has been an integral factor in project development.

The mitigation measures proposed and costs required for their implementation reflect the emphasis on protecting soils and environmental resources potentially affected by their mismanagement. This is viewed to be a reflection of the environmental and economic value of geological and soil resources.