

Chapter 6 - Design considerations

Not used

6.0 Design considerations

6.1 Design criteria

Together with the characteristics discussed in **Chapter 5**, the design considerations form the basis of the guidelines and parameters to which the upgrade must attain. This chapter presents the design criteria which apply to this project.

6.1.1 Engineering design criteria

Standard national and state guidelines apply and cover the categories including:

- RTA corporate policies.
- Occupational health and safety.
- Road design.
- Traffic.
- Environmental policies.
- Road safety.

6.1.2 Design life

The economic analysis of the route options considers design life of various infrastructure assets which comprise the upgrade. This provides a basis for whole of life cost analyses (refer **Chapter 9**). The design life requirements developed and applied to all stages of the project including concept design, detailed design and construction. Ecologically sustainable development principles and analysis also consider design life.

6.1.3 Flood immunity

The design must ensure that the appropriate level of flood immunity is provided. The RTA guidelines require that the pavement wearing surface of at least one carriageway remains above the water level during the design flood event. This project requires:

- A target of 1:100 year flood event for new alignments.
- For routes following the existing alignment, the minimum target is at least a 1:20 year flood event.

6.2 Technical criteria

Minimum technical criteria for the upgrade have been stipulated by the RTA. These incorporate standards and design guidelines required to achieve the project objectives.

The stipulated technical criteria for the upgrade are summarised in **Table 6.1**

Table 6.1 Technical criteria

Feature	Upgrade	Local roads / service roads
Design speed	<ul style="list-style-type: none"> • Minimum 110 km/h horizontal alignment. • Minimum 100 km/h vertical alignment. 	<ul style="list-style-type: none"> • Minimum 60 km/h horizontal alignment. • Minimum 60 km/h vertical alignment.
Cross section	<ul style="list-style-type: none"> • Minimum four lane single carriageway with appropriate median treatments to provide physical separation of opposing traffic. 	<ul style="list-style-type: none"> • As per RTA Road Design Guide and to match adjoining road conditions and council requirements.
Flood immunity	<ul style="list-style-type: none"> • Target of 1 in 100 year flood event for new alignments. • A minimum target of at least a 1:20 year flood event for upgrades of existing alignments. 	
Interchanges	<ul style="list-style-type: none"> • Cater for 25 metre B-double trucks where appropriate. 	

6.3 Flooding and drainage

Flood investigations have been undertaken to develop an understanding of the existing historical flood patterns and the potential impact of the project. The investigations involved the following:

- A review of existing flood modelling and historical studies of the major surface drainage systems within the study area.
- Additional flood modelling where required within the study area to complete the study.

6.3.1 Peak flow determination

Within areas covered by either the North Street Berry Bypass Environmental Impact Statement (ERM, 1997) or the Broughton Creek Flood Study (SMEC 2004), peak flows for the 1 in 100 year Annual Recurrence Interval Storm event were adopted from these flood studies where possible. The peak flows were checked against the Probabilistic Rational Method in Australian Rainfall and Runoff (1999) where required.

For areas not included in the above studies, peak flows were calculated using the Probabilistic Rational Method in Australian Rainfall and Runoff. Rainfall Intensity-Frequency-Duration Curve Parameters for Berry, Bomaderry / Nowra and Gerringong areas were determined from Australian Rainfall and Runoff (Vol 2) and used to calculate the design peak flows.

6.3.2 Flood level determination

Existing flood levels were obtained from the Broughton Creek Flood Study (SMEC 2004). For other creek crossing locations not covered in the study, HEC-RAS steady flow simulation was used to estimate the existing flood level. For Crooked River, the Rational Method (in Australian Rainfall and Runoff) was used to determine peak flows for use in steady flow data in HEC-RAS analysis to calculate the design flood levels. No existing drainage structures, neither at the highway or railway line, were included in this modelling.

6.3.3 Road level and watercourse crossing requirements

The proposed routes cross numerous watercourses and floodplains. This provides an opportunity to control the flow during flood events with the provision of drainage structures (such as culverts and bridges) within the road embankment to ensure upstream water levels (afflux) are mitigated to acceptable levels. For some minor tributaries, there may be opportunity to mitigate downstream water levels by redirection of the tributary.

Simple analysis was utilised to assess preliminary drainage crossing structure details as well as the water levels upstream and downstream of those road crossings. Bridges and culverts were included in the existing models and limited techniques were used to determine the preliminary crossing opening requirements and to determine indicative road embankment levels.

The following design assumptions were adopted for determining preliminary road embankment levels and watercourse crossing requirements for the route options:

- Road pavement levels were determined with a 500 mm minimum freeboard height above the 100 year Annual Recurrence Interval flood level.
- Due to the relative flatness of the floodplain at the Crooked River lower area, the existing railway line embankment level was assumed to act as a flow control with the road embankment levels set approximately 300 mm above the railway line along this route.
- The road pavement through Omega Flat was set at the existing Princes Highway level plus an additional 1500 mm.

6.3.4 Groundwater issues

Groundwater issues are discussed in relation to the following areas within the study area.

6.3.4.1 Omega Flat

All routes pass through the Omega Flat floodplain area which includes Ooaree Creek. This area is generally low lying and is characterised by deep soft soils, high probability of acid sulphate soils and shallow groundwater. The construction of drainage structures such as culverts and storage basins in this area may require excavation below the water table and may intersect zones of acid sulphate soils. Mitigation measures such as cut-off walls or re-injection may be required in this area to reduce the risk of lowering the water table. Construction methods adopted in these estuarine soft soils should avoid creating barriers to the lateral flow of shallow groundwater. These measures would increase the cost of construction in this area.

6.3.4.2 Crooked River floodplain

Proposed route options adjacent to the existing railway line would pass through the Crooked River floodplain. This area is similar to that of Omega Flat and is characterised by deep soft soils, high probability of acid sulphate soils and shallow groundwater. The groundwater issues that relate to this area are the same as those for Omega Flat.

6.3.4.3 Broughton Creek upper catchment

Route options in this area may include some sections of significantly deep cuttings or tunnels to traverse some of the elevated ridgelines and hills. Tunnels of approximately 40 m depth below ground level may be required to negotiate the ridgelines between Toolijooa Hill and Hartley Hill and Toolijooa and Foxground. Other route options located closer to the foothills of the undulating hills on the western side of the study area may require cuttings ranging between 10 to 30 m depth below ground level.

The cuttings are unlikely to intersect the deep water bearing zones that the majority of licensed bores access.

Existing licensed bores between Toolijooa and Harley Hill are located in the foothills and access deep fractured rock aquifers, therefore a tunnel in this area is unlikely to impact on bore yields. To the north of Toolijooa, there are two licensed bores located close to the ridge. There are no details available for these bores, therefore further investigations should be made to confirm that any tunnelling in this vicinity will not impact these bores.

6.3.4.4 Berry floodplain area

Some route options cross the low lying floodplain area directly to the east of Berry. Some options approach Berry from the northern side of Broughton Creek and may require cuttings of between 10 to 30 m depth below ground level.

Low probability acid sulphate soils and soft soils occur to the south and east of the Berry and follow the southern floodplain of Broughton Creek. This area also has a relatively shallow water table. Based on topography, these areas are likely to be groundwater discharge areas. The groundwater issues that relate to this area are the same as those for Omega Flat, however, the lower probability of occurrence of acid sulphate soils should be taken into account.

In the areas to the north and north-east of Berry a small number of bores access water bearing zones over a wide range of depths including shallow fractured rock layers. Further investigations should be made into potential impacts on the bores in this area, a result of localised lowering of the water table at any proposed cuttings.

Route options to the north of Berry are preferred in terms of avoiding the potential impacts of disturbing acid sulphate soils in areas of shallow groundwater.

6.3.4.5 Shoalhaven River upper catchment

Areas of soft soils and acid sulphate soils and shallow groundwater occur mainly to the south of the existing railway line.

Some route options in this area follow the existing highway alignment, north of the existing railway, with no significant cut or fill. Therefore there are no likely significant impacts on or from groundwater in this area.

6.4 Project urban design objectives

The following are the urban and regional design issues / objectives which were applied during the development of the route options:

- Provide a flowing highway alignment that is responsive and integrated with the landscape.
- Protect the natural systems and ecology of the corridor.
- Protect and enhance the heritage and cultural values of the corridor.
- Respect the communities and towns along the road.
- Provide an enjoyable, interesting highway with strong visual connections to the Pacific Ocean, immediate hinterland and the mountains to the west.

6.5 Geotechnical considerations

6.5.1 Geotechnical conditions

The geologic and soil conditions over the study area are described in **Chapter 5**. A discussion of the design considerations associated with the geologic and soil conditions likely to be encountered follows.

6.5.1.1 Soils

Soils requiring particular design attention are those with potential to be soft and compressible, those containing iron sulphides, or those unstable on slopes. Those soils classified as either estuarine or alluvial have potential to be soft and compressible and contain iron sulphides. Deep colluvial soils on the steep side slopes of ridges have potential for instability.

Estuarine soils are located at Omega Flat in the northern part of the study area and at a relatively isolated low lying area in the vicinity of Toolijooa. Routes traversing estuarine soils will require special treatment. All route options traverse the estuarine soils of Omega Flat. Routes crossing estuarine soils will also be constructed on fill formation in order to provide flood immunity. Embankments constructed on deep and soft estuarine clay deposits are subject to larger settlements than those on non-estuarine soft soils. Special ground treatment will be required in these areas to drain and compress the soil below the road formation.

Alluvial soils are present in the Shoalhaven River floodplain, creeks, and other low-lying areas. Areas classified as high risk acid sulphate soils are indicative of areas of soft and compressible alluvial or estuarine soils. The areas where soft and potentially compressible soil deposits are located include:

- The Oooree Creek floodplain (Omega Flat), north-west of Gerringong.
- The Crooked River floodplain, east of Toolijooa Road, south of the existing Princes Highway and south-west of Gerringong.
- The Broughton Creek floodplain east of Berry.
- The Shoalhaven River / Broughton Creek floodplain, between Berry and Bomaderry and generally lying to the south or east of the current South Coast railway line.

More targeted studies will be required to determine the extent and depth of soft soils in these areas. Accordingly, the extent and type of ground treatment required will be determined following more targeted studies. A conservative approach has been used to determine cost estimates for ground treatment. Deep colluvial soils on the steep side slopes of ridges and gullies could pose a slope stability risk. Potential slope instability can be addressed in design with appropriate batter slopes and engineering treatment.

6.5.1.2 Rock

The rock present in the study area does not pose significant issues for design consideration. Volcanic tuff underlain by sandstone is the predominant rock group in the study area. Some drilling and blasting is anticipated in deeper cuttings or where isolated latite boulders are encountered in the northern part of the study area. High strength sandstone is likely to be suitable for tunnelling (for further details refer to **Section 6.4.3**). It is anticipated that the majority of cut material would be suitable for general fill and select fill after some crushing on-site.

6.5.2 Ground treatment options

Any routes traversing potentially soft soil areas may require a range of treatments to ensure that settlement criteria are achieved, and an acceptable factor of safety against embankment failure is achieved.

A number of potential treatments for construction of embankments on soft soils are available as shown in **Table 6.2**.

Table 6.2 Potential treatments for road formation on soft soils

Treatment	Method	Advantages	Disadvantages
Preloading	Early placement of embankment material to induce settlements prior to operational phase.	<ul style="list-style-type: none"> • Reduces settlements during operation phase. • Inexpensive if fill material is readily available. 	<ul style="list-style-type: none"> • Planning and duration required (years). • Material required early. • Limited strength gain in foundation material without other treatment.
Vertical drainage (wick drains)	Placement of vertical drainage pipes to allow water to drain from the consolidating material.	<ul style="list-style-type: none"> • Accelerates consolidation settlements. • Increased rate of strength gain (relative to preload alone). 	<ul style="list-style-type: none"> • Potential impact upon hydrogeology. • High material and installation costs.
Lightweight fills	Utilisation of a lightweight embankment material reduces ground contact stress and resulting settlements.	<ul style="list-style-type: none"> • Reduces total settlement. • Reduces instability. • Rapid construction. 	<ul style="list-style-type: none"> • High cost. • Potential buoyancy and environmental impact.
Piled raft	Partial structural solution transferring vertical loads to lower levels through a combination of a raft foundation and the use of piles.	<ul style="list-style-type: none"> • Reduces settlement. • Significantly reduces instability issues. • Limited footprint leading to a possible reduction in land requirements. • Overall time reduction. 	<ul style="list-style-type: none"> • Moderate cost. • Availability of low cost (timber) piles.
Piled viaduct	Full structural solution transferring vertical loads to competent material at depth.	<ul style="list-style-type: none"> • Negligible settlement. • No stability impact. • Minimal surface drainage impact. • Possible reduction in land requirements. • Overall time reduction. 	<ul style="list-style-type: none"> • High cost. • Deep foundations difficulties.
Flattening batters	Flatter batter angle of embankment improves stability.	<ul style="list-style-type: none"> • Reduces stability impact. • Inexpensive. 	<ul style="list-style-type: none"> • Larger footprint. • Increased fill quantities.
Geotextile reinforcement	Synthetic material providing tensile reinforcement against horizontal strains in the lower part of an embankment.	<ul style="list-style-type: none"> • Improve stability. • Inexpensive (relative to piled solutions). • Possible reduction in land requirements. 	<ul style="list-style-type: none"> • Greater control over fill material required. • Limited reduction in overall settlement.

6.5.3 Suitability for tunnelling

Tunnelling may become an attractive solution where cutting depth and width become uneconomic and visual impact, land take, or environmental impact is considered unacceptable.

A dominant ridgeline extends from Foxground to Toolijooa and Harley Hill. This ridge effectively bisects the study area. All routes assessed in the study area between Gerringong and Berry must negotiate this ridge. The ridge is at its least elevation closest to the railway line. Elsewhere there are obvious peaks and troughs. The existing highway begins to ascend the ridge approximately 500 m east of the intersection with Toolijooa Road.

The combination of the ridge terrain and the requirement for high standard road geometry makes tunnelling a viable option. The most likely tunnelling locations are described as the "north saddle" and "south saddle". These locations are dips in the ridge where the effective width of the ridge is narrowest. Hence, these locations offer the best opportunity to locate the shortest length tunnels.

Limited preliminary field testing and reference to the Wollongong Geologic Map Sheet, indicates that material encountered in these locations belongs to the Permian Age Shoalhaven Group, specifically Kiama trachytic tuff with pebbly bands. At greater depth, the material is likely to be Berry formation with siltstones, shales, and sandstones with conglomerate layers. The layer thickness of these materials can be very thick. With the limited data available at this stage, it is not possible to determine if a tunnel would be located in Kiama tuff or Berry formation. However, both rock types are high strength with widely spaced jointing and are considered suitable for tunnelling.

If tunnel routes through either of these locations were selected as a preferred route, more extensive field testing would be undertaken to determine the properties of the rock with a greater degree of certainty.

6.6 Ecologically sustainable development

6.6.1 Integrating the principles of ecologically sustainable development

The principles of ecologically sustainable development as defined in the *NSW Environmental Planning and Assessment Act 1979* and the *Environmental Planning and Assessment Act Regulation 2000* and the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* need to be considered during all aspects of the project development including the evaluation of alternative route options.

As outlined in **Section 1.7**, the principles of ecologically sustainable development defined in the legislation require:

- Decision-making processes to effectively integrate both long-term and short-term environmental, economic, social and equitable considerations.
- Consideration of the precautionary principle.
- Consideration of inter-generational equity.
- Conservation of biological diversity and ecological integrity.
- Improved valuation, pricing and incentive mechanisms to be considered.

The principles of ecologically sustainable development are being considered in the development of the optimum engineering design outcome and the consideration of environmental, social and economic issues in the environmental assessment.

6.7 Property and land use impacts

6.7.1 Severance of land uses

Severance of land use occurs if the highway passes through a land holding bisecting the holding into distinct parts (note: this does not include acquisition of land through widening of existing road / rail corridors). The impacts of the severance of land could include (but are not limited to):

- Reduction or elimination of land productivity if commercial activities (agriculture, retail, industrial and the like), due either to the reduction in size of the overall holding or restricting access between the two separated parcels of land (e.g. for stock access or for crop maintenance).
- Creation of residual lots that, due to their small size or characteristics, have little or no productive use (e.g. steep land that was otherwise used for grazing and now has limited accessibility).
- Impacts on amenity of dwellings or commercial operation (e.g. restaurants in rural areas).
- Highway edge effects will be increased, such as to water quality impacts and vehicle emissions, which may be located closer to sensitive land uses (e.g. organic farms and vineyards).

The proposed upgrade to the Princes Highway should avoid fragmentation of productive agricultural land to retain land resource values. It should be noted that some farms operate over several land titles so whilst a particular land holding is not bisected it still could have an effect on the operation of the farm.

It is important to preserve agricultural areas for food production and diversification and to support the dairy industry.

Councils have advised (Planning Focus Meeting, September 2006) that they would seek to restrict or limit non-productive development in agricultural areas and provide diversification activities for existing farming areas. Severance of productive land holdings in the study area that generates significant impacts such as those discussed above would be inconsistent with the council's objectives.

6.7.2 Agricultural land

Classes 1, 2 and 3 apply to lands that are suitable for productive agriculture (horticulture, dairy, vineyards and the like) that, according to the Department of Primary Industries, should be protected from development for non-productive land uses where possible. The selection of a preferred highway route will consider the impacts of any alignment on land that is identified as suitable for regular cultivation either Class 1, 2 or 3. There is no Class 1 agricultural land in the study area.

6.7.3 Dairy

Fragmentation of productive agricultural land is a key issue for the selection of a preferred route, particularly as the locations of productive farming units identified in this study generally match the locations of Class 2 agricultural land.

Potential mitigation measures for retaining the productivity of dairy farms include (but not limited to) establishing underpasses or overpasses to enable farmers to transfer stock from one paddock to the next. Any over / under pass would require discussions with the landowner to identify the most suitable location and design for the stock route. Construction of a highway through dairy farms would need to minimise the impact on the productivity of the farm for the duration of the construction period.

It is important to retain access for trucks to dairy farms in the area. Route options would need to ensure that access to farms is not eliminated through closing of roads or altering of geometry to the extent of restricting truck access without providing an alternative solution.

There are high cost implications associated with moving or purchasing specialist dairy farming equipment if dairy farm land is impacted by the Princes Highway upgrade.

6.7.4 Vineyards

Severing vineyard properties should be avoided where possible, as severance of such activities could restrict productivity / viability and, without mitigation, generate adverse impacts on scenic quality of the locality. Mitigation measures could be necessary for any route option that is located in proximity to vineyards as run off and vehicle emissions have the potential to impact on grape growing as well as the amenity of the vineyard for visitors.

6.7.5 Organic farming

There is significant investment in organic farms as the soil needs to rest for several years before it is ready for cultivating as certified organic. The land is particularly sensitive and adjacent land uses must not introduce pollutants which could affect the soil quality and hence the organic produce. Run off and emissions are pollutants that should be taken into consideration if the upgrade is to be located adjacent to an organic farm.

6.7.6 Commercial activities

The key economic drivers of access and exposure would be considered where an upgrade is located adjacent to or in the vicinity of motels / hotels. Mitigation measures would be considered to preserve amenity. The rural aesthetic and landscape heritage values of the study area are important to the identity of the area for residents and visitors. Noise and visual treatments are likely to be required.

6.7.7 Existing residential land uses

Residential land uses are extremely sensitive to the development / expansion of roads and highways. Impacts include:

- Lifestyle and setting - The rural aesthetic and landscape heritage value is important to the identity of the area for residents and visitors.
- Noise and vibration - The study area is almost entirely rural and semi-rural in nature and rural areas experience low levels of noise, particularly at night. Preserving the amenity of all residences would necessitate noise mitigation during construction and possibly (dependent on the proximity of dwellings to the selected route) during operation.
- Visual impacts - Adequate visual amelioration would be essential to preserve the existing character of residential areas.
- Access - Access to all residential properties would be required to remain. Establishing a controlled access highway near residential land uses would necessitate changes to current accesses.
- Retirement villages - A number of retirement villages are situated on the southern and western periphery of Berry. These land uses are sensitive to safety and other amenity impacts and should be avoided if possible.
- Existing urban areas in Berry - It is preferable that any route be separated from existing residences in Berry, alternatively, mitigation measures implemented to preserve amenity (both perceived and actual).
- Existing urban areas in Bomaderry - Established areas of Bomaderry would be unsuitable for development of a new highway alignment due to high number of separate land ownerships and potential impacts on amenity of existing residents. The most appropriate route is the widening of the existing highway configuration.

6.8 Construction resources and materials

The construction of route options across floodplains and low lying areas involves sections of embankment that would require a substantial volume of fill material. A combination of routes may need to be considered to achieve a cut-fill balance and so eliminate or reduce the amount of material that needs to be imported to the site and transported around the site.

Material from excavations would be variable in quality although the preliminary geotechnical studies have shown that sufficient quantities of material won from excavations should be available and suitable for use in embankments as general fill.

6.8.1 Materials

The construction of the proposal would require a number of different materials including:

- Earthworks materials.
- Pavement materials.
- Concrete.
- Aggregates for concrete.
- Sand.
- Water.
- Cement.

6.8.2 Sources of construction materials

6.8.2.1 Earthworks

The majority of route options have been designed to generally balance the cut and fill volumes. The material in the cuttings is expected to be suitable for fill embankments. Route options traversing large areas of flood plain or low lying areas may need to import general fill material. Fill material is currently available from quarries in Tomerong and Falls Creek. Other materials such as overburden and fines are currently quarried at Dunmore, Bombo, Bass Point and Albion Park.

6.8.2.2 Pavement materials

Heavily bound or rigid pavements or a combination of both may be proposed. For the main carriageways, an asphalt wearing course over a heavily bound blast furnace slag base, or plain or continuously reinforced concrete are feasible.

Bitumen

The bitumen is currently available from refineries at Clyde and Kurnell. Asphalt may be batched on site if construction stages are of sufficient size to justify significant set up costs.

Base course

Quarries in Dunmore, Bombo and Bass Point may be sources of road base material, concrete aggregates and sand. Concrete for road pavements would be batched on site.

Select fill material

The material from cuttings is expected to be high strength sandstone which when crushed would be suitable for the selected material zone which supports the road pavement. Where the proposed alignment corresponds to the existing alignment, the existing pavement could be reused as select material.

Crushed sandstone suitable for select fill material is currently available at existing quarries such as Hellhole Pit at Falls Creek and Tomerong Quarry.

6.8.2.3 Aggregate

Aggregate for asphalt and concrete is currently available at quarries in Bass Point, Dunmore and Bombo.

6.8.2.4 Sand

Sand is currently available from quarries at Bass Point, Dunmore, and Bombo. Rocla has sand quarries at Mittagong and Kurnell.

6.8.2.5 Water

It is anticipated that water would be sourced from local town supplies, local creeks and water courses. It may also be sourced from sedimentation ponds constructed for the works. Approvals from Department of the Environment and Climate Change and NSW Fisheries would be required before any water is removed from local creeks.

Sydney Water supplies Gerringong from the Gerringong reservoir located at the northern extremity of the study area.

Shoalhaven Water operates a water network in the Shoalhaven Local Government Area. This includes the towns of Berry and Bomaderry. Water is provided to Berry from reservoirs located on Kangaroo Valley Road, approximately 400 m west of the intersection with Bundewallah Road. Water is supplied to Bomaderry from a reservoir located outside the study area.

Table 6.3 Summary of construction materials currently available locally

Material type	Supplier	Location
Fill	Sourced from cutting	Various
Select material	Sourced from cutting Tomerong Quarry Hell Hole Quarry	Various Tomerong Falls Creek
Base and sub-base	Tomerong Quarry Pioneer Boral Hanson Construction Materials Australian Steel Mill Services	Tomerong Shellharbour Dunmore Bass Point Port Kembla
Bitumen	Shell Caltex	Clyde Kurnell

Table 6.3 Summary of construction materials currently available locally cont'd.

Material type	Supplier	Location
Sand	Rocla Pioneer Boral Hanson Construction Materials Australian Steel Mill Services Dunmore Soil and Sand	Kurnell Mittagong Shellharbour Dunmore Bass Point Port Kembla Dunmore
Aggregate	Pioneer Boral Hanson Construction Materials Australian Steel Mill Services Dunmore Soil and Sand	Shellharbour Dunmore Bass Point Port Kembla Dunmore
Water	Town water Local creeks and water courses Sedimentation ponds	Gerringong, Berry and Bomaderry Various
Cement	Blue Circle Southern Morgan Cement International	Berrima Port Kembla

6.8.3 Haulage of materials and manufactured items

Transport of imported materials would be via local roads, Princes Highway and the South Coast Railway. Transport of fill materials should be by scrapers for short hauls and semi-trailers or haulage trucks with trailers for longer hauls. Impact on the existing highway and the local road network will depend on whether an on or off-line route is preferred.

6.8.4 Effect on depletion of resources

Balancing cut and fill would reduce the resources required for the project. The principles of ecologically sustainable development require that all resources are used as effectively as possible. This includes re-using materials on site e.g. rock and redundant sections of the existing pavement and using bi-products from other industry e.g. fly ash and slag.

6.8.5 Batching plants

Batching plants for asphalt and concrete could be required. These would be located at least 40 m from any water-course and outside any sensitive areas.

6.8.6 Ownership and planning approvals

Existing licensed quarries have planning approval from the relevant local government agency. Any new quarries or new asphalt or concrete batch plants would be assessed as part of the environmental assessment for the preferred route.