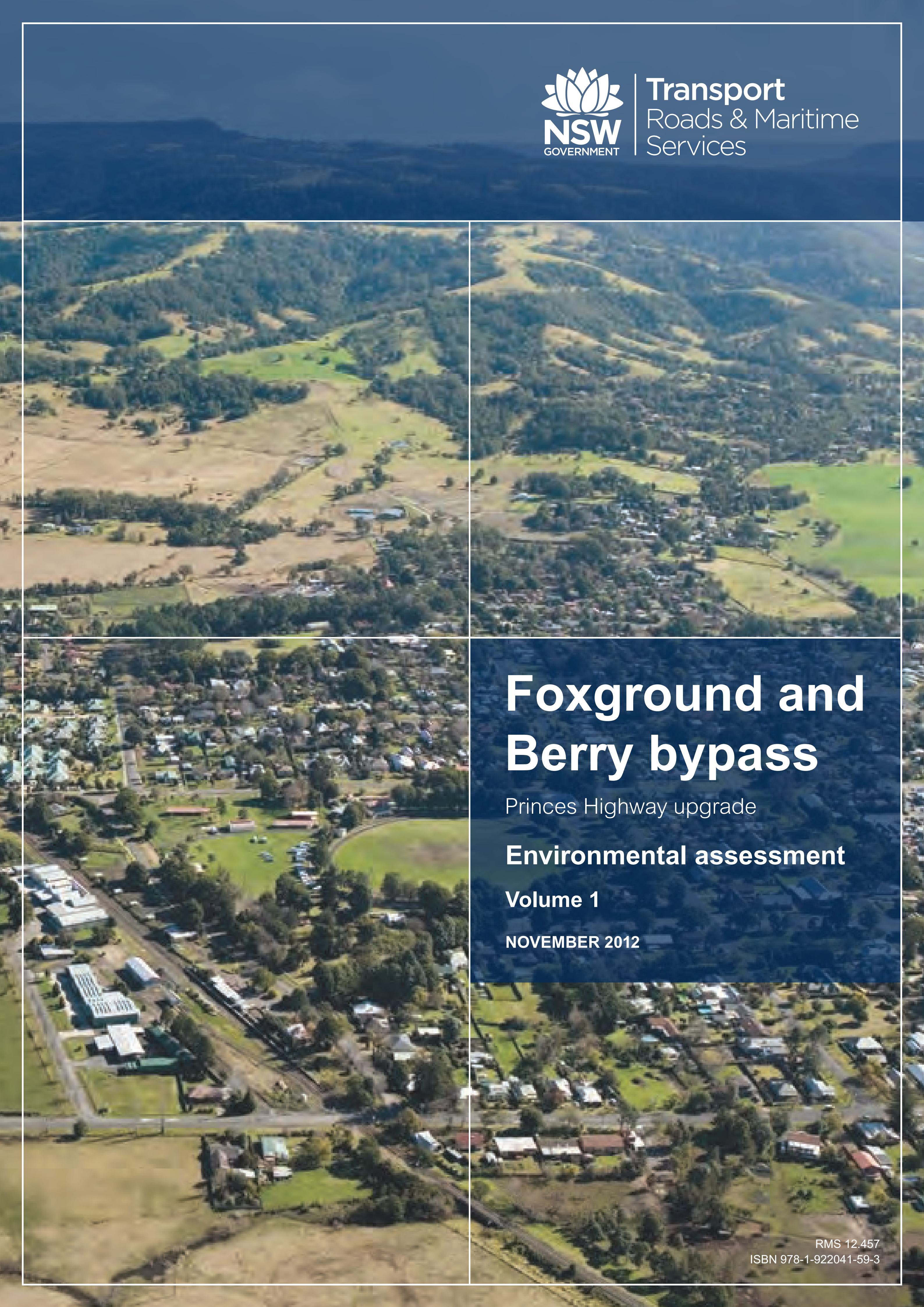

NSW GOVERNMENT | Transport Roads & Maritime Services

Foxground and Berry bypass

Princes Highway upgrade

Environmental assessment

Volume 1

NOVEMBER 2012

RMS 12.457
ISBN 978-1-922041-59-3

Roads and Maritime Services

Princes Highway upgrade - Foxground and Berry bypass

Environmental assessment

November 2012

Prepared for

Roads and Maritime Services

Prepared by

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Volume 2

Certification

Submission of environmental assessment
Prepared under Part 3A of the *Environmental Planning and Assessment Act 1979*

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Applicant name:	Roads and Maritime Services
Applicant address:	101 Miller Street North Sydney NSW 2059
Proposed development:	Princes Highway upgrade – Foxground and Berry bypass environmental assessment
Land to be developed:	Roads and Maritime Services (RMS) propose to upgrade 11.6 kilometres of the Princes Highway between Toolijooa Road north of Foxground and Schofields Lane south of Berry, in New South Wales (NSW) (the project), to achieve a four lane divided road (two lanes in each direction) with median separation. The project includes bypasses of Foxground and Berry. The project would be located in the Kiama and Shoalhaven local government areas.
Environmental assessment:	An environmental assessment is attached addressing all matters in accordance with Part 3A of the *Environmental Planning and Assessment Act 1979*.
Declaration:	I certify that I have prepared the contents of this environmental assessment in response to the Director-General's Requirements dated 11 February 2011 and that to the best of my knowledge the information contained in the environmental assessment is not false or misleading.

Signature:		Signature:	
Name:	Jon Williamson	Name:	Miriam Streulens
Date:	November 2012	Date:	November 2012

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Glossary of terms and abbreviations

Term	Meaning
μg/m	Micrograms per cubic metre.
A	
A, B, C soil horizons	Subsurface soil layers.
AADT	Average annual daily traffic The total volume of traffic passing a roadside observation point over a period of a year, divided by the number of days per year. It is calculated from mechanically obtained axle counts.
Aboriginal cultural heritage	The tangible (objects) and intangible (dreaming stories, songlines, places) cultural practices and traditions associated with past and present day Aboriginal communities.
Aboriginal object	Any deposit, object or material evidence (not being a handicraft made for sale), including Aboriginal remains, relating to the Aboriginal habitation of NSW.
Aboriginal place	Any place declared to be an Aboriginal place under s.94 of the *National Parks and Wildlife Act 1974.*
Aboriginal scarred tree	Aboriginal scarred trees show evidence of bark or timber removal by Aboriginal people for traditional purposes. Scarred trees provide significant evidence of Aboriginal occupation in what is now a highly modified landscape.
Aboriginal stakeholders	Members of a local Aboriginal land council, Aboriginal groups or other Aboriginal people who have registered their interest with the RMS to be consulted about a proposed RMS project or activity.
ABS	Australian Bureau of Statistics.
Abutment	An end support of a bridge.
Acid sulfate soils	Naturally acid clays, mud and other sediments usually found in swamps and estuaries. They may become extremely acidic when drained and exposed to oxygen and may produce acidic leachate run-off that can pollute waters and liberate toxins.
Activity	This is broadly defined in the *Environmental Planning & Assessment Act 1979* and includes most physical undertakings of the RMS in construction and maintenance of roads and road infrastructure facilities. Activities are subject to assessment under Part 5 and Part 5.1 of the Act (or under Part 3A if declared by the Minister for Planning).
Acute noise levels	Road traffic noise levels received at private dwellings that are predicted to be greater than 65dB(A)$_{Leq(15hr)}$ (day) and 60dB(A$_{)Leq(9hr)}$ (night), as presented in Practice Note IV, Step 3, Part (2) of the *RMS' Environmental Noise Management Manual*.
Adaptive management	A systematic, rigorous approach (such as monitoring) for deliberately learning from management actions with the intent to improve subsequent management policy or practice.
Afflux	An increase in water level resulting from a constriction in the flow path.
AFG	Aboriginal focus group. AFG meetings are held to consult with Aboriginal stakeholders who have registered their interest to be consulted regarding an RMS project.

Term	Meaning
Aggregate	A uniform sized material from sand, gravel, rock or metallurgical slag by screening, blasting or crushing. Used in concrete production and for bitumen sealing.
AHD	Australian Height Datum The standard reference level used to express the relative height of various features. A height given in metres AHD is essentially the height above sea level. Mean sea level is set as zero elevation.
AHIMS	Aboriginal heritage information management system. A register of NSW Aboriginal heritage information maintained by OEH.
Alignment	The geometric layout (eg of a road) in plan (horizontal) and elevation (vertical).
Alluvial	Relating to, consisting of, or formed by sediment deposited by flowing water.
Alluvial groundwater systems	Groundwater that is present in permeable (unconsolidated) material, usually small rocks and gravel.
Alluvium	Unconsolidated deposit of gravel, sand or mud formed by water.
AM peak period	6-10am weekdays.
Ancillary	A subordinate part or element.
ANZECC	Australian and New Zealand Environment and Conservation Council.
AQMP	Air Quality Management Plan.
Aquatic ecology	Flora and fauna that live in or on water for all or a substantial part of the life span (generally restricted to fresh/inland waters).
Aquatic macroinvertebrates	Macroinvertebrates are fauna with no backbone that can be seen with the naked eye (ie without the aid of a microscope or magnifying glass). Aquatic macroinvertebrates are those that spend all or part of their life cycles in water.
Aquifer	Geologic formation, group of formations, or part of a formation capable of transmitting and yielding quantities of water.
Arboreal	To live in, or be connected with, trees.
Archaeological site	A site with any material evidence of past Aboriginal or non-Aboriginal activity in which evidence of past activity is preserved.
Archaeology	The scientific study of human history, particularly the relics and cultural remains of the distant past.
ARI	Average recurrence interval. Used to describe the frequency or probability of floods occurring. (eg a 100 year ARI flood is a flood that occurs or is exceeded on average once every 100 years (100:1)).
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand.
Arterial roads	The main or trunk roads of the State road network.
AS	Australian Standard.
AS 14000	Australian Standards for environmental management. Of note: - AS 14001: Environmental management systems – requirements for guidance for use. - AS14004: Environmental management systems – general guidelines on principles, systems and supporting techniques.

Term	Meaning
AS 1940	Australian Standard: Guide to the Storage and Handling of Flammable and Combustible Liquids.
AS 2436	Australian Standard: Noise Control on Construction, Maintenance and Demolition Sites.
AS 2922	Australian Standard: Ambient Air Guide for Siting of Sampling Units.
AS 3580.10.1	Australian Standard: Methods for Sampling and Analysis of Ambient Air.
Asphalt or asphaltic concrete	A dense, continuously graded mixture of coarse and fine aggregates, mineral filler and bitumen usually produced hot in a mixing plant.
ASS	Acid sulphate soils.
Assemblage	A group of interacting populations in a given area.
ASSMP	Acid Sulfate Soil Management Plan.
At-grade	A road at ground level, not on an embankment or in a cutting. Opposite to grade separated.
AusRivAS	Australian River Assessment System. An assessment methodology for assessing river health using macroinvertebrates.
AWBM	Australian Water Balance Model.
B	
Backfill	Fill replaced in an excavation.
Background noise level	The ambient sound-pressure noise level in the absence of the sound under investigation exceeded for 90% of the measurement period. Normally equated to the average minimum A-weighted sound pressure level.
Balanced earthworks	Earthworks in which the quantity of material taken from road cuttings along the road mathematically equals the fill required to construct the embankments in that length of road.
Base case	Also known as “do nothing” case. Used in evaluating projects to compare the cost and benefit of the existing road (the base case) with another or a number of other projects or options.
Batter	The constructed slope of road embankments and cuttings usually expressed as a ratio of *x* horizontal to 1 (one) vertical. A fill batter is where the road is above the existing surface on a filled embankment and refers to the sloping sides of the embankment. A cut batter is where the road is below the existing surface.
Bedrock	Rock of a substantial thickness and extent underlying a relatively soft and variable surface.
Bench	A ledge constructed in a batter or natural slope to provide sight distance around a curve, greater security against slip or to assist batter drainage.
Benchmark	A survey mark, established as a point of reference for future measurement.
Biodiversity corridor	Linked sections of natural vegetation retained to assist in fauna movement and maintenance of local biodiversity.
Biofilm	A group of microorganisms growing on a solid substrate.
Biofiltration system	Pollution control system using living material to capture and biologically degrade process pollutants.

Term	Meaning
Bioretention system	System in which the bioretention process occurs, which removes contaminants and sediments from stormwater runoff.
Biota	All organisms including flora and fauna, in a given area considered as a unit.
Blasting	The use of explosive for excavating rock, demolition and other purposes.
Blue Book	*Managing Urban Stormwater: Soils and Construction* (Landcom, 2004)
BOM	Bureau of Meteorology.
Bore	A cylindrical drill hole sunk into the ground from which water is pumped for use or monitoring.
Borehole	A hole produced in the ground by drilling for the investigation and assessment of soil and rock profiles.
Box culvert	A culvert of rectangular cross section.
BTEX	Volatile organic compounds.
BTUCA	Berry Township Urban Conservation Area.
Bund	A small embankment designed to retain water.
C	
Cadastral	Showing the extent and ownership of land (generally on a map).
CALRoads Package	An air quality monitoring model.
Capacity	The nominal maximum number of vehicles that can travel along a road in a given time.
Carbon dioxide equivalent (CO_2-e)	The mass of a greenhouse gas that is emitted is multiplied by its global warming potential to convert greenhouse gas emissions to an equivalent quantity of CO2 emissions, referred to as carbon dioxide equivalent. For simplicity of reporting, the mass of each greenhouse gas emitted is commonly translated into a carbon dioxide equivalent (CO2-e) amount so that the total impact from all sources can be summed to one figure.
Carriageway	The portion of a roadway used by vehicles including shoulders and ancillary lanes.
Cast in place/situ	Concrete which is cast directly into its final position.
Catch drain	An open channel constructed along the high side of a road cutting or embankment outside the batter to intercept and redirect surface water.
Catchment	The area from which a surface watercourse or a groundwater system derives its water.
CCDs	Census Collection Districts.
CEMP	Construction Environmental Management Plan. A site specific plan developed for the construction phase of a project to ensure that all contractors and sub-contractors comply with the environmental conditions of approval for the project and that environmental risks are properly managed.
Centreline	The basic line which defines the axis or alignment of the centre of a road.
CH_4	Methane.

Term	Meaning
Chainage	Any point on a control line selected to provide more detailed information about the cross-section or any other feature mentioned in the drawings. Also known as a station.
CIP	Community Involvement Plan.
Clear zone	The area that begins at the outer edge of the lane, next to the shoulder and extends for a set distance, which is provided or designed for emergency use by errant vehicles.
Clearing	The removal of vegetation or other obstacles at or above ground level.
Climbing lane	An auxiliary lane, usually on a long upgrade, primarily for the use of slow moving vehicles. Differs from overtaking lanes as linemarking does not initially direct all traffic to the left hand side of the road.
CMA	Catchment Management Authority
CNVMP	Construction Noise and Vibration Management Plan
CO	Carbon monoxide.
CO_2	Carbon dioxide.
$CO_{2\text{-}e}$	Carbon dioxide equivalent.
Colluvial soils	Stony clays which have been moved downslope by soil creep and slopewash but may include a proportion of windblown red clay (parna) and higher terrace alluvium.
Compaction	An increase in density of a soil material by mechanical means such as rolling the surface layers or for deep compaction, driving sand piles, vibration or impact methods.
Compound site	Facilities used to support the operation of a construction site including (but not limited to) site offices, workshops, delivery areas, storage areas, crib sheds, staff vehicle parking, materials, plant and equipment.
Concentration (air quality)	Vehicles emit pollutants to the air, which are transported and diluted resulting in a volume of pollutant per volume of ambient air. Ambient air quality goals are expressed in terms of concentrations, which are measured in parts per million or micrograms per cubic metre.
Concept design	Initial functional layout of a road/road system or other infrastructure. Used to facilitate understanding of a project, establish feasibility, and provide a basis for estimating and to determine further investigations needed for detailed design.
Confluence	A point at which streams combine.
Constructability	The ease with which structures can be built.
CPTED	Crime prevention through environmental design.
CRG	Community Review Group.
Critical habitat	The habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified as the species' critical habitat in the recovery strategy or in an action plan for the species.
CSIRO	Commonwealth Scientific and Industrial Research Organisation.
Cul-de-sac	A street or road that is open for vehicular traffic at one end only.

Term	Meaning
Cultural heritage assessment report	A report combining an Aboriginal archaeological assessment and Aboriginal cultural assessment, required to be submitted to OEH for any Part 6 *National Parks and Wildlife Act 1974* approval or prepared for projects under Part 3A of the *Environmental Planning and Assessment Act 1979* where Aboriginal cultural heritage is identified as a key issue.
Culvert	A stream or drain.
Cumulative impacts	Impacts that, when considered together, have different and/or more substantial impacts than a single impact considered alone.
Curing	The process of keeping fresh concrete or mortar damp so that the cement is provided with enough water to harden.
Cut	The material excavated from a cutting.
Cutting	Formation resulting from the construction of the road below existing ground level – the material is cut out or excavated.
D	
dBA	Decibels using the A-weighted scale measured according to the frequency of the human ear.
DCC&EE	Australian government Department of Climate Change and Energy Efficiency.
DEC	NSW Department of Environment and Conservation (now OEH).
DECC	NSW Department of Environment and Climate Change (formerly DEC and now OEH).
DECCW	NSW Department of Environment, Climate Change and Water (formerly DEC, DECC and now OEH).
Decibel	A scale unit used in the comparison of powers and levels of sound energy. Used for measuring noise.
Deck	The floor of a bridge directly carrying traffic loads.
Design speed	A nominal speed which determines the geometric design features of a road.
Design vehicle	A hypothetical road vehicle, the mass, dimensions and operating characteristics of which are used to give geometric requirements.
Design year	The predicted year in which the design traffic would be reached.
Detour	An alternative route, using existing roads, made available to traffic during temporary closure of a road.
Development consent	Consent granted under Part 4 of the *Environmental Planning and Assessment Act 1979*. Usually relates to the approval of a development application by a local council.
Deviation	An alteration to the alignment of a portion of a road.
Dewatering	The removal of water from solid material or soil by wet classification, centrifugation, filtration or similar solid-liquid separation processes.
DEWHA	Australian Government Department of Environment, Water, Heritage and the Arts (now SEWPaC).

Term	Meaning
DGRs	Director-General's requirements. Requirements and specifications for an environmental assessment prepared by the Director-General of the Department of Planning under section 75F of the *Environmental Planning & Assessment Act 1979*.
DIPNR	NSW Department of Infrastructure Planning and Natural Resources (Now DP&I).
Discharge	The volumetric rate of water flow.
Diversion drain	A drain leading water away from a given area.
Divided road	A road with a separate carriageway for each direction of travel created by placing a physical separation (eg median) between the opposing traffic directions.
DLWC	NSW Department of Land and Water Conservation (now part of DPI)
DoP	NSW Department of Planning (now DP&I).
DP&I	NSW Department of Planning and Infrastructure (formerly DUAP, DIPNR and DoP)
DP	Deposited Plan. A plan of land deposited in Land and Property Information (part of the Land Management Authority) and used for legal identification purposes. They most commonly depict a subdivision of a parcel of land.
DPI	The NSW Department of Primary Industries now part of NSW Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS).
Drainage	Natural or artificial means for the interception and removal of surface or subsurface water.
Driven pile	A steel, concrete or timber pile which is forced into the ground by a pile driver.
Driveway	A defined area for vehicles to travel between a carriageway and a property adjacent or near to the road.
DSEWPaC	Australian Government Department of Sustainability, Environment, Water, Population and Communities (formerly DEWHA).
DTIRIS	NSW Department of Trade and Investment, Regional Infrastructure and Services.
DUAP	NSW Department of Urban Affairs and Planning (now DP&I)
E	
EA	Environmental assessment. A focussed analysis undertaken for the purposes of Part 3A of the Environmental Planning and Assessment Act 1979, written generally to comply with the environmental assessment requirements (DGRs) issued by the Director-General of the Department of Planning.
Earthworks	All operations involved in loosening, excavating, placing, shaping and compacting soil or rock.
ECF	Energy Content Factor
Ecology	The relationship between living things and the environment.

Term	Meaning
Ecosystem	A functional unit of energy transfer and nutrient cycling in a given place. It includes all relationships within the biotic community and between the biotic components of the system.
ECRTN	NSW Environmental Criteria for Road Traffic Noise.
Eddying	A movement in a flowing stream of water in which the current doubles back to form a small whirl.
Edge effects	A change in species composition, physical conditions or other ecological factors at the boundary between two ecosystems or the ecological changes that occur at the boundaries of ecosystems (including changes in species composition, gradients of moisture, sunlight, soil and air temperature, wind speed and other factors).
EEC	Endangered ecological community. An ecological community identified by relevant legislation that is likely to become extinct or is in immediate danger of extinction.
EEO Act	*Energy Efficiency Opportunities Act 2006* (Commonwealth)
Electrofishing	Electrofishing uses an electric current to stun and catch fish. It is a common method of fish sampling in ecological studies.
Embankment	An earthen structure where the road (or other infrastructure) subgrade level is above the natural surface.
Emission factor (EF)	Emission factors convert an indicator of activity into estimated greenhouse gas emissions.
Emission source	Source from which greenhouse gases are released.
EMP	Environmental management plan. A plan used to manage environmental impacts during each phase of project development. It is a synthesis of all proposed mitigation, management and monitoring actions, set to a timeline with defined responsibilities and follow up actions.
EMS	Environmental management system. A quality system that enables an organisation to identify, monitor and control its environmental aspects. An EMS is part of an overall management system, which includes organisational structure, planning activities, responsibilities, practices, procedures, processes and resources for developing, implementing, achieving, reviewing and maintaining the environmental policy.
ENCM	NSW *Environmental Criteria for Road Traffic Noise* (ECRTN) (Environment Protection Authority, 1999), which has been superseded by the ICNG but is used for guidance in assessing the potential for sleep disturbance.
ENM	Excavated Natural Material
ENMM	RMS Environmental Noise Management Manual.
Environment	All aspects of the surroundings of humans, whether affecting any human as an individual or in his or her social groupings (from EP&A Act).
EP&A Act	*Environmental Planning and Assessment Act 1979* (NSW).
EP&A Regulation	*Environmental Planning and Assessment Regulation 2000* (NSW).
EPA	NSW Environment Protection Authority (formerly part of DECCW, now part of OEH).

Term	Meaning
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth).
Ephemeral	Existing for a short duration of time.
EPI	Environmental planning instrument. Legal documents that regulate land use and development – includes state environmental planning policies and local environmental plans.
EPL	Environment Protection Licence.
Escarpment	A long, cliff-like ridge of rock commonly formed by faulting or fracturing of the earth’s crust.
ESCP	Erosion and sediment control plan.
ESD	Ecologically sustainable development. As defined by the *Protection of the Environment Administration Act 1991*, requires the effective integration of economic and environmental considerations in decision making processes including: - The precautionary principle. - Inter-generational equity. - Conservation of biological diversity and ecological integrity. - Improved valuation, pricing and incentive mechanisms (includes polluter pays, full life cycle costs, cost effective pursuit of environmental goals).
Estuary	The mouth or lower course of a river in which the current meets the sea’s tide.
Evapo-transpiration	The sum of evaporation and plant transpiration from the land to the atmosphere.
Off-ramp	A short section of road which allows vehicles to enter or exit a highway.
F	
Facies	The character of a rock expressed by its formation, composition, and fossil content.
Fauna furniture	Items such as rocks, piping, raised log railings and refuge poles, that are within fauna crossing structures and assist fauna utilising these structures.
FBB	Foxground and Berry bypass project.
Fence stiles	A structure that provides passage through or over a fence.
Fill	The material placed in an embankment.
Flood mitigation	Measures taken to control or minimise the effects of flooding.
Floristics	A branch of botany dealing with the types, numbers, distribution, and relationships of plant species in a particular area or areas
Fly ash	Particles produced as a by-product in coal fired power stations.
FM Act	NSW *Fisheries Management Act 1994*.
Footpath	The paved area in a footway.
Footprint	The extent of impact that a development makes on the land.
Formation	The final shape of the road after completion of earthworks but before placing any pavement layers.

Term	Meaning
Fragmentation	The breaking up of continuous sections of ecosystems or landscape features.
Freeboard	The vertical distance from the top water level of a flood or creek to a specific location such as a road surface level or a ground level of a house.
Frequency (sound)	Similar to the pitch of a musical note in sound pressure fluctuations of cycles per second (Hertz). Most sounds comprise a composite of frequencies of varying sound-pressure levels in the range of 20 Hertz to 20,000 Hertz.
Fretting	Wearing of exposed soils.
FullCAM	Full Carbon Accounting Model Ecosystem modeling as part of an NCAS estimate.
G	
GDE	Groundwater Dependent Ecosystems.
Geofabrics	Permeable material that separates water from particulates.
Geomorphic	Of, or pertaining to, the earth or the forms of its surface.
Geotextile	A synthetic, permeable cloth designed to be buried under the ground often used for soil strengthening or drainage purposes.
Geoweb	Geofabric within which infill material is placed and compacted.
GHG	Greenhouse gas
Global warming potential (GWP)	GWP is a measure of how much a given mass of a greenhouse gas is estimated to contribute to global warming. It is a relative scale that compares a gas with the same mass of carbon dioxide and is calculated over a specific time interval.
GPS	Global Positioning System.
Grade	1. The rate of longitudinal rise (or fall) with respect to the horizontal expressed as a percentage or ratio. 2. To trim or smooth an earth, gravel or other surface using a grader or similar implement.
Grade separation	The separation of road, rail or other traffic so that crossing movements at intersections are at different levels. Opposite to at-grade.
Greenfield	Previously undeveloped land.
Greenhouse gas (GHG)	Greenhouse gases are those gases which reduce the loss of heat from the earth's atmosphere by absorbing infrared radiation. Six greenhouse gases are regulated by the Kyoto Protocol: Carbon dioxide (CO_2), Methane (CH_4), Nitrous oxide (N_2O), Hydrofluorocarbons (HFCs), Perfluorocarbons (PFCs) and Sulphur hexafluoride (SF_6). The emissions of greenhouse gases are reported in carbon dioxide equivalents (see above).
Ground cover	A low growing woody or herbaceous plant.
Ground vibration	The combined speed of ground oscillation at a point from a source of vibration such as a blast or vehicle.
Groundwater	Water that is held in the rocks and soil beneath the earth’s surface.
Grubbing	The removal of roots or stumps from below ground level.

Term	Meaning
H	
ha	Hectare/s.
Ha ha effect	A term in urban design that refers to a barrier, one side of which is concealed from view, designed to allow an unobstructed view from one side while maintaining a physical barrier in one direction.
Habitat	The place where a species, population or ecological community lives (whether permanently, periodically or occasionally). Habitats are measurable and can be described by their flora and physical components.
Haul road	A designated road, often temporary, used for moving materials (often used when new infrastructure is being constructed).
Headwall	Small retaining wall placed at the outlet of a stormwater pipe or culvert.
Heavy vehicle	A heavy vehicle is classified as a Class 3 vehicle (a two axle truck) or larger, in accordance with the Austroads Vehicle Classification System.
HEC-RAS	Hydraulic Engineering Centre River Analysis System, developed by the US Army Corps of Engineers. Models the hydraulics of water flow through natural channels.
HFCs	Hydrofluorocarbons.
HIP	Heritage Interpretation Plan.
Hydrocarbon	Any organic compound — gaseous, liquid or solid — consisting only of carbon and hydrogen.
Hydrology	The study of rainfall and surface water runoff processes.
Hydromulching	A procedure to establish grass over a large area. A mixture of grass seed, chopped straw and fertiliser is sprayed over the area to be grassed.
Hydroseeding	Broadcasting of seed under pressure by spraying a slurry of water, seed and fertiliser in addition to mulch, binder and a green dye.
Hyporheic	The zone where surface water intersects and interacts with groundwater.
I	
I & I	Industry and Investment NSW.
ICNG	Interim Construction Noise Guideline.
Impact	Influence or effect exerted by a project or other activity on the natural, built and community environment.
Indigenous species	Plant species native to the area in which the project is located.
Inert construction waste	Byproducts from construction that are chemically and biologically inactive.
INP	NSW Industrial Noise Policy.
Intensity of rainfall	The rainfall in a unit of time (usually expressed as mm/h).
Interchange	A grade separation of two or more roads with one or more interconnecting carriageways.
Intersection at-grade	An intersection where carriageways cross at a common level.

Term	Meaning
Intersection turning counts	The number of vehicles counted turning at an intersection.
Intrusive noise	An environmental noise source that may cause annoyance.
IPCC	Intergovernmental Panel on Climate Change.
ISEPP	*State Environmental Planning Policy (Infrastructure) 2007*.
J	
Junction	A place where two or more roads meet.
Jute mesh	A mesh that is designed to hold soil and seeds in place until vegetation can take hold and which naturally degrades into the soil.
K	
Kerb	An edge stone or concrete shape used for bordering a road and defining the footway.
L	
LA_{10}	The noise level which is exceeded for 10% of the sample period. During the sample period, the noise level is below LA_{10} level for 90% of the time. The LA_{10} is a common noise descriptor for environmental noise and road traffic noise.
LA_{90}	The noise level which is exceeded for 90% of the sample period. During the sample period, the noise level is below LA_{90} level for 10% of the time. This measure is commonly referred to as background noise level.
LA_{eq}	The equivalent continuous sound level. This is the energy average of the varying noise over the sample period and is equivalent to the level of constant noise which contains the same energy as the varying noise environment. This measure is a common measure of environmental noise and road traffic noise.
LALC	Local Aboriginal Land Council.
LA_{max}	The maximum noise level over a sample period is the maximum level, measured on fast response, during the sample period.
Landscape	1. A tract of land. 2. A prospect or piece of scenery or land which may include villages, towns, cities and infrastructure.
Landscape character.	The aggregate of built, natural and cultural aspects that make up an area and provide a sense of place. Includes all aspects of a tract of land – built, planted and natural topographical and ecological features.
Lane	A portion of the carriageway allotted for the use of a single line of vehicles.
LCV	Light commercial vehicle
Left-in and left-out	Restricted turning movements for vehicles entering and leaving the highway. Only left hand turns would be permitted due to the central median barrier to prevent conflicting traffic movements.
LEP	Local environmental plan.
LGA	Local government area.
Light vehicle	A vehicle less than five tonnes gross.
Lithology	General physical characteristics of a rock.

Term	Meaning
Local provenance species	Species found growing in the locality of a project.
Local road	A road or street used primarily for access to abutting properties.
Longitudinal	Running lengthways rather than across.
LoS	Level of service. A qualitative measure describing operational conditions within a traffic stream and their perception by motorists and/or passengers.
Lot	A parcel of land defined by measurement as a lot in a deposited plan (DP) or as a Crown portion or allotment.
M	
Macrophytes	Macrophytes are aquatic plants that can be seen with the naked eye. They can grow below, within or on top of the water.
Median	The central reservation which separates carriageways from traffic travelling in the opposite direction.
Methodology	The method for analysis and evaluation of the relevant subject matter.
micron	One millionth of a metre (abbreviation μ).
Midblock	A general location on a road between two intersections.
Mode	A type or method of transport movement – including for the road corridor: cars, buses, bikes and pedestrians.
Motorway	Fast, high volume controlled access roads. May be tolled or untolled.
MP	Member of Parliament.
Mt	Million tonnes.
MUSIC	Model for Urban Stormwater Improvement Conceptualisation
MVKT	Million vehicle kilometres travelled.
N	
N_20	Nitrous oxide.
NCA	Noise Catchment Areas.
NCAS	National Carbon Accounting System.
NES	Matters of national environmental significance (from the Commonwealth *Environment Protection and Biodiversity Conservation Act 1995*).
NGA	National Greenhouse Accounts
NGER Act	*National Greenhouse and Energy Reporting Act 2007* (Commonwealth).
NOHC	Navin Officer Heritage Consultants.
NML	Noise Management Levels.
NO	Nitrogen monoxide.
NO_2	Nitrogen dioxide.
Notifiable weed	A noxious weed that is classified as a Class 1, 2 or 5 under the Noxious Weed Act 1993.
NOW	NSW Office of Water

Term	Meaning
NO_x	Oxides of nitrogen.
Noxious weeds	A weed declared to be a noxious under section 7 of the Noxious Weed Act 1993.
NPWS	NSW National Parks and Wildlife Service (now OEH).
NSW	New South Wales.
O	
O_3	Ozone
OEH	NSW Office of Environment and Heritage.
Offline construction	Sections of project that are to be constructed away from the existing highway.
OH&S	Occupational health and safety.
On-ramp	A ramp by which one enters a limited-access highway.
Online construction	Sections of the project where the existing highway would be upgraded.
Origin-destination surveys	A count of the number of vehicles travelling from one point to another.
Overtaking lane	An auxiliary lane provided to allow for slower vehicles to be overtaken. Line marked so that all traffic is initially directed into the left hand lane with the inner lane being used to overtake.
P	
PACHCI	Procedure for Aboriginal Cultural Heritage Consultation and Investigation.
PAD	Potential archaeological deposit. Any location considered to have a moderate to high potential for subsurface archaeological material.
PAH	Polyaromatic hydrocarbons.
PAMP	Pedestrian Access Mobility Plan.
Paramics	Traffic simulation modelling software.
Parish and Portion	NSW was originally divided into 141 administrative districts called Counties, which were further divided into 7515 districts known as Parishes. The parcels of land within Parishes are known as Portions.
Part 3A approvals (EP&A Act)	Major project approvals. Relates to the approval of a major project / critical infrastructure project under Part 3A of the *Environmental Planning and Assessment Act 1979.*
PASA	Potential Archaeologically Sensitive Areas.
PASS	Potential acid sulfate soils.
Pavement	The portion of a carriageway placed above the subgrade for the support of, and to form a running surface for vehicular traffic.
PCB	Polychlorinated biphenyls.
Peak Oil	The predicted time when oil extraction reaches its maximum.
pH	A measure of acidity or alkalinity of a solution, numerically equal to 7 for neutral solution, increasing with increasing alkalinity and decreasing with increasing acidity. Originally stood for the words potential of hydrogen.

Term	Meaning
PHA	Preliminary hazard analysis.
PIARC	Permanent International Association of Road Congresses.
Piezocone (electric cone)	Device used to test to determine subsurface stratigraphy for geotechnical and environmental site characterisation purposes.
Piezometer	Device used to measure the pressure of groundwater, or static pressure of a liquid.
PM	Particulate matter.
PM_{10}	Particulate matter less than 10 microns in diameter.
PMF	Probable maximum flood. Largest flood that could theoretically occur at a particular location and defines the extent of flood prone land (the floodplain).
POEO Act	NSW *Protection of the Environment Operations Act 1997.*
Pollutant	Any measured concentration of solid or liquid matter that is not naturally present in the environment.
Pool	Areas in a waterway with little or no flow.
Productive agricultural land	Land with the best combination for soil, climate and topography for agricultural production as mapped by NSW Industry and Investment. Often shown in the maps accompanying regional planning strategies and local environmental plans.
PRM	Probabilistic Rational Method.
Proponent	The person or organisation that proposes carrying out the project or activity.
Public domain	The community's public space.
Putrescibles	Material that is able to be broken down or decay.
Q	
Quadrats	A small plot of land in which a plant or animal population study is conducted.
Quarry	An open pit from which stone, sand, gravel or fill is taken.
R	
RAN	Royal Australian Navy.
RBL	Rating background level. The median value of the assessment background levels value for the period over all of the days measured. There is therefore an RBL value for each period — daytime, evening and night-time.
RCE	Riparian, Channel and Environmental.
RCMS	Riparian Corridor Management Study.
Receptor/receiver	An environmental modelling term used to describe a map reference point where the impact is predicted. A sensitive receptor is a home, work place, school or other place where people spend some time. An elevated receptor is a point above ground level.
Remnant native vegetation	Small patches of native vegetation that remain after land use changes to the surrounding area.
REP	Regional environmental plan. All regional environmental plans are now deemed State environmental planning policies.

Term	Meaning
Representative impact scenario	The r*epresentative impact scenario* would see the project as described being undertaken but without the implementation proposed measures such as: Mitigation; on site management; minimisation of impacts; offsetting measures and monitoring procedures.
Revegetation	To revegetate an area by direct seeding with native species using manual or mechanical means such as hydromulching, strawmulching and tractor seeding.
Riffle	Areas in a waterway of broken water with rapid current.
Riparian	Relating to the banks of a natural waterway.
RMS	Roads and Maritime Services of New South Wales.
RNP	NSW Road Noise Policy.
Road furniture	A general term covering all signs, street lights and protective devices for the control, guidance and safety of traffic and convenience of road users.
Road reserve	A legally defined area of land within which facilities such as roads, footpaths and associated features may be constructed for public travel.
Roadside	The area from the edge of the carriageway to the boundary of the road reserve.
Roundabout	An intersection where all traffic travels in one direction around a central island.
RTA	Roads and Traffic Authority of NSW (now RMS)
Run off	That part of the rainfall on a catchment which flows as surface discharge past a specified point.
S	
Saddle	A low point of a ridge connecting two peaks.
Safe intersection sight distances	The minimum sight distance which should be available from vehicles on the legs of an intersection.
'Sandtrack'	An alternative route to the winding, hilly section of Princes Highway between Gerringong and Bomaderry (via Fern Street, Crooked River Road, Gerroa Road and Bolong Road).
SAQP	Sampling Analysis and Quality Plan.
SCC	Shoalhaven City Council.
Scour	The erosion of material by the action of flowing water.
SCRS	South Coast Regional Strategy.
Section 170 register	A register established in accordance with section 170 of the *Heritage Act 1977* to record all heritage items in the ownership or under control of the RMS (or other state government agency).
Section 90 permit	An Aboriginal impact heritage permit issued by OEH under s.90 of the *National Parks and Wildlife Act 1974*.
Sediment	Material, both mineral and organic, that is being or has been moved from its site of origin by the action of wind, water or gravity and comes to rest either above or below water level.
Sediment/Sedimentation basin	An area where runoff water is ponded to allow sediment to be deposited.

Term	Meaning
Sediment trap	A structure or barrier designed to trap sediment in run-off before it enters the stormwater system, channels or streams.
Sedimentation	Deposition of sediment usually by water.
Select material zone (SMZ)	A road is broken up into a number of specified layers. The top layers are classified as 'base' and 'sub base' layers. The next level down is classified as a 'select zone' and the next layer below' (SMZ), which is a selection of material from the site that has higher strength qualities. The 'upper zone of formation' (UZF), includes the 'select material'.
Selected fill	Fill complying with specified requirements.
SEPP	State environmental planning policy.
SES	State Emergency Services.
Severance of land	The creation of a physical barrier between a property and an existing road access to that property, or between two sections of the same property.
Shared path	A pathway used for both cyclists and pedestrians, usually located on the side of the road.
Shotcrete	Concrete applied to a surface through a pressure hose.
Shoulder	The portion of the carriageway beyond the traffic lanes adjacent to and flush with the surface of the pavement.
SICPH CL	Southern Illawarra Coastal Plain and Hinterland Cultural Landscape.
Sight distance	The distance measured along the carriageway over which objects of defined height are visible to a driver whose eyes are at a specified height above the pavement surface level.
SIGNAL 2	Stream Invertebrate Grade Number – Average Level. A scoring system for macroinvertebrate samples from Australian rivers.
SIS	Species impact statement.
Site compound	Area enclosing construction machinery, stockpiles, site offices and other ancillary facilities.
Slag	Waste matter separated from metals during the smelting or refining of ore.
SO_2	Sulphur dioxide.
SoC	Statement of commitments.
Socio-economic	Involving combination of social and economic matters.
SOHI	Statement of Heritage Impact.
Spall	Splintering or flaking of rock (often from weathering).
Span	The distance between the centres of adjacent supports of a bridge.
Spoil	Surplus excavated material.
Spot bolting	A method of stabilising walls of excavations.
State heritage register	A register kept by the NSW Heritage Council which lists places, buildings, works, relics, moveable objects or precincts that the Minister for Planning considers are of State heritage significance.
Sterilisation of land	The project severs a property into fragments of a size or shape that causes the existing land use to become unviable. This would result in a change in land use.

Term	Meaning
Stock underpass	A structure to permit the passage of stock beneath a road.
Stockpile	Temporarily stored materials such as soil, sand, gravel and spoil/waste.
STP	Sewage treatment plant.
Stratum	Layers of rock in the ground.
Surface water	Water flowing or held in streams, rivers and other wetlands in the landscape.
Sustainability	Considering present and future needs and costs.
Swale	A shallow, grass-lined drainage channel.
SWMP	Soil and Water Management Plan.
T	
TAGG	Transport Authorities Greenhouse Group.
Taxa	Groups or categories, at any level, in a system for classifying plants or animals.
Terrestrial	Living or growing on land (ie a terrestrial plant or animal).
Terrestrial ecology	Flora and fauna whose habitat on land as opposed to in water, or on the ground as opposed to on another plant.
Threatened	As defined under the *Threatened Species Conservation Act 1994*, a species, population or ecological community that is likely to become extinct or is in immediate danger of extinction.
Tie-in point	A location where the highway connects with the local road network or a location where the upgraded highway connects with immediately adjacent sections of highway.
TIG	Technical Investigation Group.
Tip Sheet	Illustrated information documents designed to provide contractors with practical guidance of statutory and RMS best practice requirements relating to specific workplace OHS hazards.
TMP	Traffic Management Plan.
TN	Total Nitrogen.
TP	Total Phosphorus.
TPH	Total petroleum hydrocarbon.
TRACKS	Strategic traffic modelling for current to future year growth rates.
TRACL	Toolijooa Ridge Aboriginal cultural landscape.
Transport interchange	A station or other transport node that offers transferability between modes – such as between rail, road, air, and sea.
TRCL	Toolijooa Ridge Cultural Landscape.
Tributary	A river or stream flowing into a larger river or lake.
TSC Act	NSW *Threatened Species Conservation Act 1995*.
TSP	Total Suspended Particulates.
TSS	Total Suspended Solids.
Turbidity	A measure of light penetration through a water column containing particles of matter in suspension.

Term	Meaning
Type ‘S’ Interchange	An S-shaped interchange that has been designed to provide left-in and left-out access in both directions. The interchange is designed to utilise adjoining existing road infrastructure either side of the upgrade, connected by an overbridge.
Typical cross section	A cross section of a carriageway showing typical dimensional details, furniture locations and features of the pavement construction.
U	
UNFCCC	The ‘Kyoto Protocol to the United Nation Framework Convention on Climate Change’, which was signed in 1997 and Australia ratified the protocol in December 2007.
Underpass	A grade separation where the subject carriageway passes under an intersecting carriageway (or railway). A tunnel constructed for the use of pedestrians, cyclists, fauna and/or stock under the carriageway.
Unsignallised	Without traffic signals, such as traffic lights.
Urban design	The process and product of designing human settlements, and their supporting infrastructure, in urban and rural environments.
USEPA	United States Environmental Protection Agency
V	
Valley tunnels	Small but steep valleys (and ridges) running in south easterly direction into Broughton Creek off the ridgeline between Broughton Mill Creek and Broughton Creek catchments.
Vascular flora species	Plants containing specialised conducting tissues which transport water, minerals, salts and sugars throughout the plant.
Vegetated portals	The transition from the open pastoral landscape to enclosed tree lined creeks and remnant areas of forest.
VENM	Virgin excavated natural material
Verge	That portion of the formation not covered by the carriageway, the median or the footpath.
Viewshed	The area visible from a fixed point.
VKT	Vehicle kilometres travelled.
VMP	Vegetation Management Plan.
VMS	Variable Message Sign.
Volcanoclastic	Particulate aggregate, in which most fragments have been deposited by volcanic eruption
Vulnerable	As defined under the *Threatened Species Conservation Act 1995*, a species that is likely to become endangered unless the circumstances and factors threatening its survival or evolutionary development cease to operate.
W	
WARR Act	*Waste Avoidance and Resource Recovery Act 2001.*
Water table	The surface of saturation in an unconfined aquifer at which the pressure of the water is equal to that of the atmosphere.
Waterway	Any flowing stream of water, whether natural or artificially regulated (not necessarily permanent).

Term	Meaning
Wetland	A swamp or marsh in which the soil is frequently or permanently saturated with water, or under water.
Wick drains	Vertical drains that allow for the quick settlement of soft soils.
WONS	Weeds of National Significance
Worst case impact scenario	The *worst case impact scenario* would see the project as described being undertaken but without the implementation of: Mitigation measures; on site management; minimisation of impacts; offsetting measures and monitoring procedures.
WRAPP	Waste Reduction and Purchasing Policy.
X, Y, Z	
Zoning	Zoning regulates land use within an environmental planning instrument (usually by different colour codes on a map accompanying a local environmental plan). Land use tables set out the various purposes for which land may or may not be used or developed in each zone.

Executive summary

What is proposed?

Roads and Maritime Services (RMS) propose to upgrade 11.6 kilometres of the Princes Highway between Toolijooa Road north of Foxground and Schofields Lane south of Berry, in New South Wales (NSW) (the project), to achieve a four lane divided highway (two lanes in each direction) with median separation. The project includes bypasses of Foxground and Berry.

The project would comprise the following key features:

- Construction of a four lane divided highway (two lanes in each direction) with median separation (wire rope barriers or concrete barriers where space is constrained, such as at bridge locations).
- Bypasses of the Foxground bends and the Berry township.
- Construction of around 6.6 kilometres of new highway where the project deviates from the existing highway alignment at Toolijooa Ridge, the Foxground bends and the Berry township.
- Provision for the possible widening of the highway (if required in the future) to six lanes within the road corridor and, in some areas, construction of the road formation to accommodate future additional lanes where safety considerations, traffic disruption and sub-optimal construction practices are to be avoided.
- Grade-separated interchanges at:
  - Toolijooa Road.
  - Austral Park Road.
  - Tindalls Lane.
  - East of Berry at the existing Princes Highway, referred to as the northern interchange for Berry.
  - West of Berry at Kangaroo Valley Road, referred to as the southern interchange for Berry.
- A major cutting at Toolijooa Ridge (around 900 metres long and up to 26 metres deep).
- Six lanes (two lanes plus a climbing lane in each direction) through the cutting at Toolijooa Ridge for a distance of 1.5 kilometres.
- Four new highway bridges:
  - Broughton Creek bridge 1, a four span concrete structure around 170 metres in length and nine metres in height.
  - Broughton Creek bridge 2, a three span concrete structure around 75 metres in length and eight metres in height.
  - Broughton Creek bridge 3, a six span concrete structure around 190 metres long and 13 metres in height.
  - A bridge at Berry, a 19 span concrete structure around 600 metres long and up to 12 metres in height.

- Three highway overbridges:
  - Austral Park Road interchange, providing southbound access to the highway.
  - Tindalls Lane interchange, providing southbound access to and from the highway.
  - Southern interchange for Berry, providing connectivity over the highway for Kangaroo Valley Road along its existing alignment.
- Eight underpasses including roads, drainage structures and fauna underpasses:
  - Toolijooa Road interchange, linking Toolijooa Road to the existing highway and providing northbound access to the upgrade.
  - Property access underpass in the vicinity of Toolijooa Ridge at chainage 8400.
  - Dedicated fauna underpass in the vicinity of Toolijooa Ridge at chainage 8450.
  - Property access underpass between Toolijooa Ridge and Broughton Creek at chainage 9475.
  - Combined drainage and fauna underpass in the vicinity of Austral Park Road at chainage 12800.
  - Combined drainage and fauna underpass in the vicinity of Tindalls Lane at chainage 13320.
  - Dedicated fauna underpass in the vicinity of Tindalls Lane at chainage 13675.
  - Property access underpass between the Tindalls Lane interchange and the northern interchange for Berry in the vicinity of at chainage 15100.
- Modifications to local roads, including Toolijooa Road, Austral Park Road, Gembrook Lane, Tindalls Lane, North Street, Queen Street, Kangaroo Valley Road, Hitchcocks Lane and Schofields Lane.
- Diversion of Town Creek into Bundewallah Creek upstream of its confluence with Connollys Creek and to the north of the project at Berry.
- Modification to about 47 existing property accesses.
- Provision of a bus stop at Toolijooa Road and retention of the existing bus stop at Tindalls Lane.
- Dedicated u-turn facilities at Mullers Lane, the existing highway at the Austral Park Road, the extension to Austral Park Road, interchange and Rawlings Lane.
- Roundabouts at the southern interchange for Berry and the Woodhill Mountain Road junction with the exiting Princes Highway.
- Two culs-de-sac on North Street and the western end of Victoria Street in Berry.
- Tie-in with the existing highway about 75 metres north of Toolijooa Road and about 440 metres south of Schofields Lane.
- Left in/left out only provisions for direct property accesses to the upgraded highway.
- Dedicated public space with shared pedestrian/cycle facilities along the southern side of the upgraded highway from the playing fields on North Street to Kangaroo Valley Road.
- Ancillary operational facilities, including permanent detention basins, stormwater treatment facilities and a permanent ancillary facility site for general road maintenance.

Why is it needed?

The project is one of a series of upgrades to sections of the Princes Highway which aims to provide a four lane divided highway between Waterfall and Jervis Bay Road, Falls Creek. It is one of the remaining sections to be upgraded and would add to the road safety and traffic efficiency benefits provided by the other Princes Highway upgrades.

The Princes Highway between Toolijooa Road and Schofields Lane generally consists of two lanes (undivided) with horizontal and vertical alignments that result in lower speed limits and traffic inefficiency, particularly near Toolijooa Ridge, Foxground and Broughton village. There are limited overtaking opportunities, many at-grade junctions with rural roads and numerous private accesses. The highway runs through the town centre of Berry, creating conflicts between through traffic, local traffic and pedestrians and reducing the amenity of Berry.

There is a need to provide a highway that meets RMS network planning targets and minimises conflicts for current and future road users. If the highway is not upgraded, the efficiency, safety and amenity along the highway and within Berry would continue to deteriorate as traffic volumes increase over time.

How would the project satisfy this need?

The project would provide a safer and more efficient road network to better serve current and future road users by:

- Addressing the high crash history and poor road safety record of this section of the Princes Highway and delivering immediate road safety benefits.
- Ensuring compliance with current design, safety and traffic efficiency requirements of RMS.
- Removing through traffic from Berry town centre, improving the amenity of the town and road safety of the local road network.
- Delivering improved traffic efficiency by catering for projected traffic volumes in the design year (2037), which is 20 years after the project becomes operational.
- Delivering a highway design consistent with that of the majority of the remainder of the highway between Waterfall and Jervis Bay Road.

What alternatives and options were considered?

Alternatives

The following alternatives were addressed:

- Base case (‘do nothing’).
- Upgrade of the Princes Highway.
- Upgrade of the ‘Sandtrack’.
- Upgrade of the South Coast Railway.

An upgrade of the Princes Highway was identified as the preferred alternative as it would improve road safety and efficiency. It would also support regional and local economic development, and provide beneficial effects for Berry by removing highway traffic from the town centre via the bypass.

Route options

Route options for the project area were identified and evaluated as part of a broader route options process for the Princes Highway upgrade between Gerringong and Bomaderry. This process was undertaken in consultation with the community and took into account the key environmental, social and economic constraints associated with the study area.

The project covers the section of the initial route options selection study area between Toolijooa Road and Schofields Lane. A number of different route options were considered for this section, including options that were developed through a value management process and options that were developed in response to community feedback.

Access options

The upgraded highway would connect to the local road network at a number of locations. The following describes the off-ramp options from and on-ramp options to the upgraded highway that were considered.

The distinguishing features of the off-ramp options into Berry were:

- Option B1 provided a northbound off-ramp that connected to an existing roundabout in Huntingdale Park Estate.
- Option B2 provided a northbound off-ramp under the proposed Kangaroo Valley Road overbridge, rounding in a loop to the left to join with Kangaroo Valley Road opposite Huntingdale Park Estate.
- Option B3 provided a northbound off-ramp under the proposed Kangaroo Valley Road overbridge, then curved to the left onto North Street to join Kangaroo Valley Road.
- Option B4 provided a southbound off-ramp that connected directly to Alexandra Street.
- Option B5 provided a southbound off-ramp that connected to the existing highway around 400 metres north of Tannery Road.

The distinguishing features of the on-ramp options from Berry were:

- Option B6 provided a northbound on-ramp at Woodhill Mountain Road.
- Option B7 provided a northbound on-ramp that connected to the existing highway around 500 metres north of the property ‘Mananga’ and required a bridge over the proposed alignment.
- Option B8 provided a southbound on-ramp at the western end of Queen Street.
- Option B9 provided a southbound on-ramp at Alexandra Street.

Other access options also considered included the provision of flood free access for Berry, the need for a second northbound off-ramp and the feasibility of splitting the location for the southern interchange for Berry.

Preferred option

The preferred option was identified as:

- A combination of the pink and modified orange route options.
- A combination of access options B5 and B7 to form the northern access interchange, providing an exit from Berry for traffic travelling to the north and access into Berry for traffic travelling from the north.
- An all-movements interchange at Kangaroo Valley Road, allowing access into and out of Berry from the north and south.

The preferred option was considered to provide the best outcome for the local environment and community. It performed the best against the project objectives of providing value for money, supporting regional and local economic development, traffic efficiency and maximising the benefits to the local social environment and road safety.

A number of design refinements were also considered as part of the community consultation undertaken for the project. These refinements were generally focussed around the bridge at Berry and the North Street corridor but also included other aspects of the project such as a heavy vehicle rest area.

The key design refinements included:

- Moving the bridge at Berry around 95 metres to the north and lowering it by around 6.4 metres.
- Moving the alignment further north of Berry and providing a buffer of around 40 metres between North Street residents and the project.
- Lowering the embankment along North Street by up to two metres, reducing the height of the noise barriers required relative to North Street and minimising the visual impact of the project.
- Removing a proposed heavy vehicle rest area near Austral Park Road from the project.
- Revising the arrangement of the southern interchange for Berry, mainly focussing on the alignment of the northbound off-ramp.

The project alternatives and a detailed description of the options selection process are provided in **Chapter 3**.

How did the community participate in selecting the preferred option?

Throughout the project, RMS has considered meaningful and engaging community consultation to be essential. As such the community have been involved in each phase of the project development. Consultation commenced in March 2006.and will continue throughout the environmental assessment, detailed design and construction of the project.

The initial development of route options involved community information sessions, meetings with Local Aboriginal Land Councils, interest group workshops, meetings with Kiama Municipal Council and Shoalhaven City Council and specialist information sessions.

Following the establishment of route and access options, the preferred option was developed through value management workshops. This involved representatives from key government agencies, local councils, the emergency services, the Aboriginal community and the Berry urban and rural communities. The value management workshops developed key assessment criteria and evaluated the potential options. The workshops assessed and weighted the options against the project objectives (refer to **Section 2.3**) as well as functional, social and economic criteria.

In August 2011, RMS commenced a review into the preferred route north of Berry in consultation with the community. This followed a request by the local member for Kiama to consider the community's concerns relating to the potential noise and visual amenity impacts of the preferred option.

A Berry community review group (CRG) was established as part of this review, and met on seven occasions before the consultation with the wider community was undertaken between 1 December 2011 and 14 December 2011. The development of the revised preferred option continually evolved through the CRG meetings and workshops.

Between January and August 2012, RMS held a number of working groups to review community and design issues. These groups each focussed on specific areas of the project. As well as these groups, RMS also conducted a review of the bypass of Berry which included a detailed cost analysis of both a northern and southern bypass option.

Further information on options selection is provided in **Chapter 3** and community consultation is discussed in detail in **Chapter 6** of this environmental assessment.

What are the main beneficial outcomes expected?

Beneficial outcomes resulting from the project would consist of:

- Improved road safety, including reduced crash rates from providing a divided road and preventing traffic turning to and from minor roads across fast-moving two-way traffic.
- Improved efficiency, including higher safe travel speeds, shorter travel time and improved level of service on the highway and at intersections.
- Improved road safety of the local road network in Berry due to the removal of conflicts between highway and local traffic movements within Berry.
- Improved amenity within Berry due to the removal of heavy vehicles, including improved air quality, reduced noise levels and improved visual amenity along Queen Street. The reduced conflict between pedestrians and heavy vehicles along the main street would improve safety and the character of Berry.
- Improved access to the existing tourism industry on the South Coast.
- Improved access to markets and raw materials in Sydney and the Wollongong-Kiama area for industries in the Nowra area due to reduced travel times and increased road safety.
- Increased turnover for non-highway reliant businesses.

Refer to **Chapters 7 and 8** of this environmental assessment for further details.

What are the main adverse outcomes expected?

The project would result in a number of short term adverse outcomes during the construction of the project. These would include increased noise levels and reduced traffic efficiency caused by narrowing of lanes, speed reductions, temporary road closures and increased heavy vehicle and light vehicle movements along the network.

The project would result in some adverse outcomes in the longer term, including:

- Changed access arrangements and modifications to local roads and properties. Local roads and accesses would be restricted to left-in and left-out movements due to a central median and safety barrier fencing and some local roads would have highway connections closed. This would increase travel times and redistribute some local traffic but there would be a safety benefit.
- Increased noise levels. A small number of sensitive receivers would be exposed to noise levels above the relevant operational noise criteria. However, none of these receivers would be significantly affected by the project.
- Potential direct and indirect impacts to around 57.1 hectares of native vegetation. This includes the loss of 2.9 hectares of the endangered ecological community (EEC) River-flat eucalypt forest on coastal floodplains of the North Coast, Sydney Basin and South East Corner bioregions.
- The permanent diversion of Town Creek.
- Increased road runoff through drainage infrastructure due to a greater area of impervious surfaces.
- Intrusion of the project on the existing landscape character and visual environment, especially large cuttings and bridges. Loss of some visual connection between Berry and the escarpment.
- Partial impact to 18 and full impact to eight sites, items or objects of Aboriginal heritage significance.
- Partial impact to six and full impact to 13 sites, items or objects of non-Aboriginal heritage significance.
- The acquisition of 112 hectares of land currently outside the existing corridor some of which has already been acquired by RMS.
- Impacts on community cohesion between Berry and west Berry due to the severance of North Street.
- Economic impacts such as the loss of viable agricultural land and reduced turnover for highway reliant businesses.

Refer to **Chapters 7 and 8** of this environmental assessment for further details.

How will the likely adverse impacts be managed?

This environmental assessment examines the likely consequences of the project. As part of this assessment, measures to mitigate or manage each likely impact have been proposed. The mitigation measures developed for the proposed upgrade aim to remove or minimise potential impacts through design in the first instance. Where a potential impact is unable to be mitigated through design, management measures are outlined.

The environmental, social and economic impacts and measures identified to minimise those impacts are discussed in **Chapters 7 and 8** of this environmental assessment. A draft statement of commitments, which lists the desired outcomes and the actions to be implemented by the RMS or its contractor to achieve these outcomes, is provided in **Chapter 10** of this environmental assessment.

How can I comment on the proposal and/or the environmental assessment?

The NSW Department of Planning and Infrastructure will make the environmental assessment publicly available for a minimum period of 30 days. During this period, it will be available for inspection at the Department of Planning and Infrastructure website www.planning.nsw.gov.au, on the RMS project website www.rta.nsw.gov.au/roadprojects/projects/princes_hway/foxground_berry_bypass/index.html, at selected RMS offices, and at various displays in the region.

The environmental assessment will be available for viewing at the following locations:

- Kiama Municipal Council, 11 Manning Street, Kiama.
- Kiama Library, 7 Railway Parade, Kiama.
- Shoalhaven City Council, 44 Bridge Road, Nowra.
- Nowra Library, 10 Berry Street, Nowra.
- Office of Gareth Ward MP Member for Kiama, 125 Terralong Street Kiama.
- Gerringong upgrade Community Display Centre, 446 Princes Highway, Gerringong.
- RMS Wollongong office, 90 Crown Street, Wollongong.
- RMS North Sydney office, Level 9, 101 Miller Street, North Sydney.
- Berry project office, (Broughton Court) shop 3/113 Queen Street, Berry NSW.
- Department of Planning and Infrastructure Information Centre, 23-33 Bridge Street, Sydney.
- Nature Conservation Council of NSW, Level 2, 5 Wilson Street, Newtown.

Staffed displays and stakeholder / community meetings will be held during the exhibition of the environmental assessment. A project information line will be available throughout the exhibition period – 1800 506 976 (toll free).

A person may make written submissions to the Director-General of the Department of Planning and Infrastructure during the exhibition period. All submissions received will be placed on the Department of Planning and Infrastructure's website. Submissions should be made to:

Director – Infrastructure Projects
Department of Planning and Infrastructure
GPO Box 39
Sydney NSW 2001
email: plan_comments@planning.nsw.gov.au
or online at: http://majorprojects.planning.nsw.gov.au

1 Introduction

1.1 The project

The Roads and Maritime Services (RMS) is seeking approval under Part 3A of the *Environmental Planning and Assessment Act 1979* for the upgrade of 11.6 kilometres of the Princes Highway between Toolijooa Road north of Foxground and Schofields Lane south of Berry, in New South Wales (NSW) (the project), to achieve a four lane divided highway (two lanes in each direction) with median separation. The project includes bypasses of Foxground and Berry.

The project is one of a series of upgrades to sections of the Princes Highway which aims to provide a four lane divided highway between Waterfall and Jervis Bay Road, Falls Creek. This would improve road safety and traffic efficiency, including for freight, on the NSW south coast.

The project comprises the following key features:

- Construction of a four lane divided highway (two lanes in each direction) with median separation (wire rope barriers or concrete barriers where space is constrained, such as at bridge locations).
- Bypasses of the Foxground bends and the Berry township.
- Construction of around 6.6 kilometres of new highway where the project deviates from the existing highway alignment at Toolijooa Ridge, the Foxground bends and the Berry township.
- Provision for the possible widening of the highway (if required in the future) to six lanes within the road corridor and, in some areas, construction of the road formation to accommodate future additional lanes where safety considerations, traffic disruption and sub-optimal construction practices are to be avoided.
- Grade-separated interchanges at:
  - Toolijooa Road.
  - Austral Park Road.
  - Tindalls Lane.
  - East of Berry at the existing Princes Highway, referred to as the northern interchange for Berry.
  - West of Berry at Kangaroo Valley Road, referred to as the southern interchange for Berry.
- A major cutting at Toolijooa Ridge (around 900 metres long and up to 26 metres deep).
- Six lanes (two lanes plus a climbing lane in each direction) through the cutting at Toolijooa Ridge for a distance of 1.5 kilometres.
- Four new highway bridges:
  - Broughton Creek bridge 1, a four span concrete structure around 170 metres in length and nine metres in height.
  - Broughton Creek bridge 2, a three span concrete structure around 75 metres in length and eight metres in height.
  - Broughton Creek bridge 3, a six span concrete structure around 190 metres long and 13 metres in height.
  - A bridge at Berry, an 18 span concrete structure around 600 metres long and up to 12 metres in height.

- Three highway overbridges:
  - Austral Park Road interchange, providing southbound access to the highway.
  - Tindalls Lane interchange, providing southbound access to and from the highway.
  - Southern interchange for Berry, providing connectivity over the highway for Kangaroo Valley Road along its existing alignment.
- Eight underpasses including roads, drainage structures and fauna underpasses:
  - Toolijooa Road interchange, linking Toolijooa Road to the existing highway and providing northbound access to the upgrade.
  - Property access and fauna underpass in the vicinity of Toolijooa Ridge at chainage 8400.
  - Dedicated fauna underpass in the vicinity of Toolijooa Ridge at chainage 8450.
  - Property access underpass between Toolijooa Ridge and Broughton Creek at chainage 9475.
  - Combined drainage and fauna underpass in the vicinity of Austral Park Road at chainage 12770.
  - Combined drainage and fauna underpass in the vicinity of Tindalls Lane at chainage 13320.
  - Dedicated fauna underpass in the vicinity of Tindalls Lane at chainage 13700.
  - Property access underpass between the Tindalls Lane interchange and the northern interchange for Berry in the vicinity of chainage 15100.
- Modifications to local roads, including Toolijooa Road, Gembrook Lane, Austral Park Road, Tindalls Lane, North Street, Queen Street, Kangaroo Valley Road, Hitchcocks Lane and Schofields Lane.
- Diversion of Town Creek into Bundewallah Creek upstream of its confluence with Connollys Creek and to the north of the project at Berry.
- Modification to about 47 existing property accesses.
- Provision of a bus stop at Toolijooa Road and retention of the existing bus stop at Tindalls Lane.
- Dedicated u-turn facilities at Mullers Lane, the existing highway at the Austral Park Road interchange, the extension to Austral Park Road and Rawlings Lane.
- Roundabouts at the southern interchange for Berry and the Woodhill Mountain Road junction with the exiting Princes Highway.
- Two culs-de-sac on North Street and the western end of Victoria Street in Berry.
- Tie-in with the existing highway about 75 metres north of Toolijooa Road and about 440 metres south of Schofields Lane.
- Left in/left out only provisions for direct property accesses to the upgraded highway.
- Dedicated public space with shared pedestrian/cycle facilities along the southern side of the upgraded highway from the playing fields on North Street to Kangaroo Valley Road.
- Ancillary operational facilities, including permanent detention basins, stormwater treatment facilities and a permanent ancillary facility site for general road maintenance.

The project would be funded by the NSW Government, with $9 million allocated to continue the planning and preconstruction activities for the project in the 2012-2013 State Budget. Construction of the project is anticipated to commence in late 2014 and is expected to take three years to complete.

An overview of the project is shown in **Figure 1-1**. A detailed description of the project is in **Chapter 4.**

1.2 Project location

The project is located in the Illawarra and NSW South Coast regions within the Kiama and Shoalhaven local government areas (LGAs). The regional context of the project is shown in **Figure 1-2**.

The northern end of the project is at the junction of Toolijooa Road and the Princes Highway around five kilometres west of Gerringong. The southern end of the project is located at Mullers Lane, around 1.3 kilometres south of Berry.

The project follows the existing highway alignment near Toolijooa Road before deviating towards the south over Toolijooa Ridge, where it bypasses Foxground bends and crosses Broughton Creek three times. The alignment rejoins the existing highway north of Austral Park Road.

The project then continues to generally follow the existing highway alignment until just north of Berry, close to the David and Alexander Berry memorial to bypass Berry to the north. At this point the alignment begins to bypass Berry to the north with a bridge over Broughton Mill Creek, Bundewallah Creek and Connollys Creek. The project would be close to North Street, Berry until it curves southwards passing under Kangaroo Valley Road, to re-join the existing highway alignment.

To the north and west of the project are the Illawarra and Cambewarra Ranges, which contain a number of nature reserves and a National Park. These include the Barren Grounds Nature Reserve, the Rodway Nature Reserve, the Cambewarra Range Nature Reserves, and, further to the west, the Budderoo National Park. Broughton Creek (and its tributaries), Broughton Mill Creek, Connollys Creek and Bundewallah Creek all commence within these ranges.

To the east of the project lies the South Coast Rail Line, which extends from Waterfall in southern Sydney to Bomaderry, located south of the project. From Kiama, there is a single line that is not electrified. A station is located at Berry, off Railway Street.

A ridge that starts at Currys Mountain in the north and extends to Toolijooa Ridge, Moeyan Hill and eventually to Coolangatta Mountain to the south separates the project from the flat coastal areas. Coomonderry Swamp, a wetland protected by *State Environmental Planning Policy No.14 – Coastal Wetlands*, Foy's Swamp and Seven Mile Creek National Park are located along the coastline.

Urban settlements, in addition to Berry, within the vicinity of the project are largely concentrated along the coastline and include Kiama, Gerringong, Gerroa and Shoalhaven Heads. The largest urban centre in the vicinity of the project is located around thirteen kilometres to the south at Nowra/Bomaderry, located alongside the Shoalhaven River.

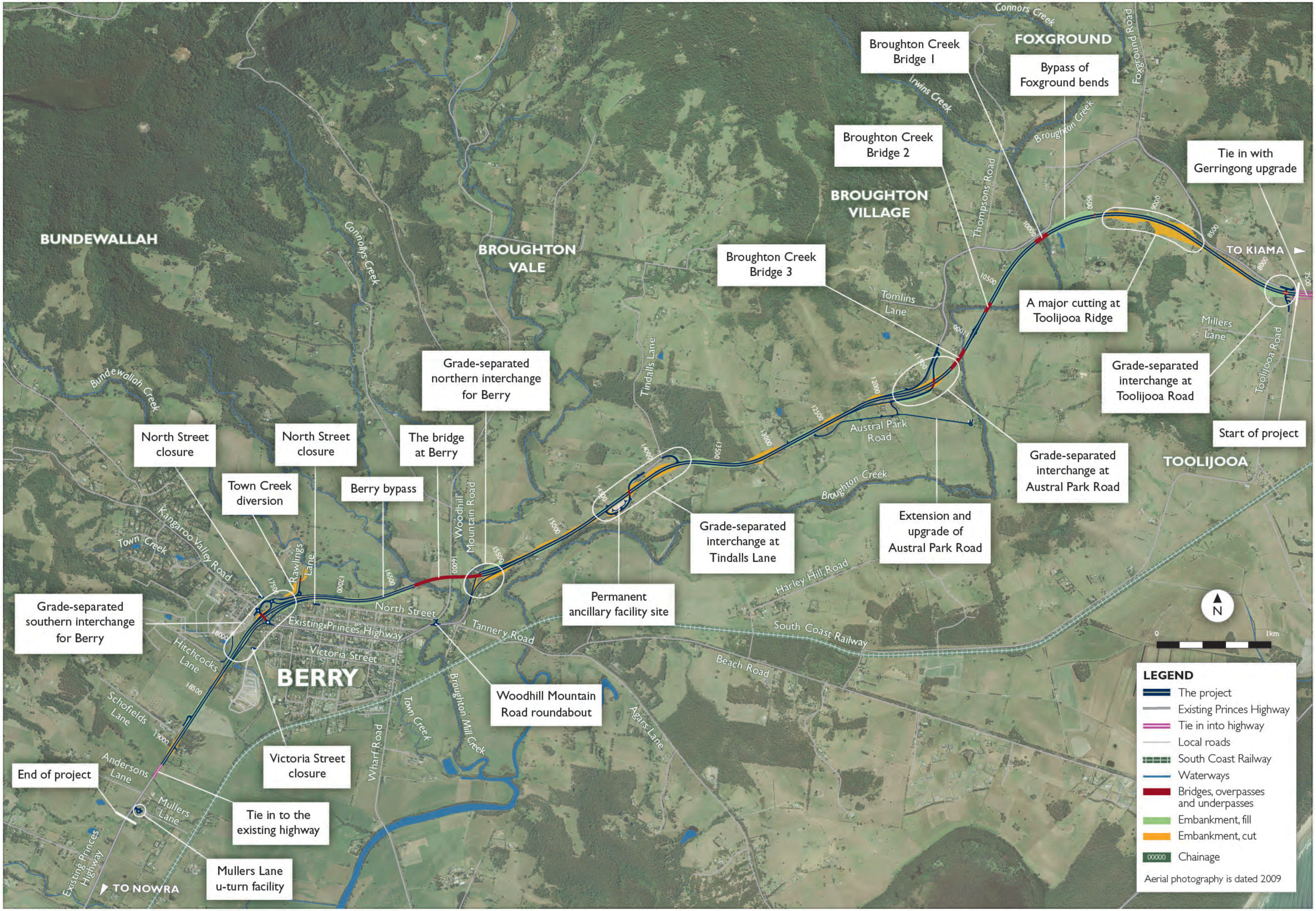

Figure 1-1 Overview of the project

Figure 1-2 Regional context of the project

1.3 Structure of the environmental assessment report

The environmental assessment is presented in two volumes. It responds to the requirements issued by the Director-General of the then NSW Department of Planning (refer to **Appendix A**).

Volume 1 has the following structure:

- Executive summary — Summarises the findings of this environmental assessment.
- Chapter 1 — Introduction — provides a broad overview of the project and a general description of the project location.
- Chapter 2 — Strategic and project justification — provides the strategic context of the project and outlines the need for and objectives of, the project.
- Chapter 3 — Project alternatives and design options — reviews the alternatives and options considered in developing the project and outlines the preferred option.
- Chapter 4 — Project description — provides a detailed description of the project including route alignment, design standards and key design features and construction methodologies.
- Chapter 5 — Assessment process — outlines the statutory requirements and explains the steps in the assessment and approval process.
- Chapter 6 — Consultation — describes the consultation strategy, objectives and consultation undertaken as part of project development and environmental assessment and summarises the issues raised.
- Chapter 7 — Assessment of key issues — identifies the key environmental issues, assesses the impacts and proposes environmental management measures.
- Chapter 8 — Other issues — identifies other environmental issues that were not identified as key issues, assesses the impacts and proposed environmental management measures.
- Chapter 9 — Environmental risk analysis — describes how the environmental issues for the project were identified through an environmental risk analysis process, and outlines the findings of the process.
- Chapter 10 — Draft statement of commitments — outlines how the environmental impacts of the project would be avoided, minimised, managed, mitigated, offset and/or monitored.
- Chapter 11 — Justification and conclusion — presents the justification for the project and summarises the main environmental issues and how they would be managed.
- Chapter 12 — References.
- List of tables.
- List of figures.

Volume 2 contains the following appendices:

- Appendix A — Director-General's requirements, checklist and cross reference table.
- Appendix B — Minister's order under Part 3A of the *Environmental Planning and Assessment Act 1979.*
- Appendix C — Community consultation.
- Appendix D — Technical working paper: Traffic and transport.
- Appendix E — Technical working paper: Noise and vibration.
- Appendix F — Technical working paper: Terrestrial ecology.
- Appendix G — Technical working paper: Aquatic ecology and water quality management.
- Appendix H — Technical working paper: Surface water, groundwater and flooding.
- Appendix I — Technical working paper: Urban design (including landscape character and visual amenity).
- Appendix J — Technical working paper: Aboriginal heritage.
- Appendix K — Technical working paper: Non-Aboriginal (historic) heritage.
- Appendix L — Property access impacts.
- Appendix M — Technical working paper: Socio-economic.
- Appendix N —Technical working paper: Air Quality.

The working papers in Volume 2 document in detail the methodologies and results of the specialist environmental studies that have been undertaken for this environmental assessment. The key findings from the working papers are presented in the relevant environmental assessment chapters in Volume 1.

2 Strategic and project justification

This chapter describes the need, objectives and justification of the project in terms of the strategic vision for NSW (including the NSW south coast). It also addresses the Director-General's requirements (DGRs) for the strategic justification of the project as shown below.

Director-General's requirements	Where addressed
Strategic justification:	
Describe the strategic need, justification and objectives for the project taking into account the aims and objectives of relevant strategic planning and transport policies including: the State Plan (2006), the Illawarra Regional Strategy and the South Coast Regional Strategy.	Sections 2.1 – 2.5 Chapter 11 (Justification and conclusion)

2.1 Strategic need

2.1.1 The Princes Highway

The Princes Highway is the main north-south transport corridor linking Sydney and Wollongong to the NSW south coast and north-eastern Victoria. It is an important freight and bus route, particularly beyond Bomaderry where the existing rail service currently terminates. The Princes Highway is also a major route for tourist destinations, such as Berry, with peak traffic experienced on weekends and during holiday periods.

The project would form part of the Princes Highway upgrade which aims to provide a four lane divided highway between Waterfall and Jervis Bay Road, Falls Creek. (refer to **Figure 2-1** for the current status of these upgrades). The upgrade of the Princes Highway would improve road safety and traffic efficiency, including for freight, on the NSW south coast.

In recognition of the importance of the project, the NSW Government announced the allocation of $9 million in the 2012-2013 budget to continue the planning and preconstruction activities for the project.

2.1.2 NSW and Australian Government plans and strategies

National Road Safety Strategy for Australia 2011 - 2020

The *National Road Safety Strategy for Australia 2011 – 2020* (Australian Transport Council, 2011) is firmly based on Safe System principles and is framed by the guiding vision that no person should be killed or seriously injured on Australia's roads. As a step towards this long-term vision, the strategy presents a 10 year plan to reduce the number of serious injuries and fatalities on Australian roads by 30 per cent. To achieve this target, four key road safety actions or interventions have been identified, supported by immediate and future steps. Of the four actions, 'safe roads' and 'safe speeds' are relevant to the project.

The 'Safe roads' action aims to adopt improved standards for road design, construction and operation to reflect the Safe System principles (which have yet to be finalised), and to improve the manner in which road safety benefits are identified and implemented in road investment programs.

The 'Safe speeds' action aims to achieve a better balance between safety and mobility objectives, and to improve compliance with speed limits.

Figure 2-1 Princes Highway upgrade between Waterfall and Jervis Bay Road

The Safe System principles are yet to be released, however guiding principles are in place that require a holistic view of the road transport system and the interactions among roads and roadsides, travel speeds, vehicles and road users. This is an inclusive approach that caters for all groups using the road system, including drivers, motorcyclists, passengers, pedestrians, bicyclists, and commercial and heavy vehicle drivers. The Safe System approach recognises that people will always make mistakes and may have road crashes, but that the system should be forgiving and those crashes should not result in death or serious injury.

The project has been designed in accordance with current RMS road design guidelines, safety and traffic efficiency requirements to address the existing high crash history, and aims to deliver immediate safety benefits through introducing design features such as: dividing the highway to instantly remove the risk of both head on collisions, and collisions resulting from turns made across the highway; and providing separate pedestrian and cyclist facilities.

The project is considered to be consistent with the guiding vision of the Safe System approach, and would contribute towards achieving, the aims of the *National Road Safety Strategy for Australia 2011 – 2020*. The detailed design of the project would continue to consider road safety requirements.

Draft NSW Long Term Transport Master Plan

The draft *NSW Long Term Transport Master Plan* (Transport for NSW, 2012), which was released for comment in September 2012, presents the NSW Government’s direction for transport planning and investment for the next 20 years. It builds on the current transport commitments of the NSW Government, as announced in the 2011-2012 budget.

Chapter 6 of the draft Master Plan addresses the provision of essential access for regional NSW. It specifically identifies the upgrade of the Princes Highway as an action to improve the availability, reliability and timeliness of travel options in the south coast region.

Chapter 7 of the draft Master Plan addresses efficiency and productivity of freight and identifies a number of actions to promote this including: fixing bottlenecks; better using the existing road network; removing obstacles to improved freight productivity; growing future network capacity; and managing the community and environmental impacts of freight. By improving the safety and the capacity of the Princes Highway and upgrading the Foxground to Bomaderry section of the highway to four lanes consistent with the majority of the remainder of the highway, the project would contribute to all these actions for the NSW south coast.

While the draft Master Plan was under preparation, the NSW Government announced its current priorities for improving transport in NSW. Improvements to the Princes Highway were identified as a current priority to support the economy and regional NSW.

NSW 2021

NSW 2021 – A Plan to Make NSW Number One (Department of Premier and Cabinet, 2011) was released in September 2011 and replaces the *State Plan 2006* (as revised in 2010) as the NSW Government’s strategic plan for the future.

The NSW-2021 plan is a 10 year plan for change in NSW, and it aims to rebuild the economy, provide quality services, renovate infrastructure, restore government accountability and strengthen local environment and communities.

The Plan provides 32 goals including to improve the efficiency of the road network and reduce travel times and to improve road safety. Priority actions are specified in NSW 2021 to achieve these goals. These actions include the provision of real–time travel time information to motorists through the delivery of key initiatives including the use of variable message signs (VMS) and the delivery of road infrastructure to relieve congestion, improve safety and enhance and expand capacity on road corridors.

The project would improve the safety and efficiency of the road network by upgrading the Princes Highway to widen one of the last remaining two lane sections of highway between Waterfall and Falls Creek to four lanes with median separation. This would relieve congestion, improve safety and increase capacity on the highway. A VMS would be installed south of Berry, on the western side of the upgrade, between the southern Berry interchange and Schofield's Lane to service northbound traffic. The project is consistent with the NSW 2021 Plan and would contribute to the achievement of traffic and transport related goals.

Illawarra Regional Strategy

The *Illawarra Regional Strategy 2006-2031* (Department of Planning (DoP), 2007a) applies to the Kiama, Shellharbour and Wollongong local government areas (LGAs) and recognises the importance of the region's transport networks in supporting economic growth and maximising the efficiency of freight transport.

The *Illawarra Regional Strategy* includes regional transport objectives, highlighting the importance of the Princes Highway as the major north-south corridor linking the Illawarra region to Sydney and the NSW South Coast, and citing the upgrade of the highway as an important transport infrastructure project in the region. The project is consistent with, and would contribute towards achieving, the objectives of the Illawarra Regional Strategy.

South Coast Regional Strategy

The *South Coast Regional Strategy 2006-2031* (DoP, 2007b) applies to the Shoalhaven, Eurobodalla and Bega Valley LGAs. The strategy envisages a 36 per cent increase in the population of these LGAs over the next 23 years. The area encompassing Nowra and Bomaderry is identified as a major regional centre in the Shoalhaven LGA, which is expected to grow by an additional 34,000 people.

The NSW South Coast has transport and accessibility limitations due to a dispersed settlement pattern. The project is consistent with the South Coast Regional Strategy as it would improve the safety and efficiency of this major transport corridor and connections between communities and neighbouring regions, enabling economic development.

Shoalhaven – an Enterprising Alternative (An Economic Development Strategy) 2005

Shoalhaven – An Enterprising Alternative, an Economic Development Strategy (Shoalhaven City Council et al, 2005) was developed by Shoalhaven City Council, the NSW Department of State and Regional Development, the Commonwealth Department of Transport and Regional Services and the Shoalhaven Area Consultative Committee.

A key transport focus area identified in the strategy is to "significantly improve access between Shoalhaven, Sydney, Canberra and Wollongong with respect to movement of goods and people" (Shoalhaven City Council et al, 2005). The project would improve access between Sydney and the Shoalhaven, and therefore between Wollongong city and regional centres within the Illawarra and the Shoalhaven.

A key tourism focus area identified in the strategy is to "foster higher levels of visitation and increased visitor yield" (Shoalhaven City Council et al, 2005). The project would improve access to the region and reduce travel times, which are expected to encourage increased visitation rates.

2.2 Need for the project

2.2.1 Existing road design

The Princes Highway between Toolijooa Road and Schofields Lane consists generally of two lanes (undivided) with horizontal and vertical alignments that result in lower speed limits and traffic inefficiencies, particularly near Toolijooa Ridge, Foxground and Broughton Village. There are limited overtaking opportunities, many at-grade junctions with rural roads and numerous private accesses.

The highway runs through the town centre of Berry, creating conflicts between through traffic, local traffic and pedestrians and reducing the amenity of Berry.

The posted speed limits along this section of the highway respond to the road conditions and conflicts along the highway, ranging from 80 kilometres per hour north of Berry, 50 kilometres per hour through Berry and 100 kilometres per hour south of Berry. This reduces the efficiency and safety of the highway, as vehicles transition between the posted speed limits.

There is a need to provide a highway that meets RMS network planning targets and minimises conflicts for current and future road users by providing an appropriate and consistent road design. If the highway is not upgraded, the efficiency, safety and amenity along the highway and within Berry would continue to deteriorate as traffic volumes increase over time.

2.2.2 Traffic volumes and transport

Based on traffic surveys undertaken in 2009 and 2011, the annual average daily traffic (AADT) on the Princes Highway near Berry is around 10,000 to 12,500 vehicles per day, of which 11 to 13 per cent are heavy vehicles. As the highway is a major tourist route, traffic flows are highest during major holiday periods. This has been measured at 20 per cent above the AADT during the Christmas holiday period at a permanent traffic count station on the Princes Highway north of Gerringong at Rose Valley Road.

The ‘Sandtrack’, as shown in **Figure 1-2**, provides an alternative route for regional traffic travelling between Gerringong and Bomaderry. It comprises Fern Street, Crooked River Road, Gerroa Road and Bolong Road. The AADT on the ‘Sandtrack’ is around 6500 to 8500 vehicles per day, which represents an average 55/45 per cent split of regional traffic flows between the Princes Highway and the ‘Sandtrack’. The proportion of heavy vehicles using this alternative route is around three to four per cent and is attributed to the imposed five tonne load limit.

Between 2008 and 2010, daily traffic volumes on the Princes Highway in this region have grown at a rate of around three per cent per year, with the proportion of heavy vehicles remaining the same. This growth rate is forecast to continue, resulting in an AADT of around 16,500 to 21,000 vehicles per day by 2037. A similar rate of growth is expected along the ‘Sandtrack’.

Without the Princes Highway upgrade, ongoing traffic growth would put pressure on the efficiency of the highway by lowering average travel speeds and increasing delays on the approach to and within Berry. Existing safety concerns would also be exacerbated.

The implications for highway efficiency and safety should the Princes Highway not be upgraded are discussed further in **Section 2.2.4** and **Appendix D** of this environmental assessment.

2.2.3 Level of service

Level of service (LoS) is a qualitative measure describing operational conditions within a traffic stream. The desirable maximum capacity of each road section is determined from the 'Guide to Traffic Management, Part 3: Traffic Studies and Analysis' (AUSTROADS, 2009). LoS has different criteria to assess the performance of a road and intersection, but is generally described in terms of service measures such as travel speed and travel time, freedom to manoeuvre, traffic interruptions, comfort and convenience, and road safety. There are six LoS, designated LoS A (best – free flow) to LoS F (worst – break-down in flow). Further information on LoS, including LoS definitions, can be found in **Section 7.1** and **Appendix D** of this environmental assessment.

Currently, the Princes Highway both north and south of Berry operates at LoS D for highway flows in both the AM peak and PM peak, and deteriorates to an unacceptable LoS E at most locations during peak periods. If the highway is not upgraded, the LoS will decrease over time as traffic volumes increase, resulting in longer travel times. By 2037, without the project, the highway is predicted to be operating at LoS E and LoS F during AM and PM peak periods.

At Berry, Queen Street (Princes Highway) intersects with numerous roads of local and regional importance. This includes Alexandra Street, Prince Alfred Street, Kangaroo Valley Road, Albert Street and Tannery Road. These intersections currently perform at LoS A, including during peak periods. Refer to **Figure 7.2** for local and regional road layout.

As traffic volumes increase on Queen Street (Princes Highway) into the future, conflicting traffic demands of through and local traffic within Berry would result in longer delays and decreased LoS. There would also be fewer gaps in the traffic flow creating significant delays to vehicles attempting to turn onto or cross Queen Street. This would cause some intersections on Queen Street, such as Kangaroo Valley Road, Alexandra Street and Tannery Road, to operate at LoS E and LoS F during peak periods, with significant average delays by 2037.

Longer delays would also have implications on the performance of the local road network in Berry where queuing traffic blocks adjacent intersections. If the road network remains unchanged and highway traffic is not removed from Berry, it is expected that intersections would be unable to accommodate the forecast increase in traffic volumes and delays would extend into local roads.

Overall, an upgrade to the highway is needed to provide additional road capacity, to maintain an acceptable LoS and to minimise conflicts between local and through traffic within Berry. In the absence of an upgrade, longer travel times and congestion within Berry would have economic consequences on local businesses, industry and tourism. Increased commuting times would also hinder employment growth in the region, and recreational travellers would become less inclined to accept the time and cost associated with travelling through the area.

2.2.4 Road safety

The current fatality rate for the project area is around 0.8 per 100 million vehicle kilometres travelled (MVKT). When compared to the NSW average fatality rate of 0.5 per 100 MVKT (for the 12-month period ending in July 2011), this indicates that the project area has over 50 per cent more fatalities per kilometre travelled than the NSW average. An analysis of crash statistics collected by the then NSW Roads and Traffic Authority (RTA) between 1 July 2003 and 30 September 2010, found that this section of the highway performs relatively poorly in comparison to connecting sections of the Princes Highway and other major highways in NSW. There were 118 recorded crashes during this period, of which 61 resulted in personal injury and three involved fatalities.

In addition, the alternative 'Sandtrack' route between Gerringong and Bomaderry has a fatality rate of 0.7 per 100 MVKT, again higher than the NSW average. Five fatal and 81 injury crashes occurred on the 'Sandtrack' between 1 July 2003 and 30 September 2010.

As projected traffic volumes increase, the potential for crashes is also likely to increase. An increase in demand on rural sections of the highway would result in lower travel speeds, and more time spent following other vehicles. This typically results in vehicles travelling closer together, increasing the likelihood of rear-end crashes. Motorists may also take greater risks to turn on or off the highway as gaps in the flow of traffic become less frequent. Access to and from local and private roads are also expected to become more difficult as traffic volumes increase.

Similarly, the likelihood of crashes at intersections along the highway and within Berry would increase, as traffic growth increases the frequency of conflicting at-grade turning movements.

Road safety improvements would be delivered by upgrading the highway with enhanced road design and travel efficiencies. Road safety would also increase by reducing the frequency of conflicting turning movements by removing highway traffic from within Berry, consolidating highway access to grade separated interchanges, and restricting direct access elsewhere to left-in left-out.

Improvements to the highway and associated improvements in road safety and travel time would lessen the inclination for regional traffic to use the ‘Sandtrack’ as an alternative route. The split between the Princes Highway and the ‘Sandtrack’ traffic is estimated to change from 55 per cent / 45 per cent to the north of Berry (60 per cent / 40 per cent to the south) in 2009 to 84 per cent / 16 per cent in 2037 (87 per cent / 13 per cent to the south), with the majority of traffic switching from the ‘Sandtrack’ in favour of the Princes Highway by 2037. As a consequence, the reduced traffic volume on the ‘Sandtrack’ would deliver safety benefits and amenity improvements to road users and the communities located alongside it.

2.2.5 Flood immunity

The highway currently has poor flood immunity, with the section immediately north of Berry, (between Woodhill Mountain Road and Prince Alfred Street, Berry) susceptible to flooding in the 1 in 5 year flood event. Flooding of the highway at this location restricts regional traffic movements and access to Berry from the north and access to the north from Berry.

Upgrading the highway to achieve flood immunity in the 1 in 100 year flood event would remove the obstacle to regional traffic flows, enhance road safety and provide for improved access during major flood events.

2.3 Project objectives

The project objectives are consistent with the strategic and project needs and incorporate environmental, social and economic considerations. Project objectives include:

- Improve road safety.
- Improve efficiency of the Princes Highway between Toolijooa Road and Schofields Lane.
- Support regional and local economic development.
- Provide value for money.
- Enhance potential beneficial environmental effects and manage potential adverse environmental impacts.
- Optimise the benefits and minimise adverse impacts on the local social environment.

2.4 Statement of strategic need

The project is part of a series of upgrades of the Princes Highway to achieve four lanes between Waterfall and Jervis Bay Road, Falls Creek. It is one of the remaining sections to be upgraded and would add to the road safety and traffic efficiency benefits provided by the other Princes Highway upgrades.

The project area encompasses both the bypass of the Foxground bends and the bypass of Berry in the one project. On completion of either bypass, traffic studies show that most through traffic (about 85 per cent) would be travelling on the upgraded highway. If only one of these bypasses were constructed, safety and efficiency issues on the remaining unimproved section of the highway would be exacerbated. The project area extends from Toolijooa Road to Schofield's Lane as the Toolijooa Road endpoint is the start of the section with the worst remaining crash statistics and the Schofields Lane end point is the earliest tie in point after addressing the efficiency concerns in Berry.

The objectives of the project are consistent with the relevant strategic planning and policy frameworks and the need for the project.

The project is needed to provide a safer and more efficient road network to better serve current and future road users. It would assist in meeting this by:

- Addressing the high crash history and poor road safety record of this section of the Princes Highway and delivering immediate road safety benefits.
- Ensuring compliance with current design, safety and traffic efficiency requirements of the RMS.
- Removing through traffic from Berry town centre, improving the amenity of the town and road safety of the local road network.
- Delivering improved traffic efficiency by catering for projected traffic volumes in the design year, which is typically 20 years after the project becomes operational.
- Delivering a highway design consistent with that of the majority of the remainder of the highway between Waterfall and Jervis Bay Road.

Further justification for the project is provided in **Chapter 11**. This chapter also includes consideration of the objectives of the *Environmental Planning and Assessment Act 1979*, the environmental, social and economic impacts of the project, the suitability of the site and whether or not the project is in the public interest.

3 Strategic alternatives and design options

This chapter describes the various alternatives that were considered as part of the project development process and explains how and why the project was selected as the preferred option. Design options for particular elements of the project are also covered. It also addresses the Director-General's requirements (DGRs) for the project justification as shown below.

Director-General's requirements	Where addressed
Project justification:	
Assess the alternatives considered (including an assessment of the environmental costs and benefits of the project relative to alternatives).	Chapter 3 Chapter 11 (Justification and Conclusion).

3.1 Options development process

This section presents a summary of the process undertaken to develop, assess and select options for various components of the project including the route, access options and interchanges at Berry, the local road modifications and pedestrian access. Information is also provided on when input on the options was sought from community, stakeholder groups and government agencies. As well as input from these external sources, an integrated design approach was taken for the development of the project, involving engineers, urban designers and bridge architects working collaboratively with environmental and heritage specialists to develop and compare the options against the project objectives including:

- Improve road safety.
- Improve efficiency of the Princes Highway between Toolijooa Road and Schofields Lane.
- Support regional and local economic development.
- Provide value for money.
- Provide significant beneficial environmental effects for the Berry town centre and manage potential adverse environmental impacts elsewhere.
- Optimise the benefits and minimise adverse impacts on the local social environment.

The environmental sensitivities and constraints of Foxground, Berry and its surrounding areas have been taken into account in the design development process, with adverse impacts avoided or minimised in design to the greatest extent practicable.

3.1.1 Development and assessment of strategic alternatives

Strategic alternatives to the project were assessed as part of this environmental assessment. Alternatives included the upgrade of other transport corridors, including road and rail within the project area and a base case 'do nothing' option which were assessed against the project objectives.

3.1.2 Development and assessment of route options

Figure 3-1 shows the route options development process that was undertaken for the project.

Route options for the project were developed as part of the broader Princes Highway upgrade program. This program included all three highway upgrade projects between Gerringong and Bomaderry. The Foxground and Berry bypass project forms part of the overall upgrade shown in **Figure 3-2**.

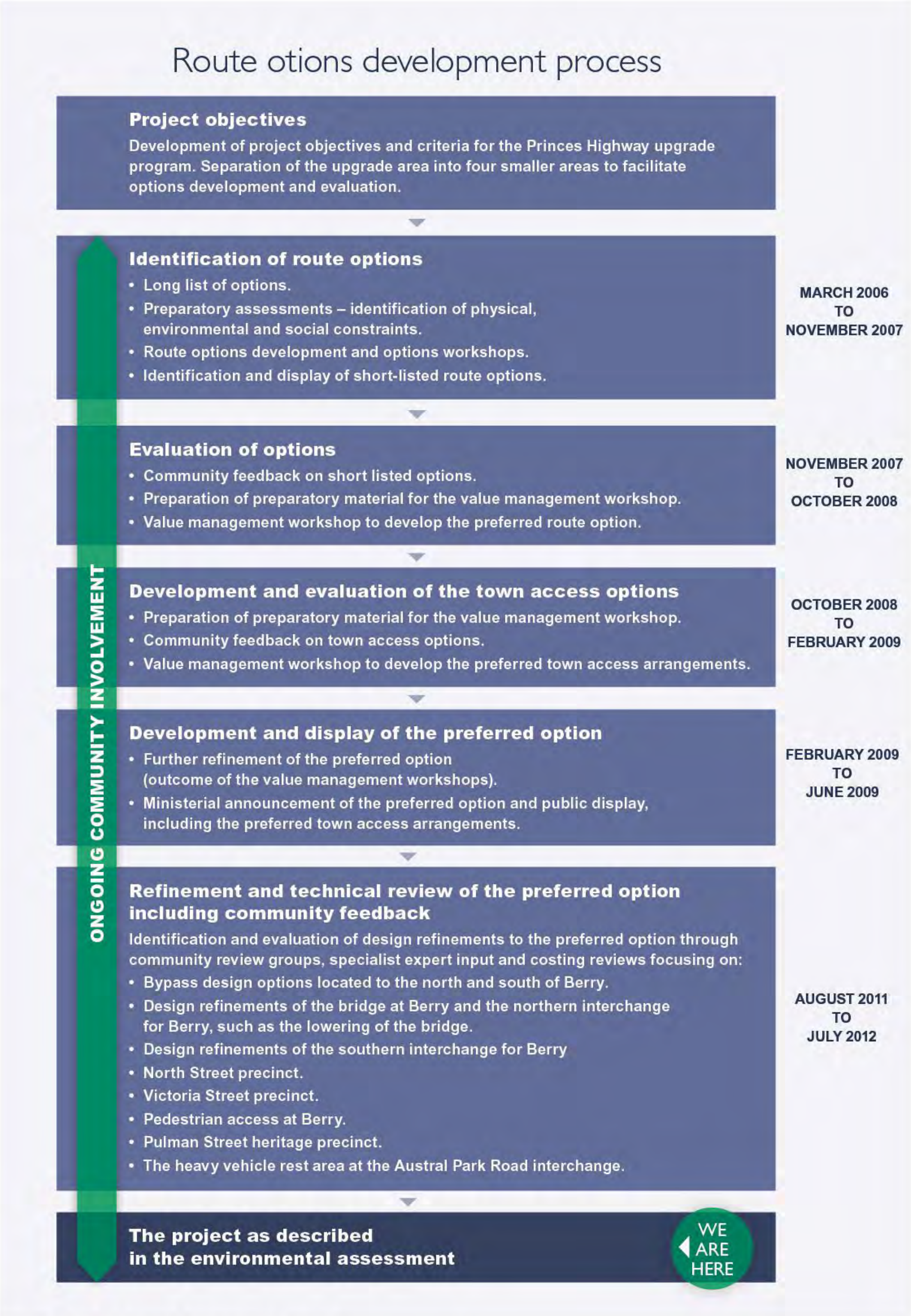

Figure 3-1 Route options development process

The Foxground and Berry bypass project area was selected as it encompasses both the bypass of the Foxground bends and the bypass of Berry in one project. On completion of either bypass, traffic studies show that most through traffic (about 85 per cent) would be travelling on the upgraded highway. If only one of the bypasses were constructed, safety and efficiency issues on the remaining unimproved section of the highway would be exacerbated. The project area extends from Toolijooa Road to Schofield's Lane as the Toolijooa Road endpoint is the start of the section with the worst remaining crash statistics and the Schofields Lane end point is the earliest tie in point after addressing the efficiency concerns in Berry.

Figure 3-2 **Preferred project route within the context of the Princes Highway between Gerringong and Bomaderry**

To assist in the development of options, the broader study area including Gerringong, Berry and Bomaderry was divided into four geographical areas referred to as 'sections' (sections A, B, C and D). Section B and section C represent the project area (refer to **Table 3-1** and **Figure 3-3**).

Table 3-1 Description of sections within the context of the three upgrade projects

Section	Description	Relevant project/proposal
Section A	Commences at Mount Pleasant and extends to Belinda Street, Gerringong.	The Gerringong upgrade.
Section B	Commences at Belinda Street, Gerringong and extends just north of Berry.	The Gerringong upgrade and the project.
Section C	Commences just north of Berry and extends to Croziers Road, south of Berry.	The project and the Berry to Bomaderry upgrade proposal.
Section D	Commences at Croziers Road, south of Berry and extends to Cambewarra Road, Bomaderry.	The Berry to Bomaderry upgrade proposal.

Figure 3-3 Geographical sections within the context of the three upgrade projects between Gerringong and Bomaderry

RMS considered and evaluated the route options for all three highway upgrade projects at the same time across the broader study area. However, the following sections of this chapter focus on how the options relevant to this project (sections B and C) were assessed and the outcomes that determined the preferred route option for the project.

A discussion on the methodology followed to assess and evaluate the route options is provided in detail in the following reports:

- *Gerringong to Bomaderry Princes Highway Upgrade, Route Options Development Report* (RTA, November 2007).
- *Gerringong to Bomaderry Princes Highway Upgrade, Preferred Option Report* (RTA, October 2008).
- *Gerringong to Bomaderry Princes Highway Upgrade, Gerringong and Berry Preferred Access Arrangements Report* (RTA, June 2009b).
- *Gerringong to Bomaderry Princes Highway Upgrade, Toolijooa Ridge Preferred Option Report* (RTA, June 2009c).

The reports are available on the project website www.rms.nsw.gov.au/fbb.

Long list of options

Feasible route options were identified by RMS and the project team and a long list of route options was developed. These were based on the output of a computer software package called Quantm, desktop studies and the application of route selection principles that include consideration of engineering and functionality constraints, avoidance of known environmental and social constraints and minimisation of environmental and social impacts.

Preparatory assessments were undertaken by the project team and technical specialists to assess the physical, environmental and social constraints associated with the long list options. These assessments fed into the route options development workshop attended by the project team and technical specialists and undertaken to short list potential options for further assessment (refer to **Chapter 6** for further details).

The assessment of the long list options considered the project objectives and specialist investigations and compared each route option against a base case scenario to determine short-listed route options. Specialist investigations considered the biophysical environment, social and cultural environment, land use and property, landscape and potential amenity impacts. Engineering functionality and economic factors were also considered.

Short-listed route options

RMS held a route options value management workshop to develop key assessment criteria and evaluate the potential options. The workshop attendants included the project team, technical specialists and members of the community from across the study area and considered specialist assessment of each option and community and stakeholder feedback. The options were assessed and weighted against the project objectives (**Section 2.3**) and the following key assessment criteria:

- *Functional* – focused on the design objectives and included constructability, maintenance, safety and efficiency considerations.
- *Socio-economic* – included business and agricultural impacts, property severance, connectivity, road traveller experience, views and impacts on community facilities/amenity.
- *Environmental (natural and cultural)* – included ecological, Aboriginal heritage, flooding, noise, groundwater and climate change impacts.

The value management workshop process and the key findings are documented in *Gerringong to Bomaderry Princes Highway Upgrade, Value Management Workshop Report (RTA, May 2008a)*.

The urban design principles and objectives (**Section 4.3.2**) are embedded in the assessment criteria and as such each option has been evaluated against them.

Following the value management workshop, a preferred option was announced by the then Minister for Roads in 2009.

3.1.3 Development and assessment of the design refinements

Ongoing community and stakeholder consultation has been undertaken throughout the planning and design stages of the project and the outcomes of this consultation have been considered during the refinement of the preferred option.

A number of options were developed and assessed against the project objectives for different sections of the project including:

- Access options for Berry.
- Bypass design options for Berry.
- Design for the bridge at Berry.
- Alignment options and design around the North Street precinct.
- Arrangement of the southern interchange for Berry.
- Options for the intersection of the Princes Highway and Victoria Street in Berry.
- A southern bypass of Berry.
- Pedestrian access in Berry.
- Rest areas.
- Pulman Street heritage precinct.

The evaluation of these design refinement options is discussed in detail in **Section 3.6**.

Access options for Berry

The access options value management workshop assessed a combination of southbound and northbound options against the following assessment criteria established by the workshop group. The workshop process is discussed in detail in *Gerringong to Bomaderry Princes Highway Upgrade, Access Value Management Workshop Report (RTA, February 2009a).*The construction cost estimates for each combination were also assessed together with the following objectives:

- Provide safer use for all users of the network.
- Minimise environmental impacts including, but not limited to, noise, flora, fauna, and dust.
- Minimise impact on heritage elements.
- Facilitate business and employment opportunities.
- Minimise visual intrusion to and from the town.
- Provide easily legible access and intuitive access for all users.
- Provide access amenity to at least current or a better level of service.
- Complement existing and future local traffic movement patterns and the social network.
- Improve access during flooding.
- Provide appropriate emergency services access.

Other stakeholder and community lead access design refinements have also been considered. These have been assessed separate to the value management workshop process and include:

- Shoalhaven City Council requested that RMS consider providing a second northbound off-ramp for Berry. This ramp would cater for future traffic growth on the highway and within Berry.
- A community submission sought consideration of splitting the southern interchange for Berry into two smaller interchanges, with the south-facing on and off-ramps relocated further south, close to Schofields Lane.

Berry bypass design options

RMS undertook a review into the preferred route north of Berry in consultation with the community. This followed a request by the Member for Kiama to consider the community's concerns relating to the potential noise and visual amenity impacts of the preferred option.

The study area considered in this review is represented as the purple zone in **Figure 3-4** and includes the northern interchange, the bridge at Berry and the North Street corridor.

A community review group (CRG) was established to examine improvements to the preferred route where it passes close to Berry.

Seven community review group meetings were held to examine the design and consider how to improve it. The process included inputs from technical studies, independent experts and community submissions. Updates documenting the meeting proceedings were published to inform the wider community. The review process also included two separate one-day workshops to carry out a detailed review of the bridge at Berry and northern interchange alignment and design.

The revised preferred option was continually developed through the CRG meetings and workshops. It did not involve a direct comparison between design refinements. Instead, options were discounted and new alternatives developed in consultation with CRG members that would best meet the project objectives and the objectives of the review.

Meetings were held with the registered CRG participants and independent experts with experience in urban design, civil engineering, noise management and construction of major road and transport projects as discussed in detail in **Chapter 6**.

Several amendments were made to the concept design for the Berry bypass through this process including:

- Shifting the Berry bypass and Berry bridge further north.
- Realigning the Huntingdale Park off-ramp to avoid Huntingdale Park Road.
- Lowering the bridge at Berry by up to 6.4 metres.

Following the CRG meetings a series of open public workshops were undertaken to further refine design issues which had arisen and to allow for increased public input to the design refinement process. The workshops were organised into design components to address urban design and community use of various areas of the project, including the:

- Austral Park Road area.
- Bridge at Berry and northern Berry interchange.
- North Street precinct.
- Southern interchange at Berry and Victoria Street arrangement.

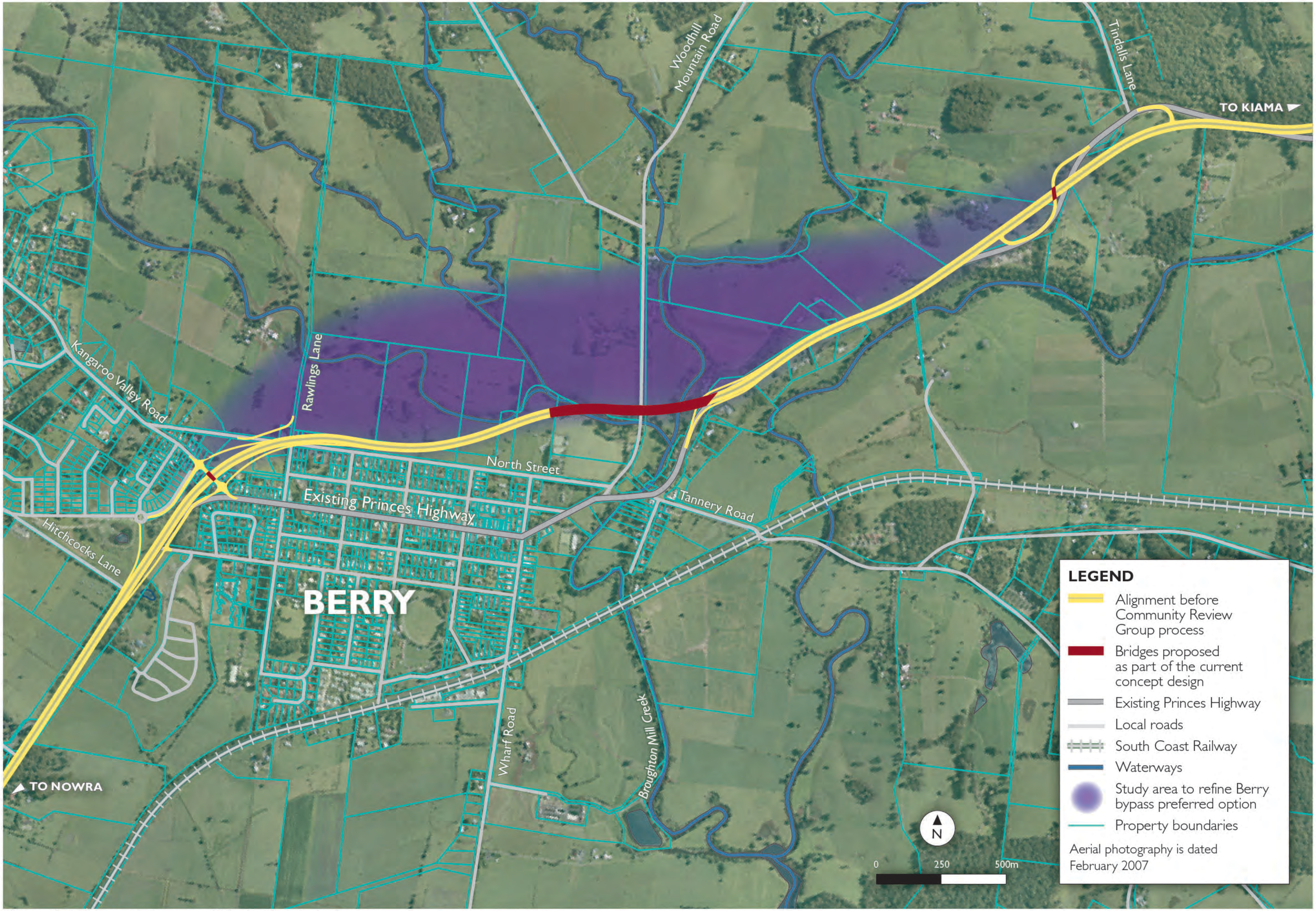

Figure 3-4 Bridge at Berry and North Street study area

Bridge at Berry and northern interchange for Berry

The CRG for the bridge at Berry and northern interchange identified 12 considerations for the review that generally related to the design and aesthetics of the bridge structure. These considerations are discussed in the *Bridge design workshops process report* (RMS, 2011). The CRG agreed that further reviews of the design take into account these considerations. However, optimising the revised preferred alignment was the primary focus of the CRG workshop.

Several design refinements were discussed in the CRG process one-day workshops. These focused on different combinations of ramp configurations, embankments, cuttings and retaining walls at the northern interchange that would optimise the cut/fill ratio and maximise the lowering of the bridge. These had varying degrees of impact on neighbouring properties (due to embankments and retaining walls), the cut/fill ratios and on road safety.

The workshop process for the bridge at Berry and northern interchange investigated urban design, landscaping and related issues for the bridge and northern interchange. This included considerations such as bridge form and colour, abutment and pier design and noise mitigation issues.

North Street precinct

The CRG for the North Street precinct assessed various options to lower the alignment and move it north, away from North Street. Through this process the need to divert Town Creek in order to facilitate the lowered alignment was identified and developed and potential urban design treatments and preferred solutions were also considered.

The workshop process following the CRG investigated urban design treatments, noise amelioration issues and potential designs for the public open space areas in the precinct. Urban design treatments considered included:

- Design concepts and approaches for the main alignment as visible to drivers and residents north of the alignment.
- Design concepts for the area facing North Street.
- Potential use of the public open space area along North Street.

Arrangement of the southern interchange for Berry

RMS undertook a review of the arrangement of the southern interchange for Berry with a particular focus on the northbound off-ramp. This process was undertaken in response to community concerns regarding the safety and amenity of the southern interchange for residents in Huntingdale Park Road. To address these concerns five community workshops were held to develop and assess different options for the location of the northbound off-ramp to address these concerns.

Victoria Street

During the workshops that were undertaken for the southern interchange for Berry, discussions were held with regards to the options to either maintain existing or modified access at Victoria Street or to close it at its western end. RMS sought advice from Shoalhaven City Council and the local community in order to provide a direction for the concept design. Community opinion on the options was split and no agreed direction was achieved. As a result RMS undertook a qualitative assessment of the options in order to progress the concept design.

Southern bypass of Berry

RMS received a submission from a community member with a suggested design for a bypass to the south of Berry between Tindalls Lane and Croziers Road. A technical investigation group (TIG) was established to develop and evaluate this option. The group comprised technical experts from a range of disciplines including road design, cost estimating, flooding and drainage, geotechnical and constructability. The TIG examined technical criteria and construction methodologies in order to develop an optimised design and cost estimate for a bypass to the south. A panel of independent reviewers was also established to verify the work undertaken by the TIG to ensure that due process was followed and the investigation was rigorous, transparent and appropriate.

Pedestrian access in Berry

Feedback from the community about the preferred option expressed concern by some about the potential loss of pedestrian and cyclist connectivity as a result of the severance of North Street. RMS responded to these concerns by assessing the feasibility of including a pedestrian overbridge to connect the two ends of North Street and investigating design options at the Kangaroo Valley Road interchange.

Rest areas

Due to community concerns regarding the location of a proposed heavy vehicle rest area near Austral Park Road, RMS established a community working group to review the social, environmental and design issues associated with the rest area. This group, together with RMS, assessed the issues against the project objectives and determined whether or not the rest area should be included as part of the project or alternatives developed and the rest area removed from the project. Light vehicle rest areas were deliberately not proposed so as to be able to direct vehicles to local towns, to assist with meeting project objective of supporting regional and local economic development.

Pulman Street heritage precinct

The community suggested moving the roundabout that was proposed at the junction of Tannery Road and the existing Princes Highway, to the junction of Woodhill Mountain Road and the existing Princes Highway in order to reduce potential impact on the curtilage of the Pulman Street heritage precinct.

3.2 Ecologically sustainable development in project development

The *Sustainability Factors, Climate Change and Economic Appraisal* (Maunsell, 2009) report prepared as part of the project development assessed the impacts of climate change, greenhouse gas (GHG) emissions, Peak Oil theory and greenfield land (not previously developed land) consumption associated with the short-listed options. This report was then included in the route options development process to assist in the selection of the preferred option.

Opportunities to reduce the environmental impact during construction and operation of the preferred option were also identified by researching contemporary best practices in sustainable transport infrastructure, including onsite reuse of materials, incorporation of renewable energy technology in the road, energy efficiency measures and infrastructure sustainability tools. Refer to **Section 8.4** for further details.

3.3 Strategic alternatives

3.3.1 Description of the alternatives

The following alternatives were addressed:

- Base case (‘do nothing’).
- Upgrade of the Princes Highway.
- Upgrade of the ‘Sandtrack’.
- Upgrade of the South Coast Railway.

These alternatives are described below.

The base case or ‘do-nothing’ option

RMS considered a theoretical base case or ‘do nothing’ alternative. It was defined as the least possible upgrade to the existing alignment with only minor improvements and ongoing maintenance. These minor improvements might include widening of road shoulders, some work on unsafe bends or installing wire rope in medians to separate northbound and southbound traffic.

This alternative did not meet the project objectives as it did not satisfy the fundamental project requirements, including the provision of a safe and efficient highway alignment. The ‘do nothing’ alternative would not provide a satisfactory solution from a strategic, regional, local planning or transport context.

The section of the Princes Highway between Toolijooa Road and Schofields Lane has an unacceptable crash record and limited overtaking opportunities. Crash analysis shows that the existing fatality rate in the project area, as defined in **Section 3.2.1**, is about 0.8 fatalities per 100 million vehicle kilometres travelled (MVKT), which is almost 50 per cent more than the projected NSW average fatality rate of 0.6 fatalities per 100 MVKT. This highlights the poor safety record of the highway in this area, and the need for this project.

Under the ‘do nothing’ alternative, highway traffic would continue to travel through the centre of Berry, impacting the amenity of the area and the main street. The efficiency and safety of the overall highway system would also be compromised in this area as travel demand increases over the next 20 years. Flow on effects to the local and regional economy would result from reduced travel efficiencies, particularly for the freight and tourism industries. This could hinder the realisation of regional and local planning objectives.

Princes Highway upgrade

The Princes Highway between Gerringong and Bomaderry is one of the remaining sections of the highway between Waterfall and the Jervis Bay Road junction, Falls Creek that has not been upgraded to four lanes.

An upgrade of the Princes Highway would consist of the upgrade of existing sections of the highway and/or the construction of new sections of highway between Mount Pleasant, north of Gerringong, and Cambewarra Road in Bomaderry (refer to **Figure 3-1**). The construction of new sections of the highway would be required where the existing corridor could not be upgraded to meet current design requirements (such as the Foxground bends) or where beneficial environmental, safety and efficiency outcomes can be achieved (such as bypassing environmentally sensitive areas or communities).

Environmental and socio-economic impacts, such as impacts on Toolijooa Ridge and Broughton Creek, or impacts on agricultural properties and the Berry township, may occur depending on what options are available within the corridor.

An upgrade to the Princes Highway would meet the project objectives as:

- It would improve the road safety and efficiency of the Princes Highway between Toolijooa Road and Schofields Lane.

- It could provide the opportunity to upgrade the existing alignment. An upgrade to the existing alignment would maximise the use of an existing asset, reducing construction and operational costs. It would also minimise the amount of land that would need to be acquired.
- It would provide an opportunity to remove traffic from Berry, while remaining close enough to the town to minimise the economic impacts on local businesses from the loss of highway generated trade.

The 'Sandtrack'

As described in **Chapter 2**, the 'Sandtrack' provides an alternative route for regional traffic travelling between Gerringong and Bomaderry. An upgrade of this route would be an alternative option to an upgrade of the Princes Highway between Gerringong and Bomaderry/Nowra. This option would require the widening and upgrade of the local roads that make up the 'Sandtrack'.

The upgrade of the 'Sandtrack' would be constrained by the Seven Mile Beach National Park, and the close proximity of Coomonderry Swamp (a wetland protected by *State Environmental Planning Policy No.14 (Coastal Wetlands)*). Other constraints include the topography closer to Gerringong and Gerroa, the floodplain areas close to the Shoalhaven River, existing industrial areas at Bomaderry and the need to cross an existing freight rail line. These constraints would mean that an upgrade of the 'Sandtrack' would need to be constructed on line, limiting staging opportunities during construction.

An upgrade to the 'Sandtrack' would achieve the project objective of delivering environmental and social benefits to Berry due to the removal of through traffic not wanting to stop in Berry. It would also improve the road safety of the 'Sandtrack'. It would not however satisfy the remainder of the project objectives as:

- It may have negative economic impacts for businesses in Berry that rely on highway generated trade, given the considerable distance separating the 'Sandtrack' and Berry and the loss of visual connectivity between the town and the highway.
- It would result in adverse amenity impacts to the communities located along the 'Sandtrack' that are currently not impacted by highway traffic and heavy vehicles, such as Gerringong and Gerroa. The 'Sandtrack' is accessed via Fern Street which runs through the centre of Gerringong and unless a bypass is provided for Gerringong, an upgrade to Fern Street would have significant severance impacts on the town resulting in adverse socio-economic impacts.
- It would provide limited improvement of the safety of the overall road network. The full length of the highway between Toolijooa Road and Schofields Lane would continue to have road safety issues albeit with lower traffic volumes.
- Greater land acquisition would be required than for upgrading the Princes Highway. Strip acquisition along the entire length of the route, including along the edge of the Seven Mile Beach National Park and through the industrial and commercial area of Bomaderry, would be required to cater for the full four lane design and interchanges.

South Coast rail upgrade

The South Coast railway extends from Waterfall in southern Sydney to Bomaderry. From Kiama, the line is non-electrified and consists of a single line. There are no direct services from Berry to Sydney, with passengers required to change trains at Wollongong, Dapto or Kiama. Rail passengers currently represent around one per cent of average weekday travel mode share in the region.

An upgrade to the South Coast railway line south of Kiama would involve the duplication of the railway to Bomaderry. Removal of level crossings and other improvements may be necessary to accommodate the widened corridor and the increase in train movements.

In the absence of an upgrade to the highway, a significant shift from road to rail would be required to improve the efficiency of the highway and to deliver significant environmental benefits to Berry. An upgrade to the rail network in the region is not likely to achieve this shift as:

- The railway line currently terminates at Bomaderry. Any freight or passengers travelling further south would be required to change transport modes at Bomaderry. The railway line would need to be extended further south for it to provide any comparable alternative service to the highway for the region.
- The low volume of freight movements along the South Coast would not make rail financially competitive compared with road transport.
- There are current and future competing needs of passenger and freight movements on the railway network between Sydney and Wollongong. This would have implications on the number of additional services that the South Coast railway line could accommodate in the absence of other rail network upgrades.

Road safety issues would also remain in the absence of any significant improvement to the highway, particularly for local rural communities that would still rely on the highway as the main transport corridor. Regional and local economic development would also suffer, as the road safety and efficiency challenges of the highway would remain.

The project would not limit the potential for the upgrade of the South Coast railway in the future.

3.3.2 Evaluation of the alternatives

A ‘do nothing’ alternative would not satisfy any of the project objectives. The highway would continue to have safety, efficiency and capacity problems. This would have flow on effects to the regional and local economy, as well as to the communities located along the corridor. Highway traffic would also continue to travel through Berry with continued adverse road safety impact to the community and local businesses. For these reasons, the ‘do nothing’ alternative was not considered further.

An upgrade to the ‘Sandtrack’ would not provide any distinct benefits to the environment, the economy or communities in the region when compared to an upgrade of the Princes Highway. It would generate adverse impacts on a number of communities located along the ‘Sandtrack’ that are not currently exposed to highway traffic. The Princes Highway would continue to have road safety issues for traffic travelling to local destinations between Gerringong and Bomaderry, and regional destinations west of Berry that cannot be accessed via the ‘Sandtrack’.

An upgrade to the South Coast railway would be unlikely to deliver a significant shift from road to rail to resolve the safety and efficiency problems of the Princes Highway. As it would be unlikely to replace the Princes Highway as the main transport corridor, the predicted increase in traffic would further decrease the safety, efficiency and capacity of this regional route. Impacts on the local and regional economy, and local communities, would result. For these reasons, an upgrade to the railway is not considered a viable alternative to an upgrade to the Princes Highway or the ‘Sandtrack’.

3.3.3 Preferred alternative

An upgrade to the Princes Highway best meets the project objectives. The Princes Highway is the preferred alternative as:

- It would improve the road safety and efficiency of the Princes Highway, particularly near Foxground bends and Berry.
- It would support regional and local economic development.
- It could provide the opportunity to upgrade the existing alignment which would minimise impacts on the environment, communities and the local economy.
- It would result in the least change to community connectivity.
- It would provide beneficial effects for Berry by bypassing the town and removing highway traffic, while remaining close enough to the town to minimise the loss of highway generated trade.

3.4 Long list of options

3.4.1 Description of the options

Figure 3-5 presents the long list of options which were assessed as part of the route options development process. These options consisted of a number of nodes which were joined to form the individual routes. Within sections B and C, over 30 options were assessed.

Long list options considered in section B were generally located between the South Coast Railway and the existing Princes Highway. There were two main options that followed the South Coast Railway, an option to the north of the existing highway and a number of options with varying alignments in the vicinity of Toolijooa Ridge and the bypass of the Foxground bends.

Long list options considered in section C largely focussed on the bypass of Berry. A number of options and variances between nodes were assessed that passed both to the north and the south of Berry at varying distances from town, including a continuation from Section B of an alignment following the South Coast Railway line on the southern side of town.

3.4.2 Evaluation of the options

The most feasible route options in sections A and D were both determined to be upgrades of the existing highway. These sections are outside of the focus of this project, but the need to tie in to these options was also considered during the assessment of the long list options.

In section B, options that followed the railway line generally performed well against the project objective of improving road safety, improving efficiency and managing potential adverse environmental impacts. These options generally performed poorly against the project objectives of providing value for money, supporting economic development and minimising social impacts. The best performing options in section B generally followed the alignment of the existing highway before bypassing the Foxground bends and rejoining the existing highway alignment north of Austral Park Road.

In section C, options that bypassed Berry to the north, including options following the North Street corridor, generally performed well against the project objective of improving road safety and efficiency and had varied performances against the remaining project objectives. Options that bypassed Berry to the south, including options along the railway line, generally performed well against the project objectives of improving road safety and efficiency but performed poorly against the remaining objectives, particularly providing value for money and supporting economic development.

The best performing options in sections B and C in the assessment were carried forward as short listed route options and further consideration through the value management workshop process. A description and evaluation of the shortlisted options is presented in **Section 3.5**.

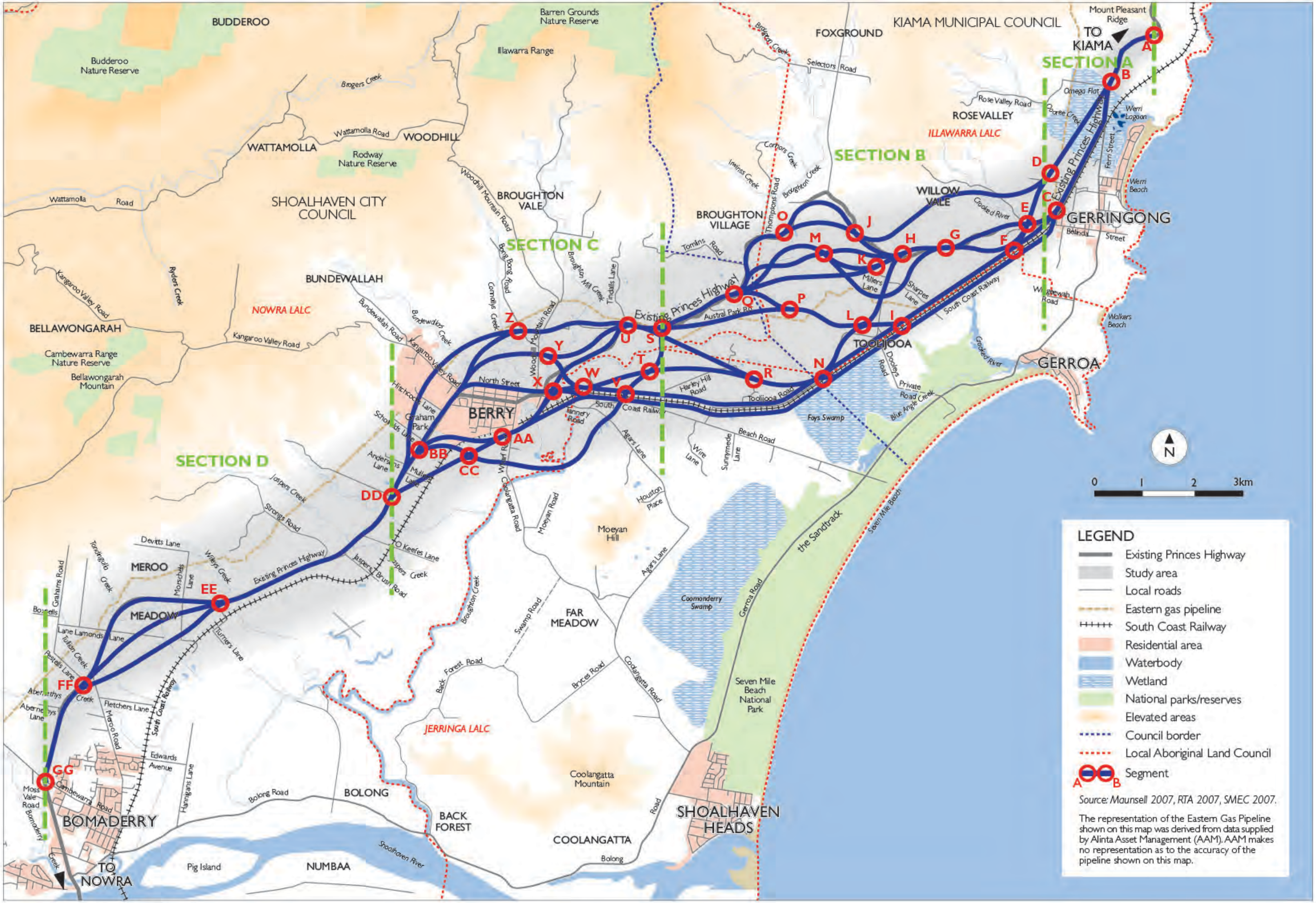

Figure 3-5 Long list of options

3.5 Short-listed route options

3.5.1 Description of route options

Options for sections B and C are described in **Table 3-2** and illustrated in **Figure 3-6**. Three options were proposed in section B, the pink, green and yellow options. The blue and orange options were proposed in section C and a third option, the modified orange option was developed through the value management process in response to community feedback (refer to **Chapter 6**). The modified orange option and the orange option are shown in **Figure 3-7**. The brown option was the only option to cover sections B and C.

As described in **Section 3.1.3**, an option for a bypass to the south of Berry was also assessed.

Table 3-2 Description of route options for sections B and C

Section	Route option	Description
B	Pink option	The pink option followed the existing highway from Gerringong to around Toolijooa Road north of Berry where the existing alignment became significantly sub-standard. At this point, around one kilometre southeast of Foxground Road, the pink option cut through the peak of Toolijooa Ridge. The option included a cutting around 900 metres in length, descending to Broughton Creek in a long sweeping curve. This curve crossed Broughton Creek three times before ascending a ridge to rejoin the existing highway at Austral Park Road. From this point, the pink option was common with the green option and generally followed the existing highway to around 500 metres east of Tindalls Lane.
	Green option	The green option diverged to the southwest from the existing highway at Toolijooa Road in a new corridor. The corridor passed under the north saddle of the Toolijooa Ridge in a 350 metre long twin tunnel. The option emerged in the Broughton Creek floodplain and curved south before crossing Broughton Creek three times. The green option then ascended a ridge to meet the existing highway at Austral Park Road and was common with the pink option and generally followed the existing highway to around 500 metres east of Tindalls Lane.
	Yellow option	The yellow option formed a new road corridor along the western edge of the railway line south of Gerringong for around 4.5 kilometres. This option then went west around the south eastern spur of the Toolijooa Ridge, passing under the south saddle in a 350 metre long twin tunnel. From the western side of the ridge, the route travelled in a relatively straight alignment before it rejoined the existing highway at Austral Park Road and followed an alignment common to the pink and green options and generally followed the existing highway to around 500 metres east of Tindalls Lane.
C	Blue option	The blue option began at around 500 metres east of Tindalls Lane and travelled west, across Woodhill Mountain Road and Bundewallah Creek in a circular arc to bypass Berry. It swept to the south under Kangaroo Valley Road and across North Street where it joined the existing highway in a cutting. The option continued to follow the existing highway to Croziers Road.

Section	Route option	Description
	Orange option and modified orange option (**Figure 3-7**)	The orange option generally followed the existing highway from around 500 metres east of Tindalls Lane until the northern entrance to Berry. The route then curved right onto and along the North Street corridor to bypass Berry. The option ran parallel to North Street within an existing road reserve to the north of North Street and enabled North Street to remain operational as a service road. The orange option rejoined the existing highway as it passed under Kangaroo Valley Road in a cutting and continued to follow the existing highway to Croziers Road. The modified orange option was developed as an outcome of the value management workshop in consultation with the community. The option departed from the existing Princes Highway alignment from around 500 metres east of Tindalls Lane with the aim of avoiding the sportsground, Camp Quality Memorial Park and the heritage precinct at Pulman Street. The option crossed Bundewallah Creek to the north of the sportsground and joined the North Street corridor near Albany Street.
B and C	Brown option	The brown option was about 16 kilometres in length and was the only short listed option that passed through sections B and C. This option ran along the western side of the railway line in a new 10 kilometre corridor from south of Gerringong to the north of Berry. Travelling west from the David Berry Hospital this route crossed the existing highway, Broughton Mill Creek and Woodhill Mountain Road and continued west along the North Street corridor along a common alignment to the orange option to bypass Berry. It turned south as it passed under Kangaroo Valley Road in a cutting, continuing along the existing highway to Croziers Road.

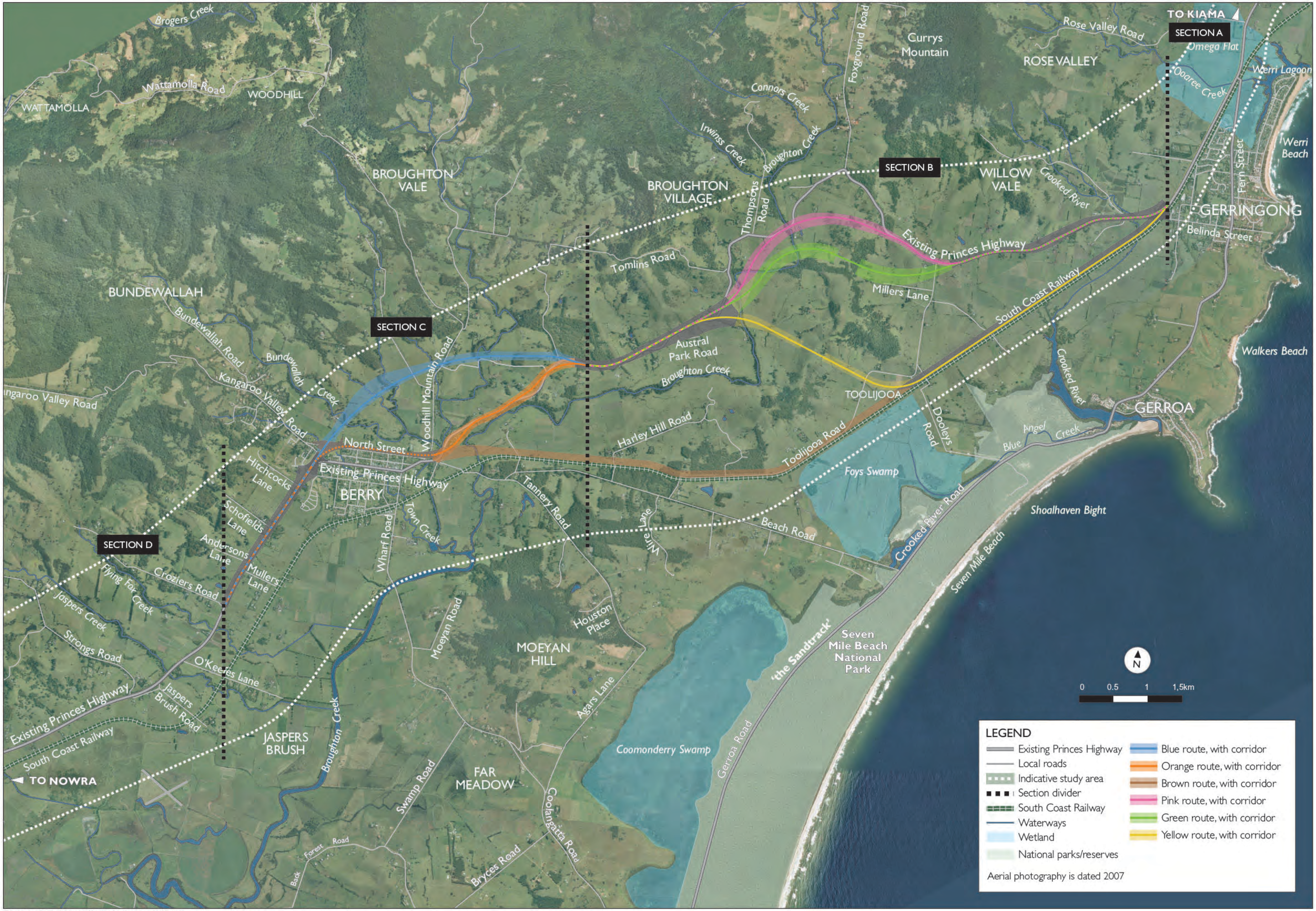

Figure 3-6 Short listed route options

Figure 3-7 Modified orange option and the orange option

Southern bypass of Berry

An option to bypass Berry to the south was investigated and is shown in **Figure 3-8**. The southern option commenced around the same location that the blue and orange options started. This option followed the existing highway before running directly south, on the eastern side of Berry. It crossed Tannery Road (east of Pulman Street) and the South Coast Railway before sweeping west with a large curve and crossing Broughton Mill Creek. The option crossed Wharf Road and required a second crossing of the South Coast Railway before rejoining the existing Highway near Mullers Lane.

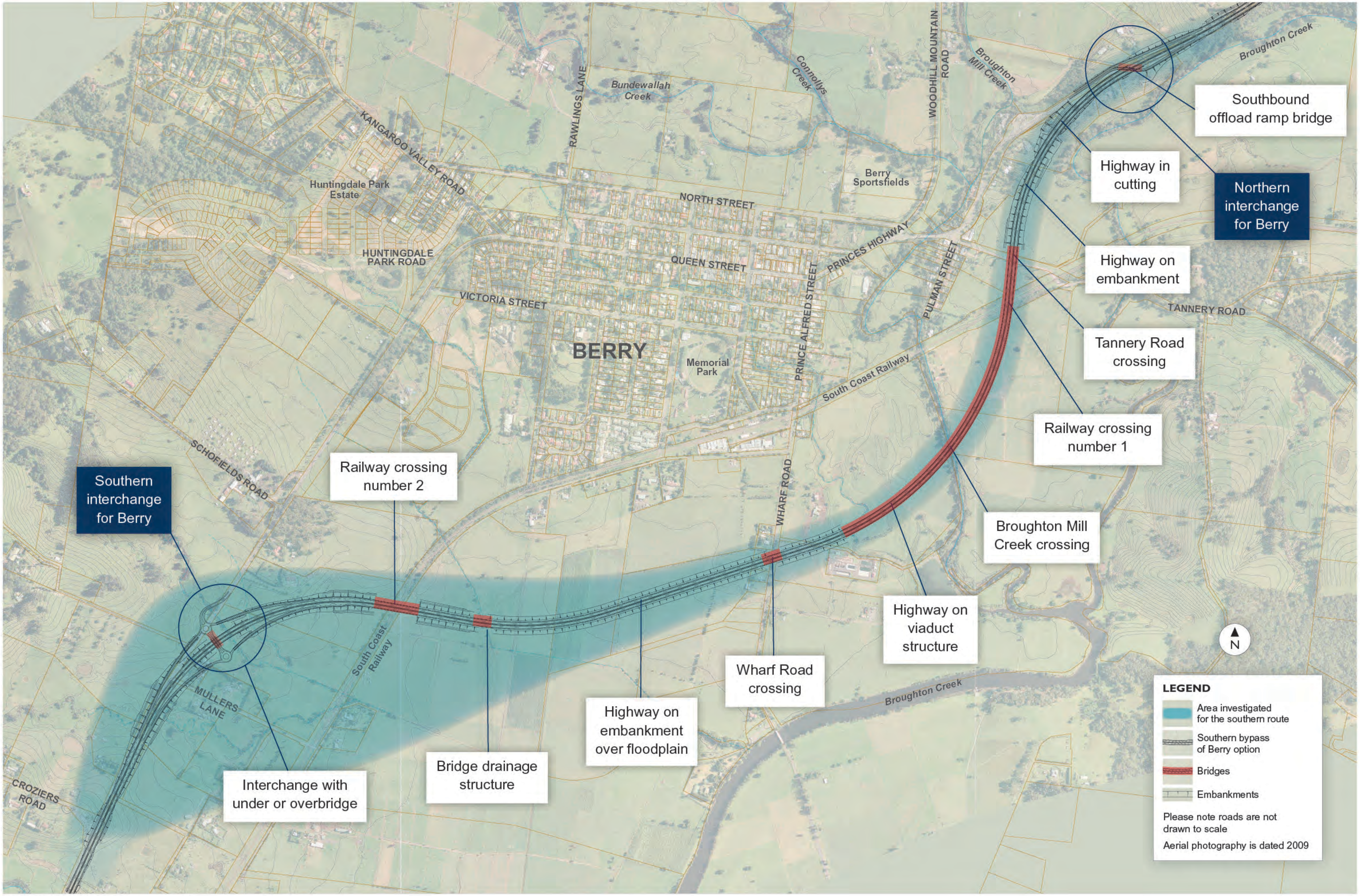

Figure 3-8 Southern bypass of Berry

3.5.2 Evaluation of route options

Evaluation of route options for section B

Yellow option

The yellow option performed marginally better against the environmental criteria when compared to the pink and green options. The option had the least impact on threatened species, habitats and biodiversity corridors. It also had the least impact on Aboriginal and non-Aboriginal heritage.

However, the value management workshop concluded that the yellow option should not be pursued as it performed poorly against the functional and socio-economic criteria. The option created a new highway alignment remote to the existing alignment, crossed high value agricultural land and required a greater level of land acquisition. As such, when compared to the pink and green options, it was determined that the yellow option would:

- For functionality, perform the worst in terms of constructability due to the presence of acid sulfate soils and soft soils, and due to the need to import fill for the construction of embankments. It would also leave a significant length of residual highway with a lower frequency but higher severity of accidents.
- For communities, have a direct impact on the viability of local communities and a significant change to the landscape due to impact on relatively undisturbed rural land and communities.
- For agricultural and non-agricultural businesses, perform the worst due to the impact on higher quality agricultural land, including the severance and acquisition of agricultural land.

For these reasons the yellow option would not meet the project objectives of supporting regional and local economic development and minimising adverse impacts on the local social environment.

Pink and green options

The pink and green options performed well against the value management assessment criteria and project objectives. In particular, both performed well against the project objectives of improving road safety and efficiency. The pink option included a deep cutting through Toolijooa Ridge and the green option included a tunnel through the ridgeline. To different degrees, the options also satisfied the project objectives of minimising adverse environmental and local social impacts.

To determine a preferred option for section B, additional investigations were undertaken as an outcome of the value management workshop. These investigations concluded that the green option generally performed better than the pink option against the socio-economic and environmental selection criteria as:

- For the socio-economic environment, the tunnel minimised the intrusion into the landscape and required a smaller project footprint. This also minimised the severance and acquisition of properties, and the associated impacts on agricultural businesses.
- For the natural and cultural environment, the tunnel largely avoided direct impacts on the cultural and ecological values of Toolijooa Ridge including impacts on an endangered ecological community and a potential wildlife corridor along the ridgeline.

However, through the gathering of detailed geotechnical information and design development of the tunnel as part of these investigations, it was found that the construction of the portal at the northern end of the tunnel would require some removal of the vegetation that it was intending to avoid. This therefore lessened the potential benefits that the tunnel was believed to provide.

Further, the traffic efficiencies associated with the gentler grades and shorter length of the tunnel were not deemed sufficient to out-weigh the additional capital and operation and maintenance expenditures of about $91 million (in present value terms calculated in 2009) required for the tunnel compared to the cutting. Therefore, based on the project objective of providing value for money, the pink option was carried forward as part of the preferred option for the project.

Further discussion of the evaluation of the pink and green options is provided in *Gerringong to Bomaderry Princes Highway Upgrade, Toolijooa Ridge Preferred Option Report (RTA, June 2009c).*

Evaluation of route options for section C

Blue option

There was little difference between the blue, orange and the modified orange options when assessed against the functionality criteria. However, the blue option was considered to provide the best alignment and had the least constructability issues.

Due to the distance from Berry, the blue option was considered to have a lower noise and visual impact on the Berry community. It was also considered to have the least impact on Aboriginal and non-Aboriginal heritage, including the heritage precinct at Pulman Street. However, the blue option overall performed the worst against the environmental and the socio-economic criteria as:

- The option was largely greenfield and impacted on high value agricultural land. This would result in a greater impact on agricultural productivity and viability of the directly impacted properties, the severance of land, and the viability and connectivity of the rural community.
- The option would result in a greater impact on businesses within Berry, due to the potential losses in highway generated trade associated with a loss of visual connectivity with the town with a bypass diverge point and interchange located about three kilometres from town at Tindalls Lane.
- The option performed the worst in terms of the impacts on the natural and cultural environment. In particular, it had the greatest impact on endangered ecological communities (EECs), threatened species and wildlife corridors, compared to the orange and modified orange options.

As such, the blue option would not satisfy the project objectives of supporting regional and local economic development, and minimising adverse environmental and local social impacts. For these reasons the blue option was not pursued further.

Orange option

Due to the proximity to Berry, both the orange and modified orange options had the greatest visual and noise impacts on the town. However, both options performed consistently better than the blue option against the environmental, and the socio-economic criteria as they would:

- Maintain the visual connection between the highway and Berry.
- Minimise the potential losses in highway generated trade, while enhancing the amenity of Queen Street through the removal of highway traffic.
- Minimise land take, vegetation clearance and impacts on agricultural land by utilising an existing road corridor for much of its length.

As such, the orange and modified orange options would satisfy the project objectives of supporting regional and local economic development and maximising the benefits to the local social environment.

The value management workshop recommended that the modified orange option be pursued further, subject to proving its feasibility, as it performed better than the orange option against the socio-economic, natural and cultural value management assessment criteria. This specifically related to the impacts of the orange option on the Berry sportsground, the Camp Quality Memorial Park, and on the heritage precinct at Pulman Street. For these reasons, the modified orange option would be better placed to meet the project objectives of minimising adverse environmental and local social impacts, and supporting regional and local economic development.

Evaluation of route options across both sections B and C

Because the brown option extended across both Section B and Section C, it was evaluated against the combined options of the pink/modified orange and green/modified orange options. The value management workshop recommended that the brown option should not be pursued further as it was considered deficient on constructability, environmental, functionality and socio-economic grounds. Specifically, the key limitation of the brown option was that it had the greatest impact on:

- The natural environment, including impacts on EECs, wetlands, wildlife corridors and water quality.
- The cultural environment, specifically impacts on the David Berry Hospital, Broughton Mill and the heritage precinct at Pulman Street.
- The socio-economic environment, with significant impacts on agricultural properties and the associated flow on effects on productivity and viability resulting from land take and the exacerbation of property severance.
- Communities, with the route having a greater level of severance and property acquisition, impacting on community connectivity, accessibility and amenity (such as at Toolijooa Ridge and Harley Hill).
- Landscape, with poor integration with the natural landform and the introduction of new visual impacts.

As such the brown option did not satisfy the project objectives of supporting regional and local economic development, minimising adverse local social and environmental impacts.

The brown option also performed inconsistently against the functional criteria. While it provided the greatest saving in travel times and minimised the number of direct or controlled accesses, it performed poorly against elements of the functional criteria, as:

- The option had greater constructability challenges due to soft soils, flooding risks and the need to import significant volumes of fill. This would not meet the project objective of providing value for money.
- It ranked the lowest in overall network safety due to the considerable length of residual highway that would remain with continued safety issues. As such, the brown option would not meet the project objective of improving road safety.

Evaluation of the southern bypass of Berry

The southern bypass of Berry option differed from the other options assessed. It's location to the south of the Berry township presented environmental, social and functional constraints and benefits that were not associated with the northern options. Specific limitations included impacts on:

- The cultural environment, specifically impacts on the David Berry Hospital, the heritage precinct at Pulman Street and an Aboriginal heritage encampment located at the confluence of Broughton Mill Creek and Broughton Creek.
- Constructability, there would be a high probability of encountering soft soils and acid sulfate soils through this area.
- Surface water and flooding, with the alignment being located across a floodplain.
- The socio-economic environment, with the severance of a number of large agricultural properties as opposed to the northern options that utilise the existing road corridor.
- Landscape character, with the introduction of new visual impacts due to the dominant structures required through this area.

As such the southern bypass of Berry did not satisfy the project objectives of supporting regional and local economic development, and minimising adverse local social and environmental impacts.

The option would also require the construction of nine viaduct or bridge structures in order to cross the floodplain and the South Coast railway. As a result the southern bypass of Berry would not meet the project objective of providing value for money. Further discussion of the evaluation of the southern Berry bypass option is provided in **Section 3.6.7**.

3.5.3 Preferred option

The options evaluation process and the additional investigations clearly identified and documented the route and access options to be carried forward as the preferred option. The preferred option was a combination of the pink and modified orange route options.

The preferred option was considered to provide the best outcome for the local environment and community. It performed the best against the project objectives of providing value for money, supporting regional and local economic development, traffic efficiency and maximising the benefits to the local social environment and road safety.

3.6 Design refinement options

3.6.1 Access options for Berry

A number of access options for Berry were assessed as part of the value management workshops. As well as this, additional options were also assessed, which included the provision of flood free access to Berry, the inclusion of a second northbound off-ramp and the splitting of the southern interchange to provide ramps in two separate locations.

Description of access options

Workshop options

Nine separate access options were shortlisted for Berry (B1-B9), as shown in **Figure 3-9** and **Figure 3-10**. These were a combination of on and off-ramps at both ends of the town and at a central location.

The distinguishing features of the access options into Berry were:

- Option B1 provided a northbound off-ramp that connected to an existing roundabout in Huntingdale Park Estate.
- Option B2 provided a northbound off-ramp that travelled under the proposed Kangaroo Valley Road overbridge, rounding in a loop to the left to join with Kangaroo Valley Road opposite Huntingdale Park Estate.
- Option B3 provided a northbound off-ramp that travelled under the proposed Kangaroo Valley Road overbridge, then curved to the left onto North Street to join Kangaroo Valley Road.
- Option B4 provided a southbound off-ramp that connected directly to Alexandra Street.
- Option B5 provided a southbound off-ramp that connected to the existing highway around 400 metres north of Tannery Road.

The distinguishing features of the highway access options from Berry were:

- Option B6 provided a northbound on-ramp at Woodhill Mountain Road.
- Option B7 provided a northbound on-ramp that connected to the existing highway around 500 metres north of the property ‘Mananga’ and required a bridge over the proposed alignment.
- Option B8 provided a southbound on-ramp at the western end of Queen Street.
- Option B9 provided a southbound on-ramp at Alexandra Street.

Flood free access options

Several options were identified to provide flood immune access to Berry. These options were the upgrade of a residual section of the existing highway in the vicinity of the existing Broughton Mill Creek bridge to provide flood immune access for Berry, a flood free u-turn facility at Schofields Lane, a gated access at Alexandra Street for use during flood times and additional ramps that would connect to Kangaroo Valley Road.

Additional northbound off-ramp

An option was considered to provide a second northbound off-ramp to provide access to Berry. The off-ramp would likely be located at the western end of the bridge at Berry and tie into Woodhill Mountain Road.

Split southern interchange

An option was considered that split the southern interchange for Berry into two smaller interchanges, with the north-facing on and off-ramps remaining at Kangaroo Valley Road and the south-facing on and off-ramps relocated further south, close to Schofields Lane. This option was assessed against the provision of a full interchange at Kangaroo Valley Road.

Figure 3-9 North and southbound off-ramp options B1 to B5

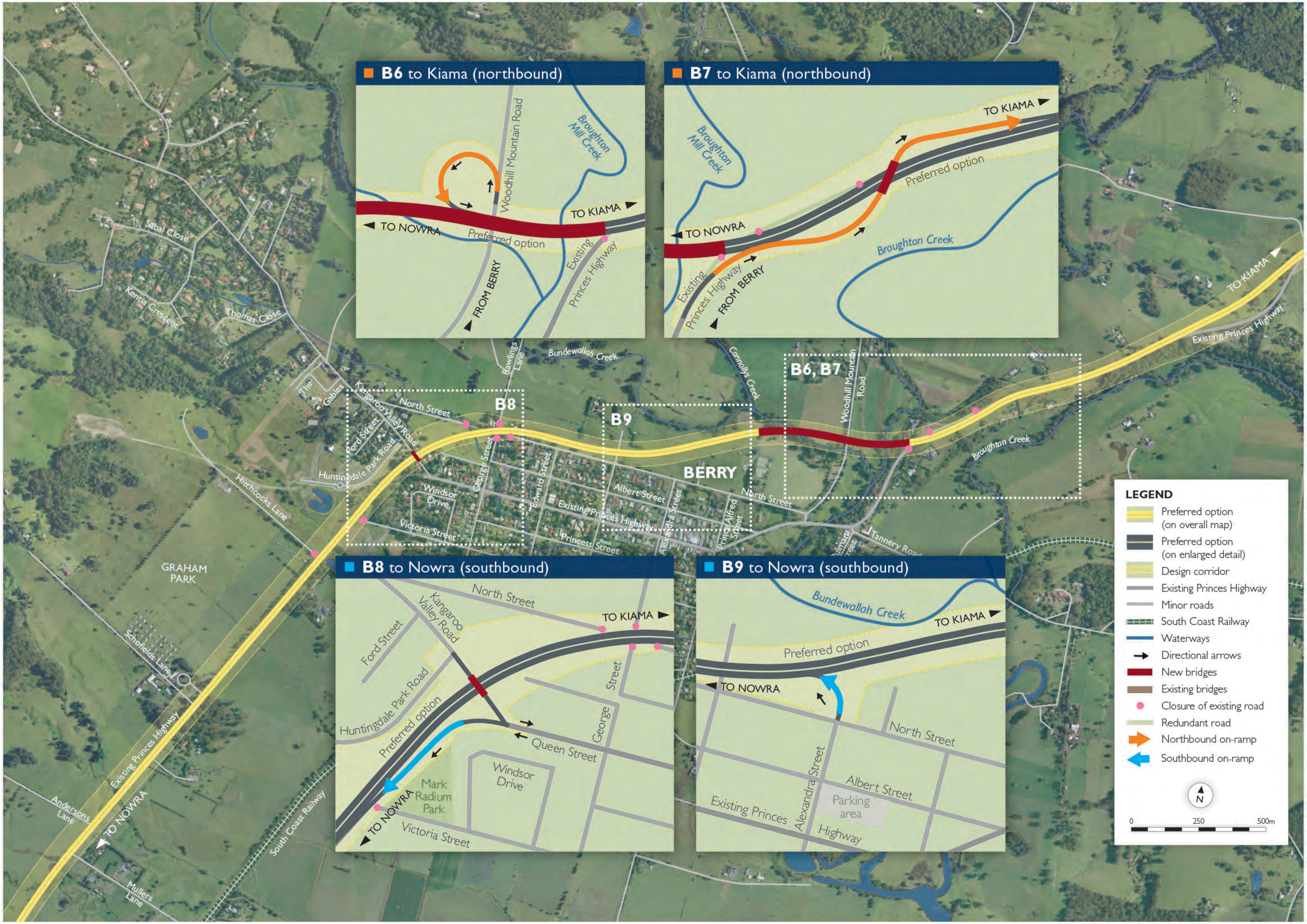

Figure 3-10 North and southbound on-ramp options B6 to B9

Evaluation of access options

Workshop options

The outcomes of the access options workshop were as follows:

- Options B9 and B4 (which provides access to/from Berry via Alexandra Street) were not favoured due to the potential impacts on the local residential amenity, socio-economic environment (given the retail core of Berry focuses on Queen Street) and the alterations to the local road network. As such, these options would not satisfy the project objectives of minimising adverse impacts on the local social environment, supporting the regional and local economic environment.
- Option B3 was removed from the assessment as it was considered to be an indirect route, was overly intrusive, and impacted on a greater number of residences. This option failed to meet the project objective of minimising adverse impacts on the local social environment. Option B2 provided the same function but with a lesser potential social and visual impact.
- Option B1 was not favoured given the potential amenity impacts on the Huntingdale Park estate (particularly noise and visual impacts associated with the increased traffic). This would be inconsistent with the project objective of minimising adverse impacts on the local social environment.
- A combination of remaining access options (B2, B5, B6, B7 and B8) at both the northern and southern ends of Berry were favoured and recommended to be carried forward for further consideration as these options maintained the existing gateway into Berry from the north and the east-west traffic movements through town. These options would support the project objectives of minimising adverse impacts on the local social environment, and supporting the regional and local economic environment.
- The access options at the northern end of Berry (B5, B6 and B7) rely on the existing flood prone highway alignment and would remain flood prone at and above the 1 in 5 year flood event. As a result, further investigations were recommended to assess ways to provide flood immune access to and from Berry.

Further evaluation and investigation of the workshopped options led to:

- A reduction in the footprint and bulk of the access options at the northern end of Berry (Option B5 and B7) by consolidating the ramps and passing the northbound ramp exiting Berry under the highway.
- The southbound on-ramp exiting Berry (Option B8) being shifted to the south of Victoria Street to minimise the direct impact on Mark Radium Park and to maintain access to the park from Queen Street.
- The reintroduction of the northbound off-ramp providing access into Berry that connects to Huntingdale Park Road (Option B1) in favour of Option B2. The long term safety concerns with the 180 degree turn associated with the Option B2 ramp were considered to outweigh the potential amenity impacts associated with Option B1.

Flood free access options

The assessment of the flood immune access options concluded that:

- The upgrade of the existing highway between Broughton Mill Creek bridge and the retail precinct of Berry represented poor value for money (with an estimated cost of $3 million). The extent of works would have adverse impacts on surrounding land use, business viability and amenity. As such, this option failed to meet the project objectives of providing value for money, and minimising adverse impacts on the local social environment.
- A flood free u-turn facility at Schofields Lane would not provide a safe or efficient solution during adverse weather when compared to a dedicated access. Therefore, this option did not satisfy the project objective of improving road safety.
- A gated access at Alexandra Street (Option B4), which would be used in times of flood only, would not be carried forward, as it would alter the existing local road network and traffic movements in town. This would result in amenity impacts on surrounding residential areas and would create conflicts between motorists and pedestrians. In addition gated accesses have proven difficult to manage, resulting in uncontrolled use. Therefore this option did not satisfy the project objectives of minimising adverse impacts on the local social environment, improving road safety, and supporting regional and local economic development.
- Providing a northbound on-ramp from Berry and a southbound off-ramp into Berry at the southern interchange for Berry was the preferred option. This would provide flood immune access as well as direct access to the highway for existing residents to the north west of Berry along Kangaroo Valley Road and beyond. It would also service the Huntingdale Park Estate, which is the major growth area of Berry. This option supports the project objective of improving road safety and negates the need to travel through Berry to access the highway when heading north.

Second northbound off-ramp for Berry

Traffic modelling undertaken for the southern interchange for Berry indicated that the proposed northbound off-ramp would experience minimal delays during the holiday peak period. As such, including a second northbound off-ramp is not considered to provide value for money as modelling indicates that the southern interchange for Berry would continue to operate at an acceptable level of service until around 2070.

Providing a second northbound off-ramp for Berry would also not meet the project objectives of managing adverse environmental and social impacts. The off-ramp would likely be located at the western end of the bridge at Berry and tie into Woodhill Mountain Road, which would result in additional environmental impacts during construction and operation due to the proximity of Bundewallah Creek and associated geological conditions.

The second northbound off-ramp for Berry has not been included as part of the project. However, the concept design does not preclude the addition of this ramp should it become warranted in the future. Further details are provided in **Section 7.1.3** and **Appendix D**. The ramp would be subject to a separate environmental assessment in the future should it be needed.

Split southern interchange

The option to split the southern interchange for Berry was assessed against the construction of a full interchange at Kangaroo Valley Road.

It was proposed that the split southern interchange option would reduce the operational noise and visual impacts associated with a full interchange at Kangaroo Valley Road. It would also slightly reduce the size and cost of excavation required for the construction of this interchange at Kangaroo Valley Road.

Overall however, the split southern interchange option would increase the cost of construction of the southern interchange for Berry as it would require the construction of an additional bridge close to Schofields Lane and a two-way service road (approximately 1 kilometre long) between the interchange and Berry. As a result this option would not meet the project objective of providing value for money.

The split southern interchange option would also not meet the project objectives of minimising adverse environmental and social impacts. The option would require a larger footprint and would increase impacts on adjacent properties.

The split southern interchange has not been included in the project and as such further consideration of this option is not included in this environmental assessment.

Preferred option

The preferred access options for Berry are:

- A half interchange comprising a combination of access options B5 and B7 to form the northern access interchange, providing an exit from Berry for traffic travelling to the north and access into Berry for traffic travelling from the north.
- An all-movements interchange at Kangaroo Valley Road, allowing access into and out of Berry from the north and south.

3.6.2 Berry bypass design options

The objectives of the Berry bypass review were to identify possible refinements that could:

- Improve the aesthetics and form of the bridge at Berry.
- Lower the height of the bridge at Berry as much as practicable, to minimise environmental and community impacts.
- Relocate the alignment near North Street further north and to identify urban design solutions for the area between the Berry bypass and North Street.

Description of options

Three options were presented to and developed by the CRG which placed the alignment to the north of Bundewallah Creek. These initial options are shown in **Figure 3-11** and are described in **Table 3-3**.

Table 3-3 Initial design refinement options

Option	Description
Bypass option 1	This option moved the alignment further north near Tindalls Lane. It crossed Woodhill Mountain Road north of the existing preferred option, which required Woodhill Mountain Road to bridge over the highway. The option crossed Connelly's Creek, Bundewallah Creek and the associated floodplain before rejoining the existing preferred option near Kangaroo Valley Road.
Bypass option 2	This option deviated from the existing preferred option near Tannery Road. It swept steeply to the north adjacent to Connelly's Creek. It then crossed Bundewallah Creek and associated floodplain before rejoining the existing preferred option near Kangaroo Valley Road.
Bypass option 3	This option deviated from the existing highway slightly north east of the existing preferred option. It crossed Woodhill Mountain Road and traversed the North Street corridor north of the existing preferred option. It then rejoined the existing preferred option near Rawlings Lane.

Evaluation of options

Preliminary design investigations for option one and option two determined that the construction of extensive structures, such as bridges and/or viaducts would be required to cross Bundewallah Creek and the associated floodplain on the northern side of the creek. These options would not be consistent with the project objective of providing value for money, as they could potentially cost double that of the existing preferred option to construct.

The social and environmental impacts were also considered when analysing these options against the remaining project objectives. Bypass option one in particular would sever a number of agricultural properties that would not be largely impacted by the existing preferred option. Both option one and option two would cross the Bundewallah Creek floodplain and would have surface water and flooding impacts. As a result, option one and option two would not be consistent with the project objectives of minimising social and environmental impacts.

In comparison to option one and option two, the location of bypass option three closer to the existing preferred option, minimised the property severance impacts and reduced the requirement for large structures to be built. As a result, bypass option three was able to satisfy the objectives of the CRG process by moving the alignment further north away from Berry whilst still meeting the project objective of providing value for money.

Preferred option

The CRG concluded that bypass option one and option two did not represent value for money. As a result bypass option three was accepted as the preferred option. Further refinements of the preferred option were undertaken and split the alignment into two sections for development by separate community working groups, the bridge at Berry and the northern interchange as one section considered by one group, and the North Street corridor as the other section developed by another group (refer to **Section 3.6.3** and **Section 3.6.4** for further details). Bypass option three was used as the benchmark for these design refinements.

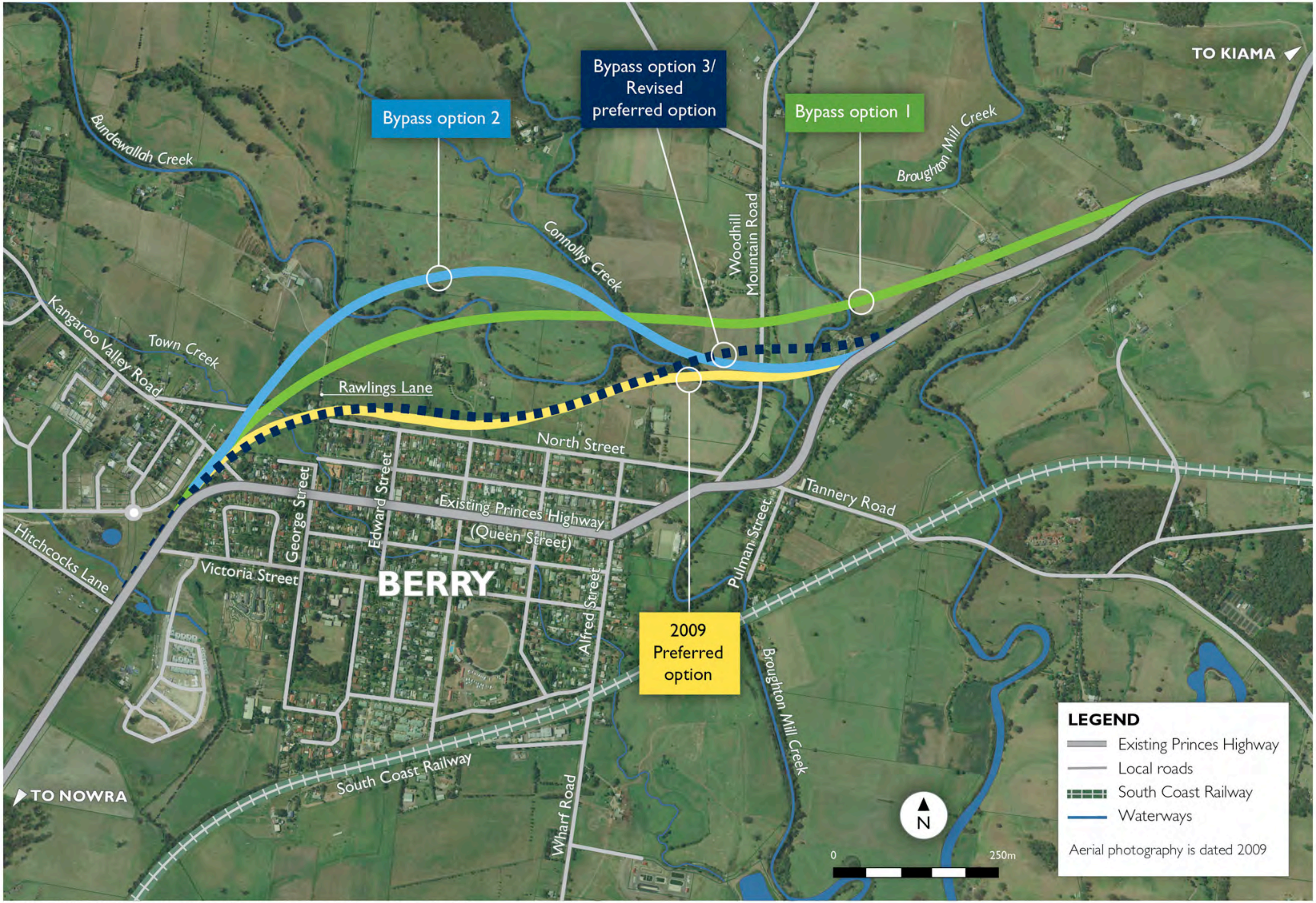

Figure 3-11 Bypass options north of Berry and the preferred option

3.6.3 Bridge at Berry and northern interchange for Berry

The aims of refining the preferred option through north of Berry included:

- The relocation of the bridge further north away from Berry.
- The redesign of the northern interchange to accommodate the change in bridge location, and to lower the bridge as much as possible.

The key constraints to the alignment within the preferred corridor included:

- The additional volumes of excess fill that would be generated at the northern interchange at Berry to accommodate a lower bridge, and the associated costs.
- The vertical grade of the bridge. This was set at a three per cent vertical grade to avoid noise impacts from heavy vehicles accelerating or slowing down at this location.
- The minimum height clearance for vehicles on Woodhill Mountain Road.

Evaluation of options

There were no specific options assessed, however a number of different combinations of ramp and bridge configurations were developed through the community review workshop process. These included assessing different embankments, cuttings and retaining walls at the northern interchange that would optimise the cut/fill ratio and the lowering of the bridge. These had varying impacts on neighbouring properties (due to embankments and retaining walls), the cut/fill ratios and on road safety.

Preferred option

The revised preferred option is shown in **Figure 3-12**. The key differences between the previous preferred option and the revised preferred option were that:

- The bridge has been moved around 95 metres to the north where it crosses Woodhill Mountain Road.
- The bridge has been lowered by around 6.4 metres where it crosses Woodhill Mountain Road.
- The highway at the northern interchange would depart further north along the existing highway alignment, requiring the use of more extensive cut and fill embankments (or retaining walls) on the south side of the project.

The revised preferred option was considered to best meet the project objectives as:

- The reduction in bridge height has been maximised within the identified constraints. This would minimise the visual and noise impact of the project and as such would best meet the project objectives of minimising the social and environmental impacts.
- An optimised cut/fill balance has been achieved to accommodate the north Berry review objectives. Reducing the size of the cutting and increasing the size of the embankments on the north side of the project at the northern interchange to lower the bridge (when compared to the other design refinements considered) would balance the earthworks with the larger cutting on the south side of the project and reduce the costs involved with removing excess spoil from the site. The preferred option was considered to best meet the project objective of providing value for money as it minimises the costs associated with managing excess spoil while still lowering the bridge.

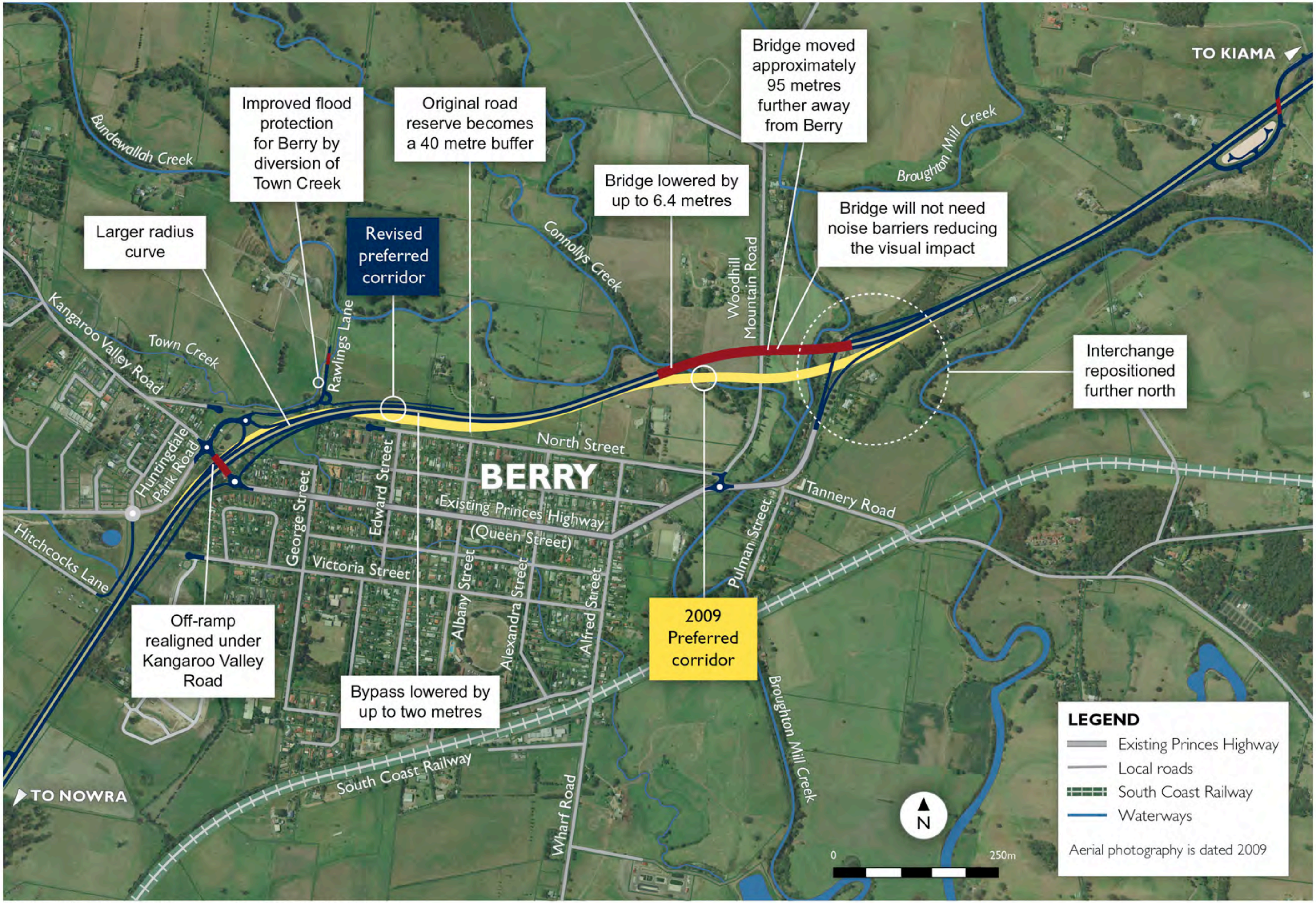

Figure 3-12 The revised preferred option north of Berry

3.6.4 North Street corridor

Options for location of the alignment

Description of options

The preferred corridor through this section moved the alignment further north, away from North Street. Design options were assessed to find the optimal location of the project between North Street and the rural agricultural residence at Lot 31 DP 818336 (property 46 on **Figure 7-38** in **Section 7.9**). The first option was the mid-point between the rural residence building line and a typical building line on North Street. Other options looked at locating the alignment at varying distances between the residence and North Street.

Evaluation of options

Consultation with the owner of the agricultural property determined that locating the alignment at the mid-point between the rural residence building line and a typical building line on North Street would compromise the viability of agricultural activities due to severance and the quality and flood prone nature of remaining land. The best option was considered to be locating the alignment about 40 metres from North Street. This option provided a 40 metre buffer between the North Street residents and the alignment and also reduced the impact on the productive agricultural land of the rural property.

Options for lowering of the alignment

Description of options

Lowering the alignment would minimise the visual and amenity impacts along North Street. However, the ability to lower the alignment was significantly constrained by flooding, the limitations of appropriate pavement drainage and the need to maintain partial flows in Town Creek. As such, the following options were considered in order to facilitate a lowered alignment:

- Lower the alignment as much as possible to the point that permanent pumps would be required to drain the road pavement and flood waters.
- Lower the alignment to the maximum depth to allow the pavement to drain naturally without introducing pumps and include a full diversion of Town Creek to Bundewallah Creek.

Evaluation of options

The use of permanent pumps to drain road pavement and flood waters was not considered viable given the cost of the options, the volumes of water required to be pumped and the risk for road closures. The design of the full diversion of Town Creek considered measures to minimise the impacts on Town Creek, Bundewallah Creek and riparian vegetation. This is discussed in **Section 7.2**, **Section 7.4** and **Section 7.4**. The full diversion of Town Creek would best meet the project objectives of improving road safety and minimising environmental impacts whilst providing a lowered alignment and improved visual amenity for North Street residents.

Preferred option

The revised preferred option is shown in **Figure 3-12**. The key differences between the previous preferred option and the revised preferred option are:

- The alignment has been moved further north and would provide a buffer of around 40 metres between the majority of North Street residents and the bypass.
- The alignment along North Street has been lowered by up to two metres. While the height of the noise wall relative to the highway pavement would remain the same, the height of the noise wall as viewed from North Street would be lowered. This would help to reduce the visual impact of the project.

The preferred option in this section is considered to best meet the project objectives of providing beneficial environmental effects for Berry town centre and minimising the impacts on the local social environment.

Urban design, with the objective to minimise the visual impact of the project was a key consideration during the design refinement process outlined above. A series of urban design workshops were held with a focus to optimise the preferred option in consultation with the community and minimise the visual impact of the project in this area. The outcomes of these workshops and the ongoing consideration of urban design and visual amenity have been included in the concept design and are documented in detail in **Section 7.6** and **Appendix I**.

3.6.5 Arrangement of the southern interchange for Berry

As discussed in **Section 3.6.1**, the southern interchange for Berry would be a full interchange comprising both northbound and southbound on and off-ramps. Further to this, options were assessed to change the arrangement of the interchange, primarily focussed on the alignment of the northbound off-ramp to reduce the potential amenity impacts on Huntingdale Park Road.

Description of options

RMS investigated three alternative options for the southern interchange:

- Option one involved the consolidation of the two proposed roundabouts on Kangaroo Valley Road to a single roundabout centred over the highway. All on and off-ramps would directly connect to this roundabout.
- Option two maintained Kangaroo Valley Road as a single span bridge over the highway but included a new northbound off-ramp that would directly connect to Kangaroo Valley Road at a roundabout. This option would require the realignment of Huntingdale Park Road further west along Kangaroo Valley Road in order to accommodate this ramp.
- Option three resembled the initial option B2 which had previously been assessed at the route options phase. As with option B2, it provided a northbound off-ramp under the Kangaroo Valley Road overbridge. It differed from option B2 by providing a roundabout that would connect to the northbound off-ramp, the northbound on-ramp, Kangaroo Valley Road and the eastern end of North Street. It would also provide for access to the two agricultural properties on Rawlings Lane.

Evaluation of options

The benefits of option one were the streamlined design and the separation of the northbound off-ramp from Huntingdale Park Road. However, this option was considered overly large in terms of bulk and scale, presented constructability difficulties and would be significantly more expensive to construct. As such this option was not considered to support the project objective of providing value for money. The scale and engineered features of the option were also not considered to fit within the landscape character of Berry's rural setting.

Option two would reduce noise impacts due to the separation of highway and local traffic volumes and would reduce changes to the character of Huntingdale Park Road. However, it would also require the additional acquisition of two properties for the realignment of Huntingdale Park Road.

Option B2 was initially rejected due to safety concerns arising from the 180 degree turn required to connect with Kangaroo Valley Road. Option three has alleviated this concern by including a roundabout to slow and control traffic. Option three would further minimise the amenity impact along Huntingdale Park Road and would minimise property acquisition as the land required for the off-ramp and roundabout have already been acquired by RMS.

Preferred option

Option three was chosen as the preferred option as it would best meet the project objectives of providing value for money and minimising environmental and social impacts.

3.6.6 Victoria Street

Description of options

Three options were considered for the western end of Victoria Street. These options are displayed in **Figure 3-13** to **Figure 3-15** and included:

Option 1 Full closure of Victoria Street (created by a cul-de-sac) with a southbound on-ramp from Queen Street. providing access to the new bypass.

Option 2 Victoria Street remains open, providing one-way travel between Queen and Victoria streets, with a southbound on-ramp south of Victoria Street.

Option 3 Victoria Street remains open, maintaining two-way travel adjacent to the highway between Queen and Victoria streets, with a southbound on-ramp south of Victoria Street.

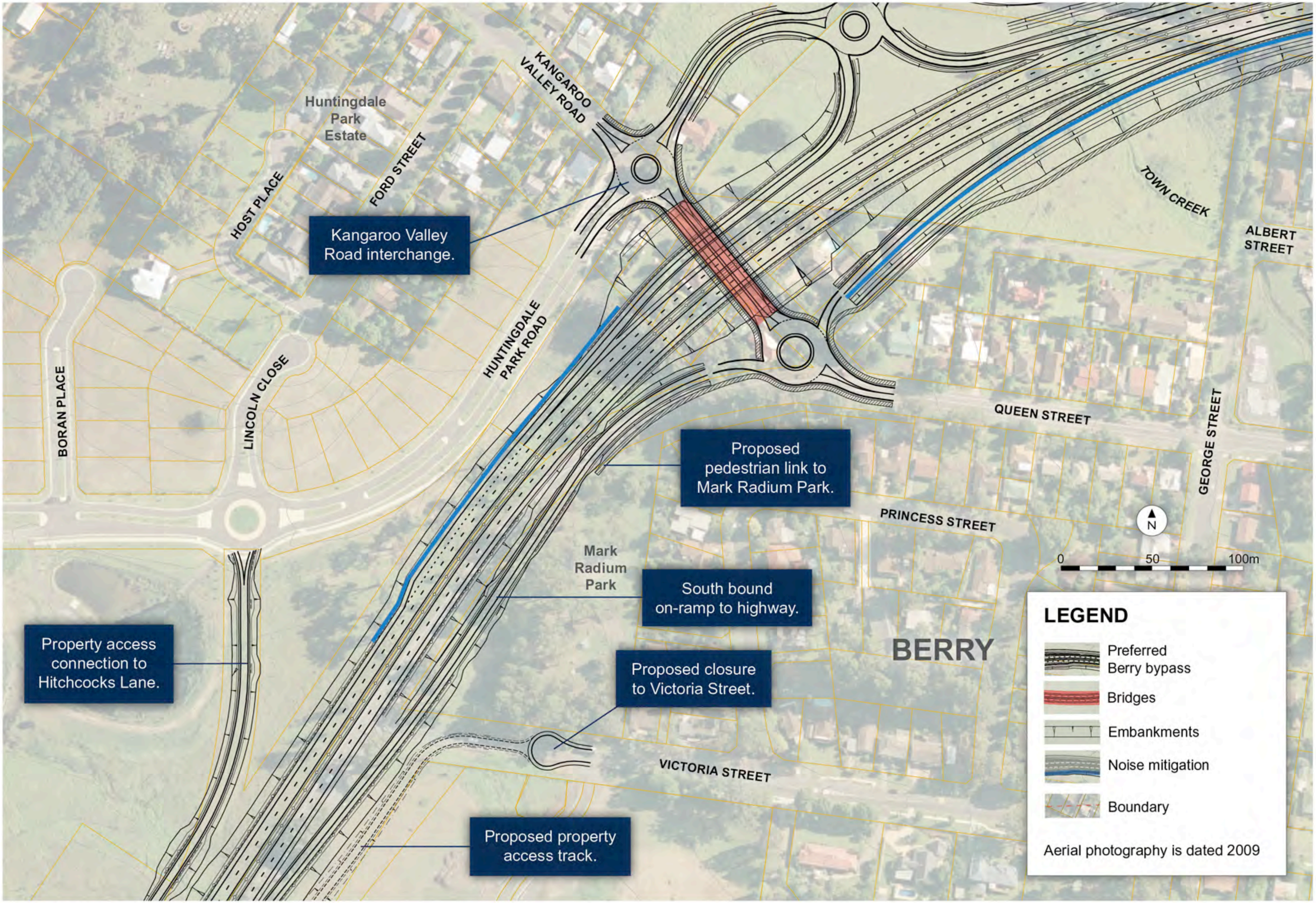

Figure 3-13 Victoria Street Option 1

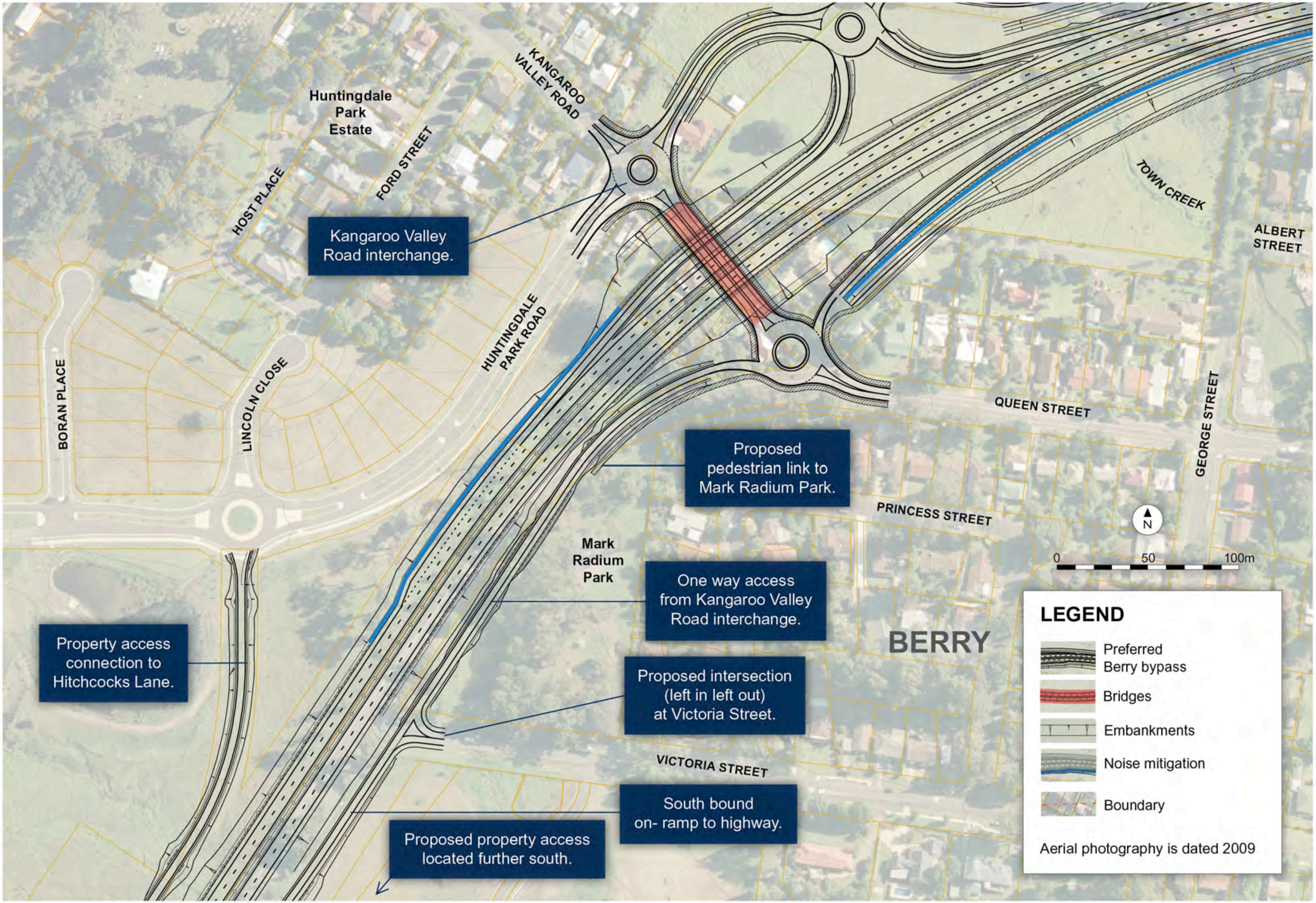

Figure 3-14 Victoria Street Option 2

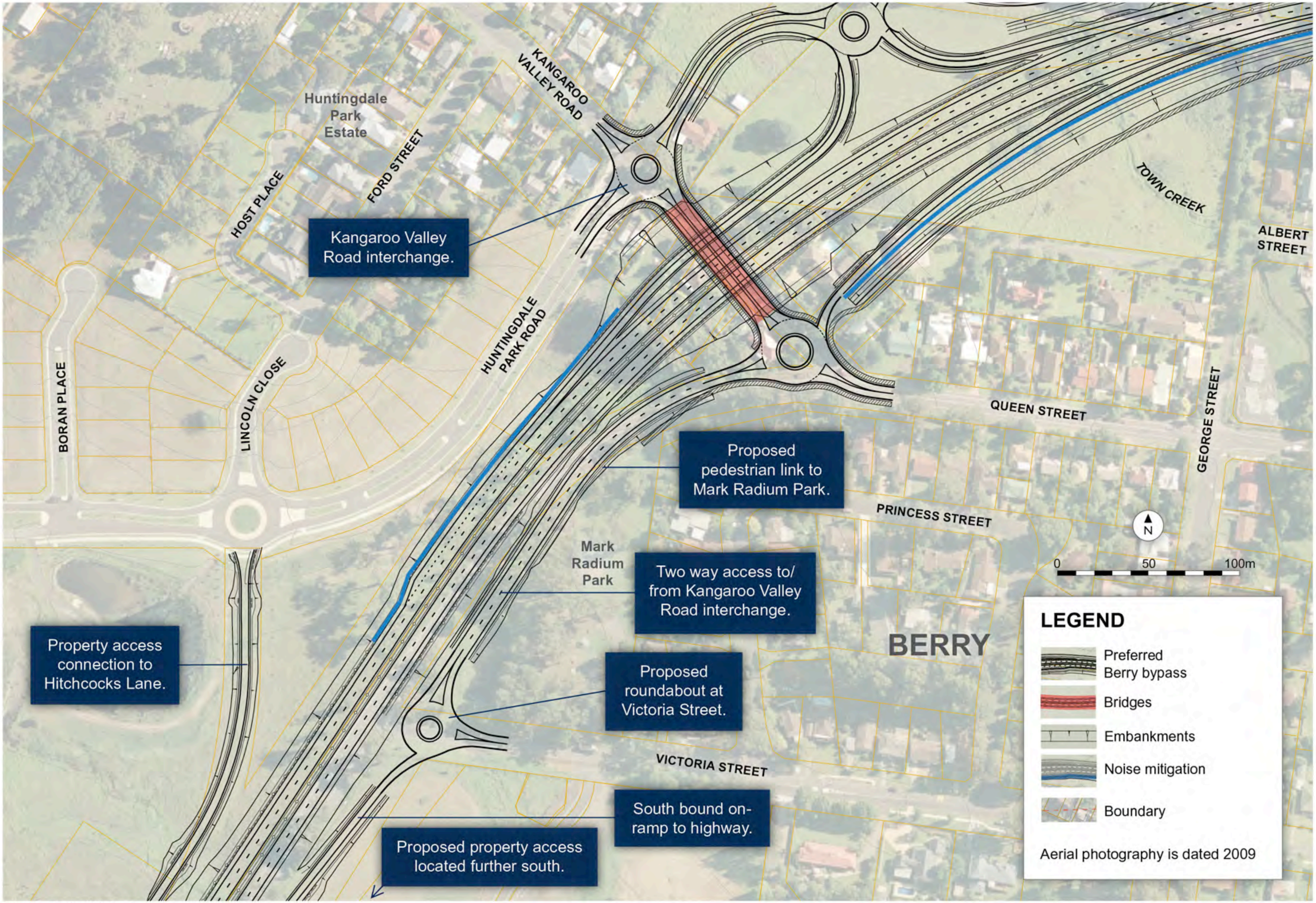

Figure 3-15 Victoria Street Option 3

Evaluation of options

Community feedback to close Victoria Street at its western end or to keep it open with a connection to the highway suggested that there was generally a split with some preferring to keep it open and others preferring the closure. This feedback is discussed in more detail in **Chapter 6**.

With no clear agreed direction forthcoming from the consultation undertaken, a qualitative assessment of the three options was undertaken by RMS against the project objectives. The aim of this assessment was to develop a clear preferred option to take forward, with the understanding that the concept design would not preclude any of the options being developed in the future.

The full closure of Victoria Street would have the greatest impact on local traffic movements within Berry by redirecting the traffic currently utilising Victoria Street to access the highway, to the southern interchange via Queen Street. **Section 7.1.3** discusses the existing traffic patterns within Berry and the impacts of the closure of Victoria Street at the western end in detail. The result of this would be an increase in traffic volumes on the north-south local roads between Victoria Street and Queen Street. These roads include George Street, Edward Street, Albany Street, Alexandra Street and Prince Alfred Street.

However, the full closure of Victoria Street would also best meet the project objective of improving road safety by reducing the potential traffic conflicts associated with traffic accessing the southbound on-ramp in one or both directions and potential conflicts associated with the school and retirement villages at the western end of Victoria Street.

All three options would have some impact on Mark Radium Park. Option 1 would impact about 25 per cent of Mark Radium Park. Option 2 would impact around 24 per cent of Mark Radium Park and Option 3 would impact about 29 per cent. Therefore, given that the full closure of Victoria Street would reduce the overall footprint of the southern interchange for Berry and would have a relatively small impact on Mark Radium Park, it would satisfy the project objective of reducing environmental and social impacts.

Preferred option

The assessment found that the closure of Victoria Street at the western end with a cul-de-sac and a one-way southbound on-ramp from Queen Street narrowly outperformed the other options when assessed against the project objectives and should be taken forward as the preferred option on that basis with the understanding that the concept design would not preclude any of the options being developed in the future.

3.6.7 Southern bypass of Berry

A description of the southern bypass of Berry has been provided in **Section 3.5.1**. Evaluation of this option against the project objectives has also been provided in **Section 3.4** and **Section 3.5**. A number of options to the south of Berry were assessed as part of the route options development process. These options were considered in the long list of options and the physical, environmental and social constraints of these options were assessed. Options south of Berry did not perform as well against the project objectives as the short-listed options to the north of Berry.

Further to this, a cost estimate was prepared to assess the value of this option against the northern bypass of Berry. The cost estimate of the southern bypass of Berry was greater than the cost estimate for the northern bypass by around $150 million. The main factors contributing to this difference were the cost of the structures and earthworks required. As a result, the southern bypass of Berry did not meet the project objective of providing value for money and was not carried forward as part of the project. This review process is documented in '*Foxground and Berry bypass Princes Highway upgrade, Report on route feasibility comparative cost estimates*' (RMS, June 2012).

Further consideration of this option is not included in this environmental assessment.

3.6.8 Pedestrian access to Berry

The feasibility of including a pedestrian overbridge to connect the two ends of North Street was assessed. **Section 7.1** provides an assessment of the number of pedestrians currently utilising North Street and the likely impact of the severance of North Street on these pedestrians. It concluded that the small number of pedestrians currently using the corridor would not justify the large cost of the bridge and as such the option would not meet the project objective of providing value for money.

The provision of shared path connections on both sides of the Kangaroo Valley Road overbridge linking the proposed pedestrian and cyclist link along the northern side of North Street to the sports ground is considered to be appropriate to cater for the number of pedestrians currently using this link and expected future growth.

The provision of additional pedestrian connectivity along North Street via a pedestrian overbridge that is separate and in close proximity to the Kangaroo Valley Road overbridge would be unlikely to provide value for money and has not been taken forward for further consideration.

3.6.9 Rest areas

Description of options

Two rest area options were proposed and considered:

- No rest area as part of the project, with consideration for an alternative location outside of the scope of this project.
- Inclusion of a heavy vehicle rest area near the Austral Park Road interchange to service southbound heavy vehicles only and not light vehicles.

Evaluation of options

Issues associated with the inclusion of the heavy vehicle rest area at Austral Park Road generally related to amenity impacts including noise, air quality and light spill. These impacts meant that the heavy vehicle rest area did not meet the project objective of minimising impacts to the local social environment.

Other issues associated with the rest area would not meet the project objectives of minimising environmental impacts, supporting the local economy and providing value for money. These issues included proposed property accesses, property acquisition, potential flooding and potential biodiversity issues associated with the impact of additional infrastructure on local fauna movement corridors and landscaping. These issues are discussed in **Chapter 6**.

Preferred option

An alternative location for the southbound heavy vehicle rest area outside of the scope of this project was considered to best meet the project objectives. Consequently the rest area at Austral Park Road was not proposed as part of the preferred option.

3.6.10 Pulman Street heritage precinct

The existing preferred option included a roundabout at the junction of Tannery Road and the existing Princes Highway. The purpose of this roundabout is to provide a u-turn facility for property owners just north of Tannery Road who would access the highway via a left-in left-out movement.

The location of this roundabout at Tannery Road would impact on the heritage curtilage of Pulman Street and the original junction arrangement that formed part of the original Berry. As a result, the roundabout was moved to the junction of Woodhill Mountain Road and the existing Princes Highway. This change would not affect the u-turn functionality of the roundabout but it would better preserve the historic heritage of original Berry. As such it performed better against the project objectives of minimising adverse social and environmental impacts and is included as part of the project.

3.7 The project

The project incorporates the preferred option announced in 2009 and the design refinements developed through ongoing community engagement since. The project is shown in **Figure 1-1** and is described in detail in **Chapter 4**.

The project is considered to best meet the project objectives as well as the functional, socio-economic and environmental criteria established through the value management workshop process (See **Section 3.2.2**).

Specifically, the project would best meet the project objectives as follows:

- Improving road safety:
  - The alignment would satisfy road safety criteria.
  - Interchanges that deliver flood immune access to Berry would be provided.
  - The safety of pedestrians crossing Queen Street in Berry would be improved.
- Improving road efficiency
  - Traffic would be able to maintain a 100 kilometres per hour travel speed.
  - Parking manoeuvres in Queen St Berry would no longer block the passage of through traffic.
- Providing value for money:
  - The design solution at Toolijooa Ridge achieves the project objectives but at a lower overall cost.
  - The realignment of the project north of Berry would reduce the amenity impacts experienced within Berry, while optimising the cut/fill balance to provide the best value solution.
- Supporting regional and local economic development:
  - The impacts on high quality agricultural land would be minimised.
  - The existing internal road network in Berry would remain unaltered as a result of the access arrangements and the east-west movements through Berry would be maintained, except at Victoria Street.
  - There would be a visual connection between the highway and Berry, minimising potential losses in highway generated trade, while enhancing the amenity of Queen Street through the removal of highway traffic.

- Providing significant beneficial environmental effects for the Berry town centre and managing potential adverse environmental impacts elsewhere:
  - There would be a lower impact on ecology as the extent of disturbance to threatened species, EECs, wetlands and the associated drainage catchments was minimised through the options assessment.
  - The diversion of Town Creek would reduce flooding impacts experienced within Berry.
  - The project generally responds to the natural landscape by following the existing contours and utilising the existing highway alignment where possible. It maintains a visual connection to the ocean, Berry, rural land and forested escarpment, and maximises the broader regional views.
- Optimising the benefits and minimising adverse impacts on the local social environment.
  - The heritage precinct at Pulman Street, Berry would be preserved and impacts on the David Berry Hospital would be avoided.
  - Direct impacts on the Berry sportsground and Camp Quality memorial park would be avoided and the connectivity of these community spaces with the main township of Berry would be maintained.
  - The extent of property severance would be minimised, as would the potential impacts on community connectivity by following the existing highway alignment where possible and the North Street corridor.
  - The heritage and cultural values of the area would be protected by limiting the extent of the project footprint, by upgrading sections of the existing highway.
  - The location of the project within the North Street corridor balances the social (visual and noise) impacts to North Street residents with the economic impacts of maintaining viable agricultural land north of the bypass of Berry, by providing a 40 metre buffer between north street and the project.

4 Description of the project

This chapter describes the project, including the route alignment, corridor width, main project elements, ancillary facilities, design standards and construction activities. It addresses the Director-General’s requirements (DGRs) for the description of the project as shown below.

Director-General’s requirements	Where addressed
*A **detailed description** of the project including:*	
• *Route alignment and corridor width.*	Section 4.2.1 and Section 4.2.4
• *Design elements (requirements for bridges, culverts, Level of Service, pedestrian and cyclists, rest areas and service centres, etc).*	Section 4.2 and Section 7.1
• *Clear identification of and/or options for the proposed location of ancillary facilities (eg compound site, batching plants, etc).*	Section 4.4.7
• *Resourcing (eg construction material needs, spoil disposal, natural resource consumption including water supply sources).*	Sections 4.4.4 to 4.4.6
• *Potential staging.*	Section 4.4.10

4.1 Project scope

4.1.1 The project

Roads and Maritime Services (RMS) proposes to upgrade 11.6 kilometres of the Princes Highway between Toolijooa Road south of Gerringong and Schofields Lane southwest of Berry, in New South Wales (NSW) (the project), to achieve a four lane divided highway (two lanes in each direction) with median separation. The project includes bypasses of Foxground and Berry.

The project comprises the following key features:

- Construction of a four lane divided highway (two lanes in each direction) with median separation (wire rope barriers or concrete barriers where space is constrained, such as at bridge locations).
- Bypasses of the Foxground bends and the Berry township.
- Construction of around 6.6 kilometres of new highway where the project deviates from the existing highway alignment at Toolijooa Ridge, the Foxground bends and the Berry township.
- Provision for the possible widening of the highway (if required in the future) to six lanes within the road corridor and, in some areas, construction of the road formation to accommodate future additional lanes where safety considerations, traffic disruption and sub-optimal construction practices are to be avoided.

- Grade-separated interchanges at:
  - Toolijooa Road.
  - Austral Park Road.
  - Tindalls Lane.
  - East of Berry at the existing Princes Highway, referred to as the northern interchange for Berry.
  - West of Berry at Kangaroo Valley Road, referred to as the southern interchange for Berry.
- A major cutting at Toolijooa Ridge (around 900 metres long and up to 26 metres deep).
- Six lanes (two lanes plus a climbing lane in each direction) through the cutting at Toolijooa Ridge for a distance of around 1.5 kilometres.
- Four new highway bridges:
  - Broughton Creek bridge 1, a four span concrete structure around 170 metres in length and nine metres in height.
  - Broughton Creek bridge 2, a three span concrete structure around 75 metres in length and eight metres in height.
  - Broughton Creek bridge 3, a six span concrete structure around 190 metres long and 13 metres in height.
  - A bridge at Berry, a 19 span concrete structure around 600 metres long and up to 12 metres in height.
- Three highway overbridges:
  - Austral Park Road interchange, providing southbound access to the highway.
  - Tindalls Lane interchange, providing southbound access to and from the highway.
  - Southern interchange for Berry, providing connectivity over the highway for Kangaroo Valley Road along its existing alignment.
- Eight underpasses including roads, drainage structures and fauna underpasses:
  - Toolijooa Road interchange, linking Toolijooa Road to the existing highway and providing northbound access to the upgrade.
  - Property access underpass in the vicinity of Toolijooa Ridge at chainage 8400.
  - Dedicated fauna underpass in the vicinity of Toolijooa Ridge at chainage 8450.
  - Property access underpass between Toolijooa Ridge and Broughton Creek at chainage 9475.
  - Combined drainage and fauna underpass in the vicinity of Austral Park Road at chainage 12800.
  - Combined drainage and fauna underpass in the vicinity of Tindalls Lane at chainage 13320.
  - Dedicated fauna underpass in the vicinity of Tindalls Lane at chainage 13675.
  - Property access underpass between the Tindalls Lane interchange and the northern interchange for Berry in the vicinity of at chainage 15100.
- Modifications to local roads, including Toolijooa Road, Austral Park Road, Gembrook Lane, Tindalls Lane, North Street, Queen Street, Kangaroo Valley Road, Hitchcocks Lane and Schofields Lane.
- Diversion of Town Creek into Bundewallah Creek upstream of its confluence with Connollys Creek and to the north of the project at Berry.

- Modification to about 47 existing property accesses.
- Provision of a bus stop at Toolijooa Road and retention of the existing bus stop at Tindalls Lane.
- Dedicated u-turn facilities at Mullers Lane, the existing highway at the Austral Park Road interchange, the extension to Austral Park Road and Rawlings Lane.
- Roundabouts at the southern interchange for Berry and the Woodhill Mountain Road junction with the exiting Princes Highway.
- Two culs-de-sac on North Street and the western end of Victoria Street in Berry.
- Tie-in with the existing highway about 75 metres north of Toolijooa Road and about 440 metres south of Schofields Lane.
- Left in/left out only provisions for direct property accesses to the upgraded highway.
- Dedicated public space with shared pedestrian/cycle facilities along the southern side of the upgraded highway from the playing fields on North Street to Kangaroo Valley Road.
- Ancillary operational facilities, including permanent detention basins, stormwater treatment facilities and a permanent ancillary facility site for general road maintenance.

Construction activities would include:

- Site preparation and establishment works.
- Temporary construction facilities, including construction compounds, stockpile sites, creek crossings, sediment control basins and haulage roads.
- Temporary works, including relocation/protection of services, traffic facilities and side tracks.
- Earthworks and bridge construction.
- Pavement construction.
- Drainage construction.
- Road furniture installation.
- Site restoration and landscaping.

The project and the key features of the project are shown in **Figure 4-1**, **Figure 4-2** and **Figure 4-3**.

During detailed design, refinements could be made to the design features and construction methods (refer to **Section 4.3.4** for further detail).

4.2 Project elements

4.2.1 Route alignment from north to south

The project is described below in three sections.

Section one – Toolijooa Road interchange to Austral Park Road (Chainages 7650 – 12300)

As depicted in **Figure 4-1**, the project within this section would consist of around 4.7 kilometres of new highway. The alignment would depart from the Princes Highway at the Toolijooa Road interchange to bypass Foxground bends and re-join the Princes Highway near the Austral Park Road interchange.

The Toolijooa Road interchange would provide north facing ramps only including a northbound on-ramp and south bound off-ramp. The ramps would be constructed as part of the adjacent Gerringong upgrade project and provide temporary connectivity of the new highway to Toolijooa Road, until the proposed interchange is complete. Toolijooa Road would be realigned about 50 metres to the west of its existing location to accommodate the interchange. Toolijooa Road would pass under the new highway and connect with the existing Princes Highway. When the interchange is complete, the realigned Toolijooa Road would connect to the north facing ramps that would be constructed prior to the project.

The alignment would bypass Foxground bends and cross Toolijooa Ridge, a prominent ridge within the landscape. This would require a major cutting around 900 metres in length and varying in depth to a maximum of around 26 metres, with a 10 metre average depth. The cutting would be benched at about 10 metre intervals, with the uppermost batter to be ‘rolled back’ to provide a gradual slope that is consistent with the surrounding landscape. A third lane would be provided in each direction in the Toolijooa Ridge cutting, and would be designated as a climbing lane.

The alignment would then cross the Broughton Creek floodplain, curving back to the south before crossing Broughton Creek on a new bridge structure near the current highway alignment. The alignment would continue across the floodplain on an embankment, at a maximum height of about 5.5 metres, and would cross Broughton Creek two more times. The width of the embankments would be in accordance with the lane widths provided in **Section 4.2.2** and **Section 4.2.3**. An emergency vehicle u-turn facility would be provided at chainage 10950 (refer to **Figure 4-1** and **Section 4.2.12**).

The alignment would re-join the existing highway immediately after the Austral Park Road interchange, with the upgraded highway in a cutting (around 11 metres in depth) and the southbound on-ramp bridging over the highway. A northbound off-ramp would provide a connection to the retained highway which would continue to service Broughton Village and Foxground. Further details of interchanges are presented in **Section 4.2.4**.

Fauna crossings, including rope bridges would be constructed to aid fauna passage, particularly near Broughton Creek (refer to **Figure 4-1**). Refer to **Section 4.2.9** and **Section 7.3** for further details.

There would be no direct property access to the new highway alignment within this section of the project. Current property access would be maintained in sections along the retained existing Princes Highway, which would become a local road and by providing property underpasses at chainages 8400 and 9475 (refer to **Section 4.2.7**). The exception would be for properties close to the Austral Park Road interchange. At this location, a residual section of the highway to the west of the new alignment would be modified to form part of the interchange, requiring existing property access to be realigned.

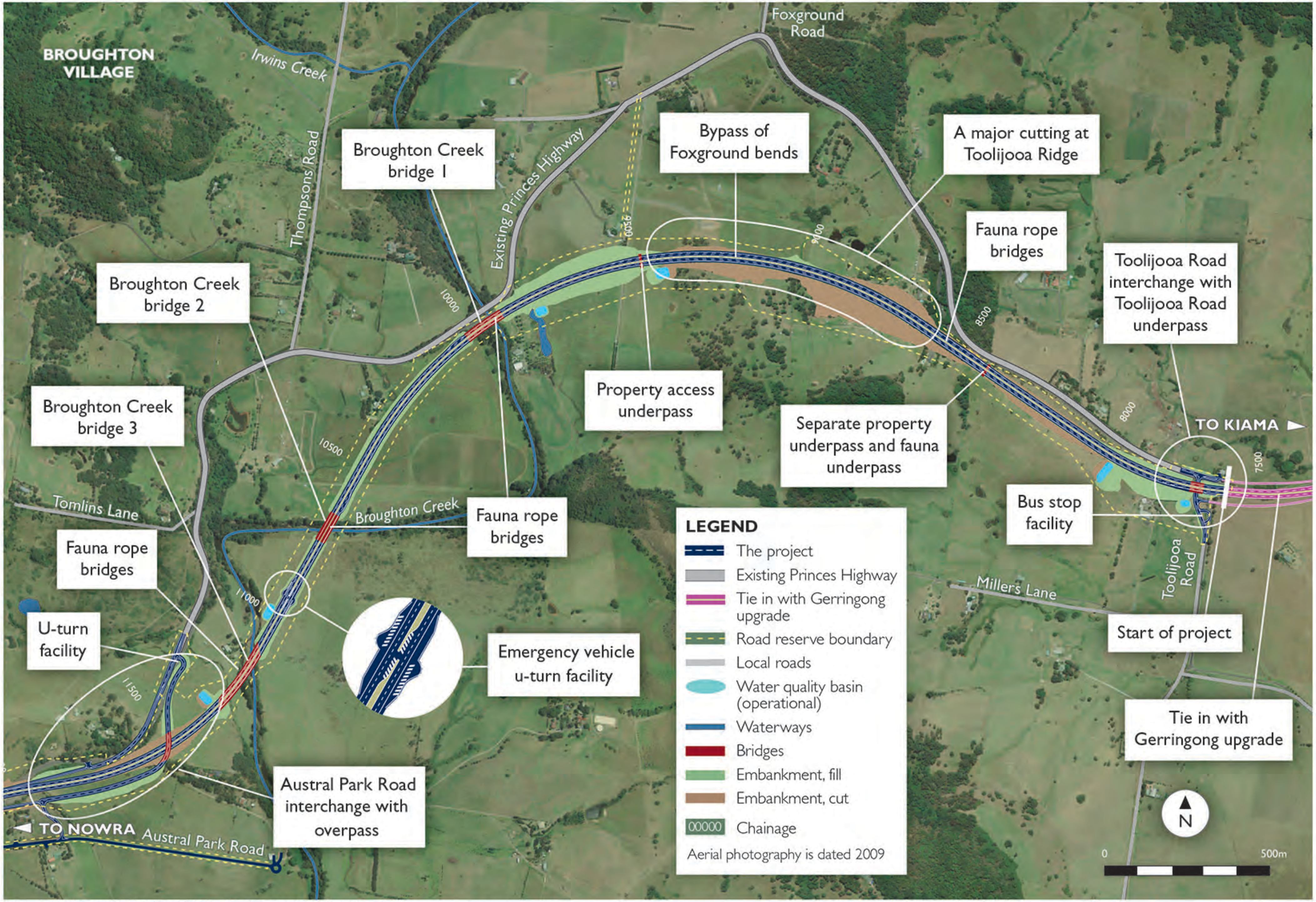

Figure 4-1 Section 1 (Toolijooa to Austral Park Road)

Section two – Austral Park Road to the northern interchange for Berry (chainages 12300 – 15500)

Section two of the project would start at chainage 12150 where the project alignment would re-join the existing Princes Highway near Austral Park Road and extend to the northern interchange for Berry (chainage 15500) (refer to **Figure 4-2**).

The proposed alignment within this section generally follows the Princes Highway and would involve the widening and realignment of 3.4 kilometres of the highway. While parts of the existing highway would be used for the project, the majority of these sections of highway would require regrading and reconstruction to satisfy current road design standards.

As the alignment passes through this section, the project would incorporate a series of cuttings and embankments to respond to the undulating terrain. The most significant of these is a cutting near Tindalls Lane with a maximum depth of around 11 metres.

The other key features of this section would include:

- The extension and upgrade of Austral Park Road to provide safe access to properties on the eastern side of the project. The Austral Park Road interchange would provide direct southbound access to the upgraded highway for those properties, with northbound access provided via a two-way overbridge connection over the project to the existing highway and the Toolijooa Road interchange. Southbound vehicles would access Austral Park Road via the Toolijooa Road interchange and the existing highway to the two-way connection over the project.
- Crossing the Eastern Gas Pipeline (refer to **Figure 4-18**).
- Tindalls Lane interchange to provide access to and from Tindalls Lane in both directions and act as a u-turn facility for highway traffic. The interchange accesses would be formed by modifying sections of the existing highway and would require the construction of a new overbridge.
- A permanent ancillary facility site at the Tindalls Lane interchange that would be used by RMS and Shoalhaven City Council for road maintenance purposes (refer to **Section 4.2.15**).

Residual sections of the existing Princes Highway would be retained near Austral Park Road and near Tindalls Lane interchange to provide access to the new highway.

Fauna rope bridges and underpasses would be provided in this section (refer to **Figure 4-2**). Refer to **Section 4.2.9** and **Section 7.3** for further details.

Where no local road access would be provided, direct property access would be maintained along this section of the highway. These accesses would be limited to left-in left-out by the inclusion of a central median barrier for road safety reasons and these residents would rely on the Austral Park Road and Tindalls Lane interchanges for movements other than left in/left out. .

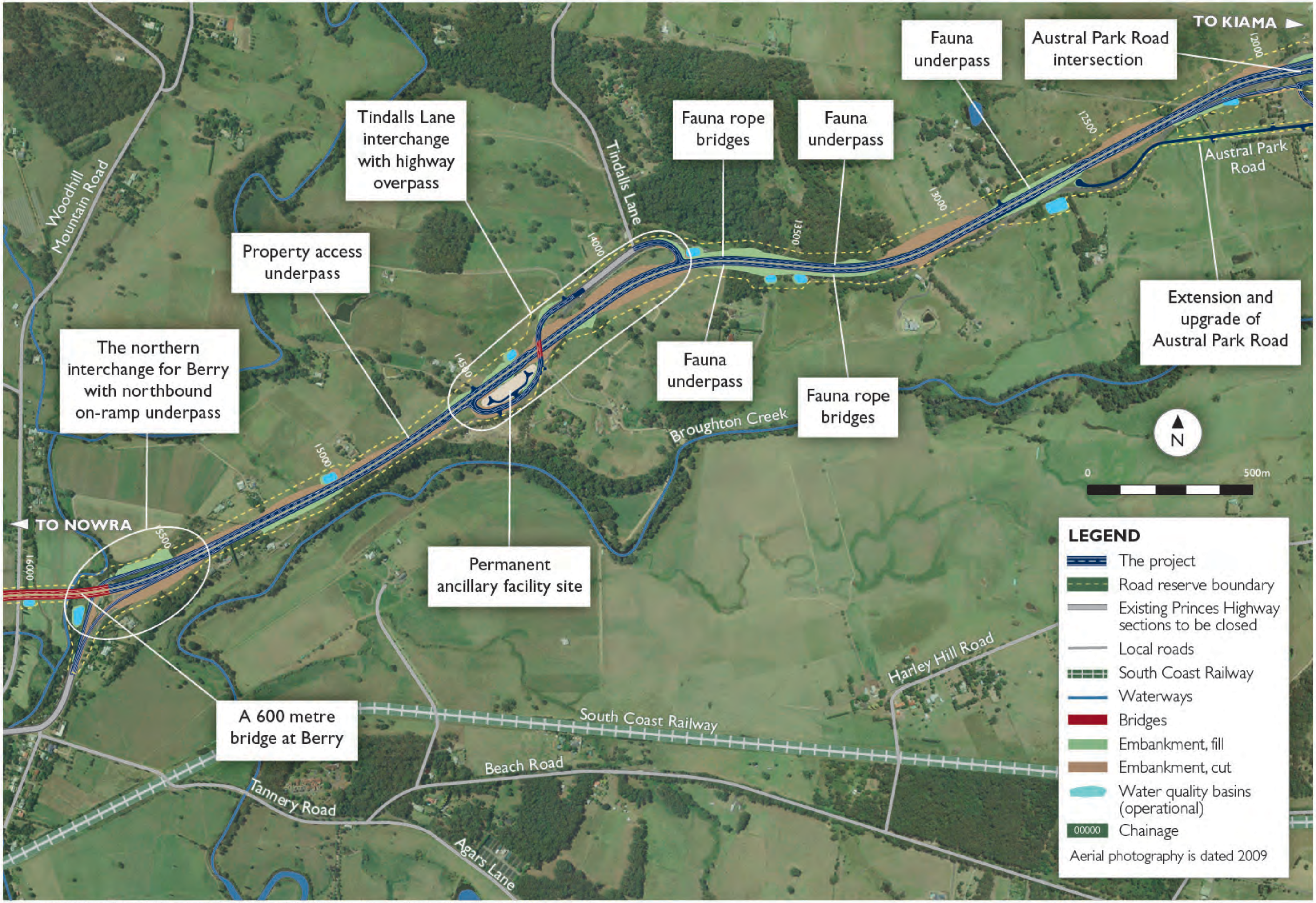

Figure 4-2 Section 2 (Austral Park Road to the northern interchange for Berry)

Section three – Berry (chainages 15500 – 19200)

Section three of the project would be between the northern interchange for Berry and the Schofields Lane junction where it would re-join the existing two lane highway. In addition to the northern interchange, this section would include the bypass of Berry, the southern interchange for Berry, the Schofield Lane junction upgrade, a tie-in to the existing Princes Highway and the u-turn facility at Mullers Lane.

North of Berry, the proposed alignment would generally follow the existing Princes Highway along a ridgeline, before curving and deviating towards the west. A northbound on-ramp and southbound off-ramp at the northern interchange would utilise the existing Princes Highway to provide access to and from Berry. A roundabout would be constructed at the intersection of the existing highway (Queen Street) and Woodhill Mountain Road to provide a u-turn facility for local traffic.

The proposed alignment would then curve towards the west to pass north of Berry. At this point, a proposed bridge would span a length of around 600 metres to cross Broughton Mill Creek and Bundewallah Creek. The maximum height of the bridge would be around 12 metres, close to the northern interchange for Berry. It would then drop in height to around 6.7 metres at Woodhill Mountain Road, and finally to a height of around 3.5 metres at the abutment on the western side of Bundewallah Creek. From here, the proposed alignment would continue in a south-west direction opposite Alexandra Street at chainage 16600, where it would start to curve round to run east-west opposite Albany Street at chainage 16800. This section has been referred to as the North Street corridor for the purpose of this environmental assessment.

The alignment would transition from an embankment of around two metres in height to a cutting along the North Street corridor to tie in with the southern interchange. The majority of this section would be at the existing ground level or in a cutting.

The highway would cross North Street where it intersects with George Street at about chainage 17400, separating North Street into two sections. East of this location a cul-de-sac would be provided on North Street west of the junction with Edward Street. To the west a cul-de sac would be provided on North Street immediately east of the last residence. A local road would be provided to connect the northbound interchange ramps with Rawlings Lane (north of the project) and a u-turn and garbage collection facility would be provided on Rawlings Lane to allow for garbage trucks to turn around and service the two properties on Rawlings Lane (refer to **Section 4.2.5**).

A green space buffer would be provided between North Street and the project. This buffer would separate North Street from the project and the noise barrier proposed along the southern side of the alignment. The noise barrier would extend between the western end of the bridge at Berry, along the length of the North Street corridor and the southbound off-ramp of the southern interchange, located at the intersection of Queen Street and Kangaroo Valley Road. The barrier would be four metres high from the pavement of the project with low level landscaping at the base of the traffic side of the barrier where feasible. A landscaped embankment would be built close to the top of the barrier on the North Street side to minimise the visual impact. The embankment would be sloped at 2:1 or flatter with a flat landscaped section at the top and there would be a stock fence constructed at the base of the slope.

Town Creek, a small ephemeral watercourse, would be diverted and connect to Bundewallah Creek north of the project (refer to **Figure 4-3**). Refer to **Section 4.2.11** for further details.

At the southern interchange for Berry, the highway would be in a cutting around 7.5 metres deep, with Kangaroo Valley Road bridging over the highway. Kangaroo Valley Road would remain close to the existing ground surface level and the provision of a wide bridge with pedestrian and shared cyclist facilities on both sides separated from traffic, would maintain connectivity between Berry town centre and the residential development to the north-west along Kangaroo Valley Road and beyond. The shared pedestrian and cyclist facilities on the Kangaroo Valley Road overbridge would connect into a similar facility running east-west along the northern side of North Street between the southern interchange for Berry and the Berry sportsground at the eastern end of North Street.

The southern interchange would provide for all traffic movements entering and exiting Berry in both northbound and southbound directions and would ensure flood free access to Berry in a 1 in 100 year flood event. A four metre high noise barrier would be constructed along the northbound off-ramp of the southern interchange for Berry. It would be located between Huntingdale Park Road and the off-ramp and would be around 200 metres in length, south from the Kangaroo Valley Road overbridge.

At its junction with the existing Princes Highway, Victoria Street in Berry would be closed with a cul-de-sac. Access to the project from Victoria Street would be via Queen Street and the southern interchange for Berry.

From the southern interchange, the southbound lanes of the upgraded highway would follow the existing highway alignment with the new northbound lanes construction on the western side of the current highway. The Schofields Lane junction would be upgraded, and traffic accessing the project at this location would be restricted to left-in left-out movements due to the inclusion of a wire rope median barrier on the upgraded highway. A tie-in would be constructed west of Schofields Lane where the duplication finishes, to safely transition highway traffic to or from a four to a two lane configuration (refer to **Figure 4-3**). Further details regarding tie-ins are provided in **Section 4.4.8**. The tie in would remain until the proposed future upgrade of the highway south of the project (the proposed Berry to Bomaderry upgrade) is completed.

Direct property access would be maintained along this section of the highway, but would be restricted to left-in left-out movements. A u-turn facility would be constructed at Mullers Lane (chainage 19625), and would be designed to cater for heavy vehicle movements. The u-turn facility would enable motorists from properties located along the eastern side of the project to turn safely and travel north.

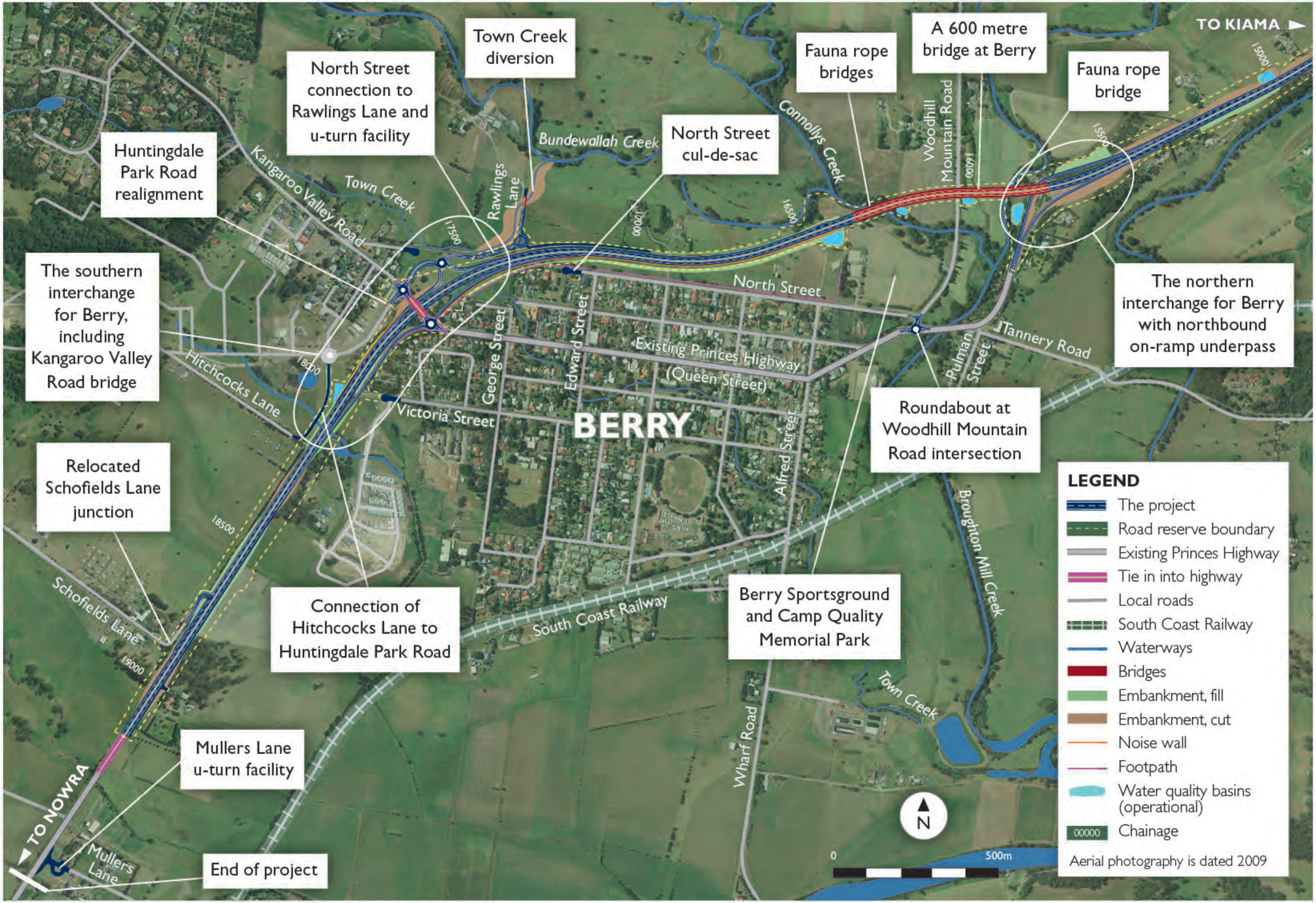

Figure 4-3 Section 3 (Northern interchange for Berry to Mullers Lane)

4.2.2 Road grade and lane widths

A typical cross section that has been adopted for the project is shown in **Figure 4-4** and **Figure 4-5**. The project has been designed in accordance with the RMS' 'Road Design Guide' (RTA, 1998) and has considered subsequent design guide updates.

Two 3.5 metre wide lanes would be provided in each direction, separated by a five metre wide central median with a wire rope safety barrier (or a concrete barrier if space is constrained) and one metre wide shoulders. An outer shoulder would typically be 2.5 metres wide, increasing to three metres where a safety barrier is provided. A verge would be provided, and would vary between one to two metres in width depending on topography and safety barrier requirements.

The typical cross section would vary within the Toolijooa Ridge cut where six lanes would be constructed to accommodate a climbing lane in each direction (refer to **Figure 4-6**).

The desired maximum grade for the project is six per cent, with an absolute maximum grade of eight per cent.

The vertical alignment of the highway has been designed for a speed of 100 kilometres per hour with a horizontal design speed of 110 kilometres per hour. The project would have a posted speed limit of 100 kilometres per hour.

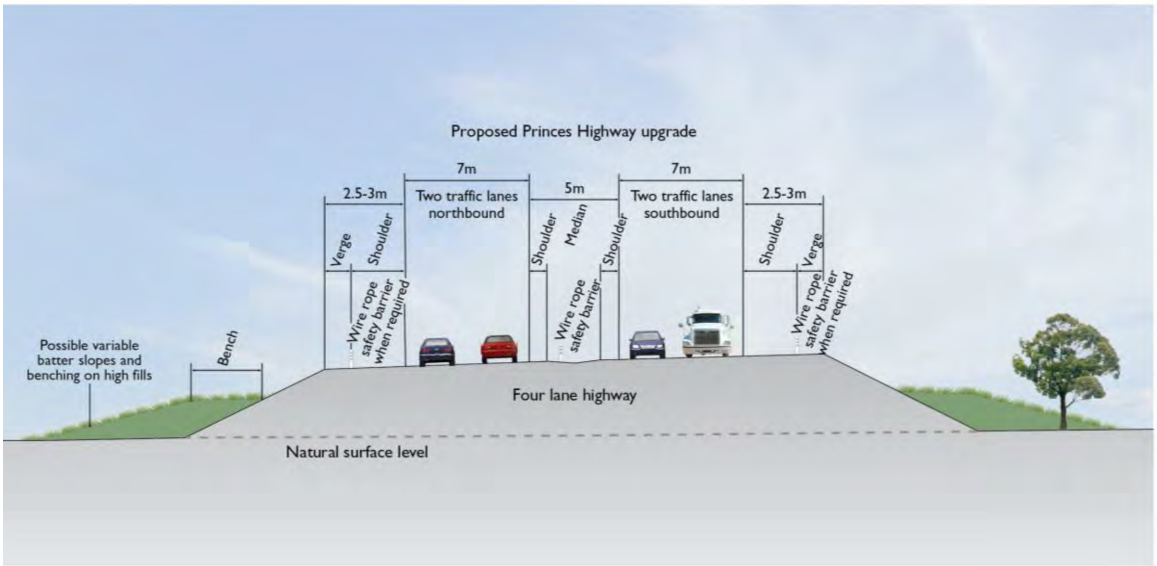

Figure 4-4 Cross section of typical four lane configuration on embankment

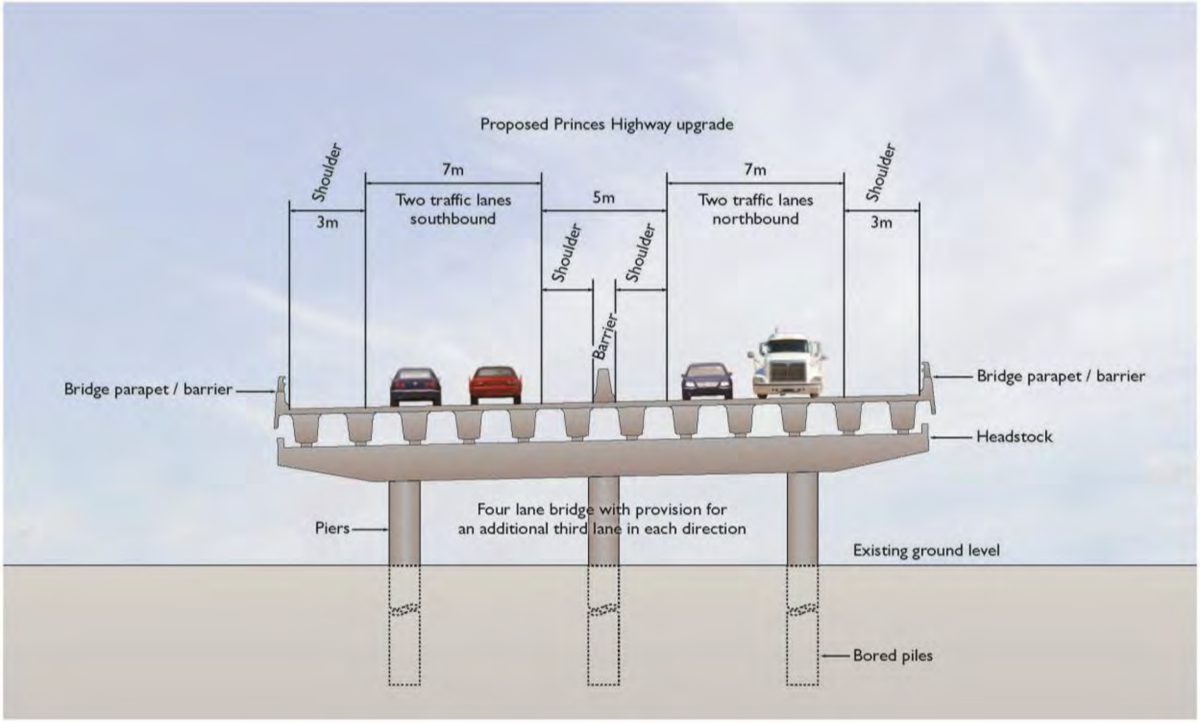

Figure 4-5 Cross section of a typical bridge

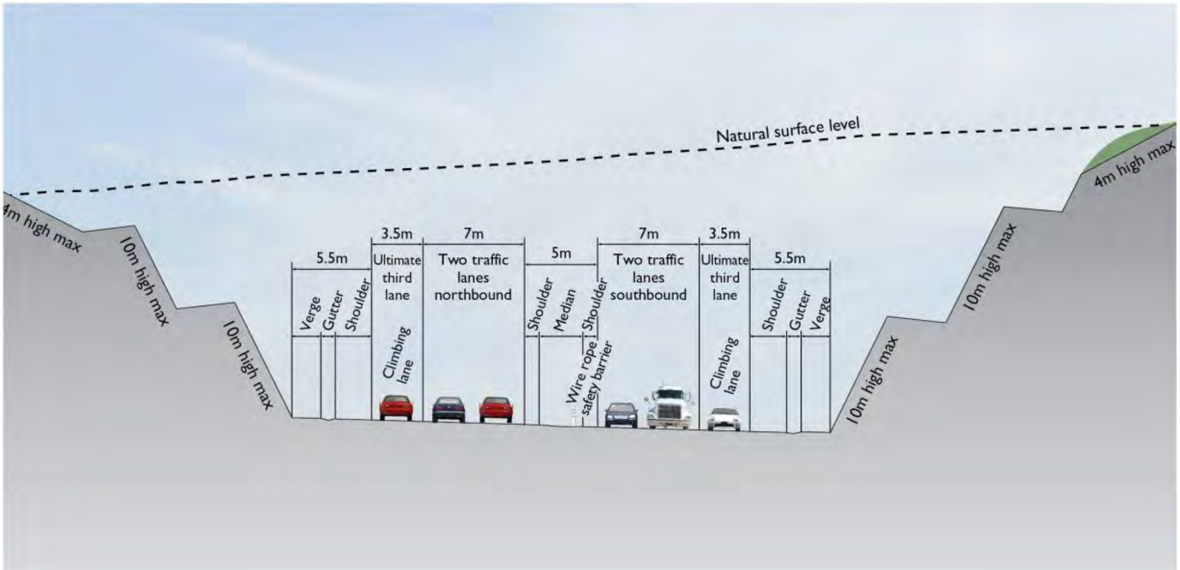

Figure 4-6 A typical cross section of Toolijooa Ridge cutting

4.2.3 Level of service

The Princes Highway both north and south of Berry currently operates at level of service (LoS) D in both the morning and afternoon peak periods. During holiday peak periods, the operational performance of the Princes Highway deteriorates to an unacceptable LoS E at most locations. By 2037, the Princes Highway would operate at an unacceptable LoS E or LoS F for all peak periods in the absence of the project.

Following construction, the highway would operate at LoS A or LoS B throughout the project area during typical morning and afternoon peak periods. During the busiest northbound and southbound holiday peak periods, the highway would operate at LoS C or better. Further details are provided in **Section 7.1**.

4.2.4 Corridor width and project footprint

The typical corridor width (or road reserve) would vary from 25 metres to 140 metres in response to the terrain and environmental constraints of the corridor, as well as the requirements for interchanges, fencing, drainage structures (such as stormwater treatment basins) and access ways for maintenance vehicles. Provision for pedestrians and cyclists have been included as part of the project (refer to **Section 4.2.17**).

The road reserve for the project would provide an ultimate six lane configuration (three lanes in each direction) to accommodate any need to further widen the Princes Highway in the future. Future widening would be generally an outside third lane and would not form part of this project.

However, where significant structures (such as the bridge at Berry), difficult earthworks (such as the crossing of soft soils near Broughton Creek) or substantial cuttings are required, the formation of the third lane would be constructed as part of the project to minimise costs and disruptions for future construction and operation.

The climbing lanes that would be constructed as part of the project at Toolijooa Ridge would revert to standard third travel lanes when future traffic volumes dictate the ultimate six lane highway configuration is required.

Interchange ramps have also been designed to accommodate an additional third lane on the outside of the carriageway without requiring significant changes under operation.

The width of the project footprint (the width required to construct the project) varies from 55 metres to 170 metres. This includes temporary sediment control basins, haulage routes, stockpile and compound sites within the immediate corridor that would be required during construction.

The concept design may change during detailed design if flattening of slopes at significant embankments or cuttings to accommodate urban design objectives is required. This would be dependent on the availability of suitable materials and volumes of spoil from major cuttings and would be subject to further impact assessment if necessary.

Further detail on the construction is provided in **Section 4.4**.

4.2.5 Junctions and interchanges

The following unsignallised junctions and interchanges are proposed as part of the project:

- Three half interchanges (Toolijooa Road, Austral Park Road and the northern interchange for Berry).
- One ‘Type-S’ interchange (Tindalls Lane interchange).
- One full interchange (southern interchange for Berry).
- Four junction modifications associated with changes to local roads (Austral Park Road, Gembrook Lane, Woodhill Mountain Road and Schofields Lane.
- Three u-turn facilities (near the Austral Park Road interchange, Rawlings Lane and Mullers Lane).

Toolijooa Road interchange

The grade-separated Toolijooa Road half interchange (refer to **Figure 4-7**) would consist of north facing ramps only, providing a northbound on-ramp and a southbound off-ramp. Toolijooa Road would be realigned to join the existing highway, passing under the upgrade. Southbound access from Toolijooa Road to the new highway would be from the existing highway and the Austral Park Road interchange to the south. Similarly, northbound access to Toolijooa Road would be from the Austral Park Road interchange and the existing highway.

The north facing ramps would be constructed as part of the Gerringong upgrade, with temporary tie-ins with Toolijooa Road and the existing highway. The interchange would be completed with the proposed realignment of Toolijooa Road and the construction of the highway alignment from chainage 7650.

The Toolijooa Road interchange would provide highway access to and from the north for the properties and communities located at Foxground and along the existing highway, which would be kept as a local access road It would also provide highway access to and from the north for properties along Toolijooa Road and beyond.

A bus stop facility would be provided on the eastern side of Toolijooa Road close to the southbound off load ramp.

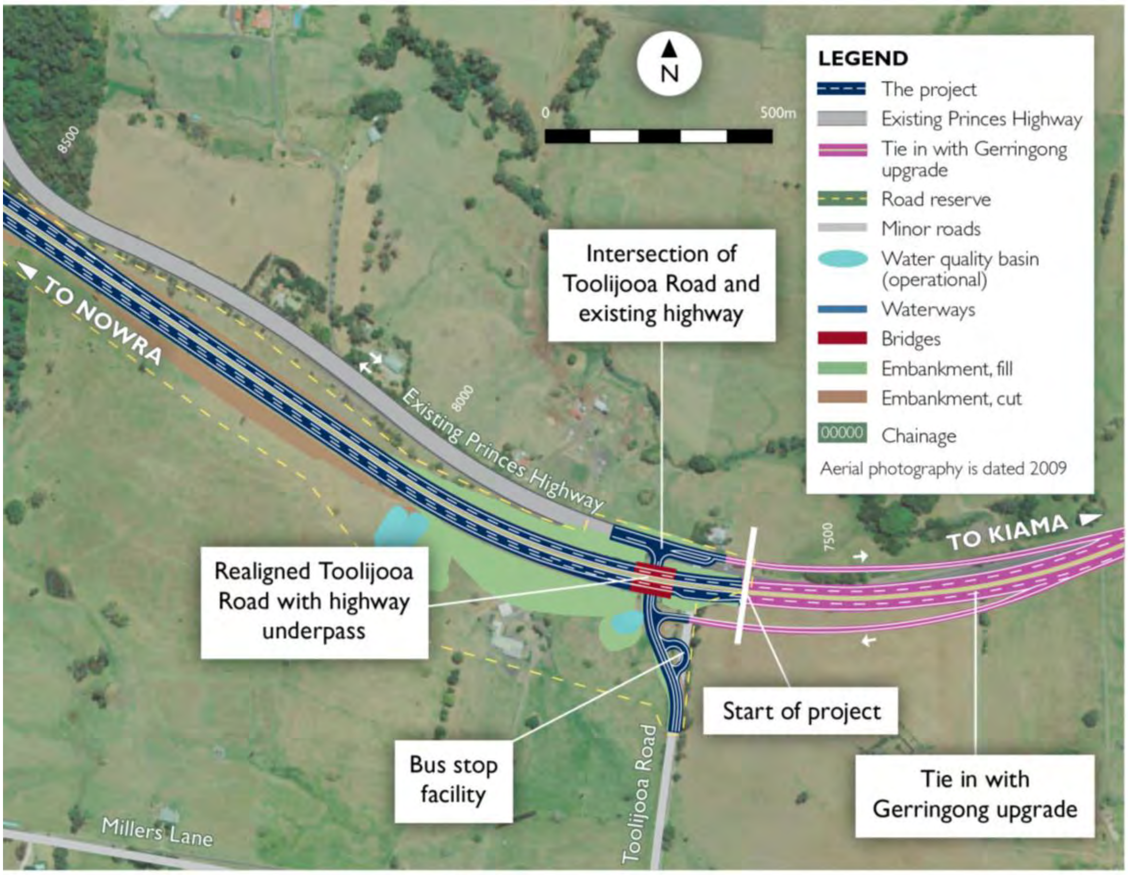

Figure 4-7 Toolijooa Road interchange

Austral Park Road interchange

The Austral Park Road half interchange (refer to **Figure 4-8**) would consist of a northbound off-ramp and a southbound on-ramp serving traffic to and from the south. A new two way local road connects the existing highway via a bridge over the upgraded highway to Austral Park Road and the southbound on-ramp. Austral Park Road would cross over the new highway with a bridge to connect on the eastern side of the project. Austral Park Road would be connected to the new two way local road and the southbound on-ramp by a two way service road.

Together, the Toolijooa Road and Austral Park Road interchanges would perform the function of an 'all movements' interchange, with the existing highway providing a connection between the two interchanges and maintaining access to properties along the existing highway and the local road network.

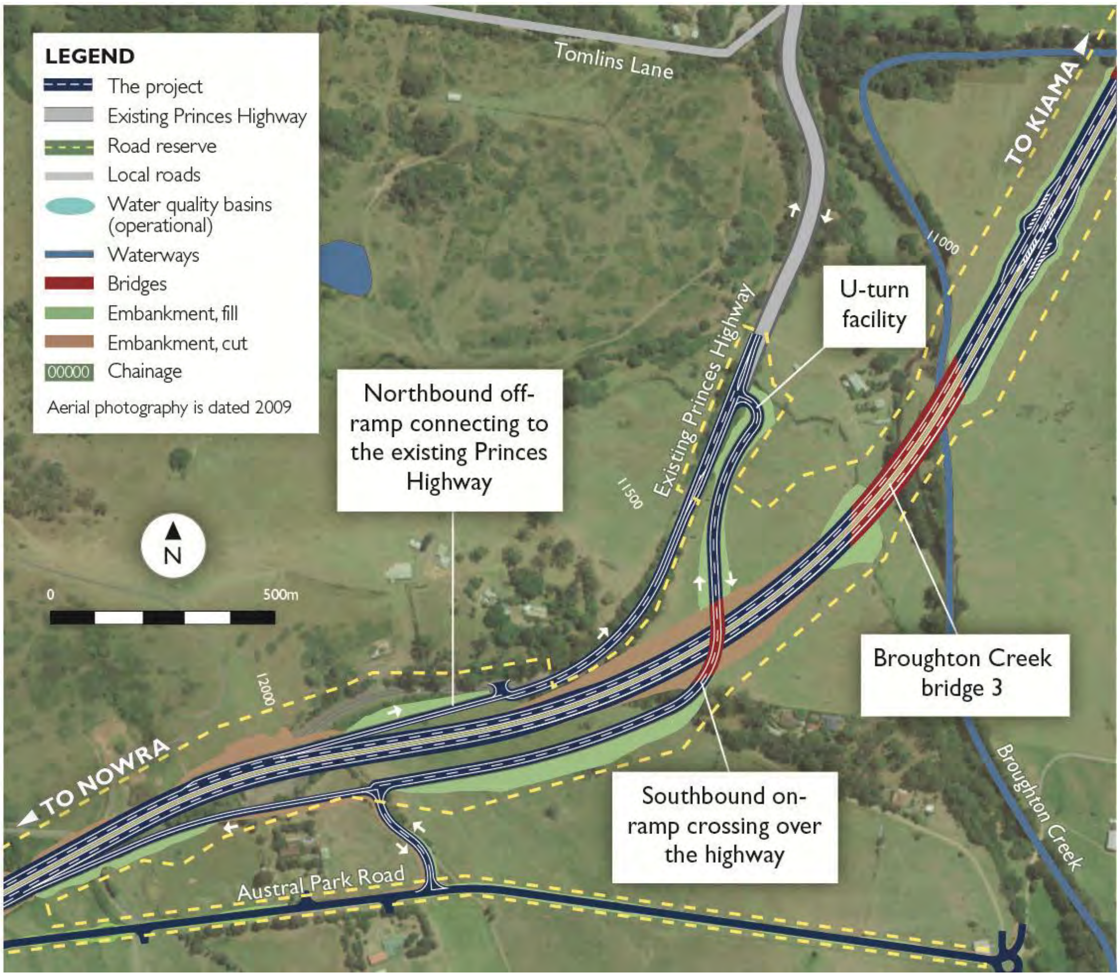

Figure 4-8 Austral Park Road interchange

Tindalls Lane interchange

The Tindalls Lane S Type interchange (refer to **Figure 4-9**) would consist of two at grade left-in left-out junctions. The interchange would cross the upgraded highway with a bridge, effectively allowing for all directional movements. A deceleration lane would be provided at each junction.

The interchange would also act as a u-turn facility for highway traffic travelling in both directions. The interchange would incorporate sections of the existing highway and the current bus stop facility at Tindalls Lane would be retained. A permanent ancillary facility site would be provided within the southern 'loop' for use by local RMS and Shoalhaven Council road maintenance organisations, with access to the upgraded highway via the interchange junctions.

Northern interchange for Berry

The northern half interchange for Berry (refer to **Figure 4-10**) would consist of a northbound on-ramp and a southbound off-ramp, serving traffic to and from the north. The southbound off-ramp would follow sections of the existing highway, while the northbound on-ramp would be on a new alignment passing under the new bridge over Broughton Mill Creek. Both ramps would connect to the existing highway just north of Tannery Street.

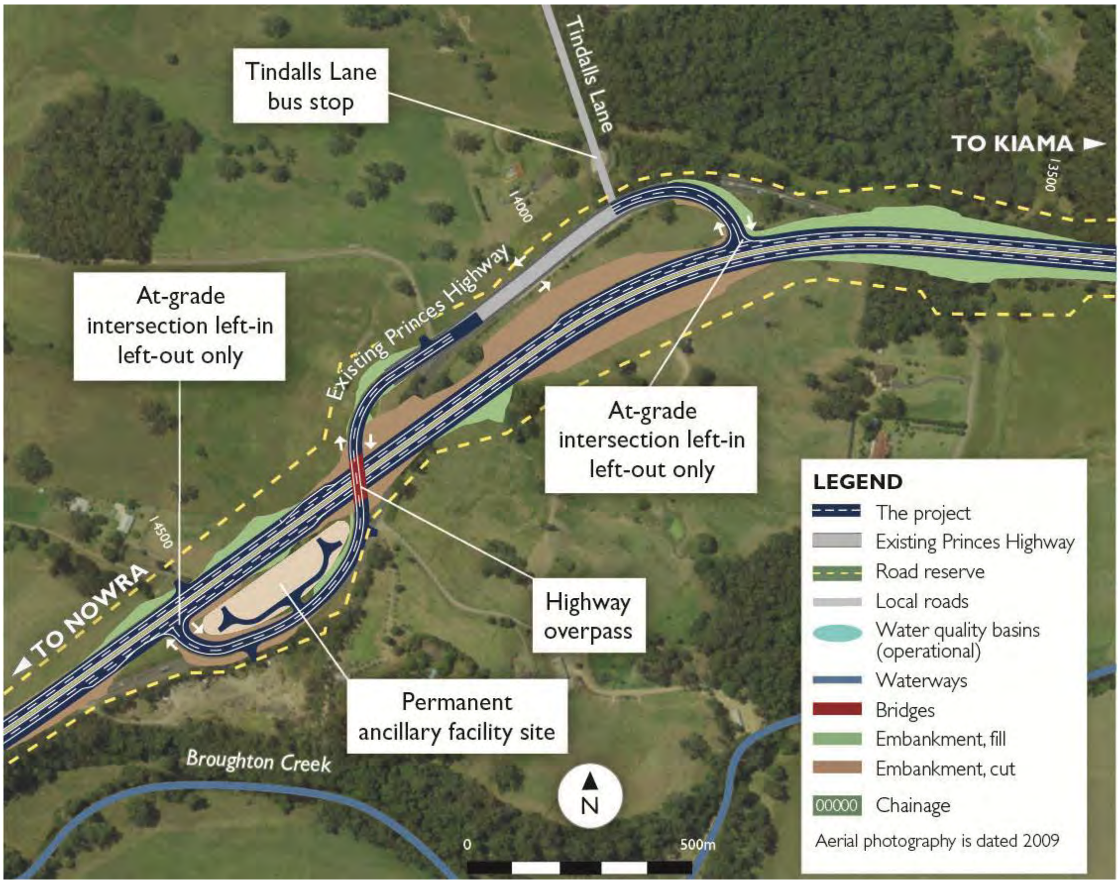

Figure 4-9 Tindalls Lane interchange

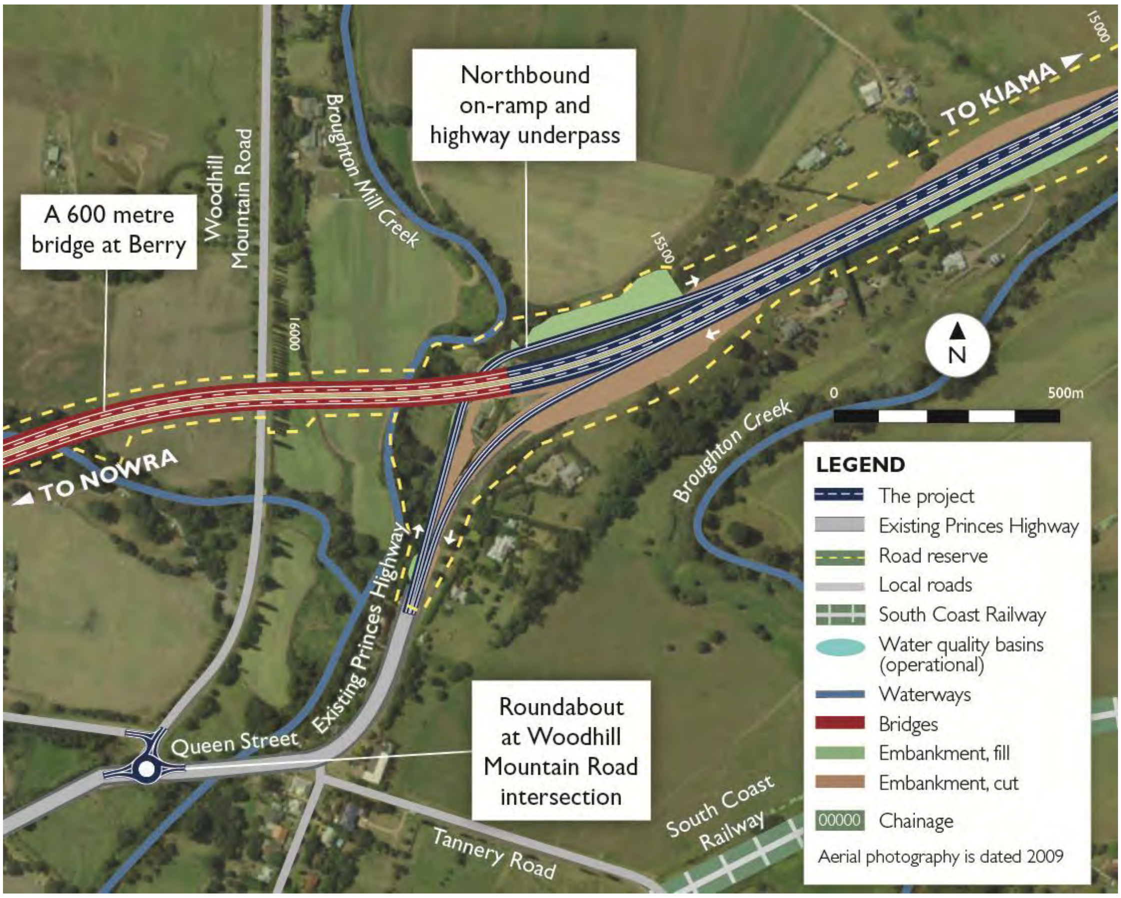

Figure 4-10 Northern interchange for Berry

Southern interchange for Berry

At the southern interchange for Berry (refer to **Figure 4-11**), the highway would pass through a cutting with Kangaroo Valley Road bridging over the highway. Kangaroo Valley Road would be maintained close to current ground surface level, retaining the existing standard of connectivity between the Berry township and the residential development to the north-west along Kangaroo Valley Road and beyond.

The southern interchange would provide for all traffic movements entering and exiting Berry in both northbound and southbound directions and would ensure flood free access to Berry in a 100 year flood event.

The northbound off-ramp would pass under the Kangaroo Valley Road overbridge ending at a new round about. This roundabout has a two way connection to Kangaroo Valley Road and Rawlings Lane as well as a connection to the northbound on-ramp.

Two new roundabouts would be built on Kangaroo Valley Road, one at each end of the overbridge. The roundabout at the northern end of the overbridge would connect to Huntingdale Park Road and to the two-way off and on-ramps.

The roundabout at the southern end of the overbridge would connect to the southbound off-ramp, Queen Street and the southbound on-ramp. Pedestrian and cyclist access would be provided on both sides of the Kangaroo Valley Road bridge (refer to **Section 4.2.15**).

Figure 4-12 provides a cross section of the proposed Kangaroo Valley Road overbridge. It would include a 2.5 metre shared pedestrian and cyclist path on both sides, separated from the traffic lanes by a 1.5 metre wide verge with planter box landscaping.

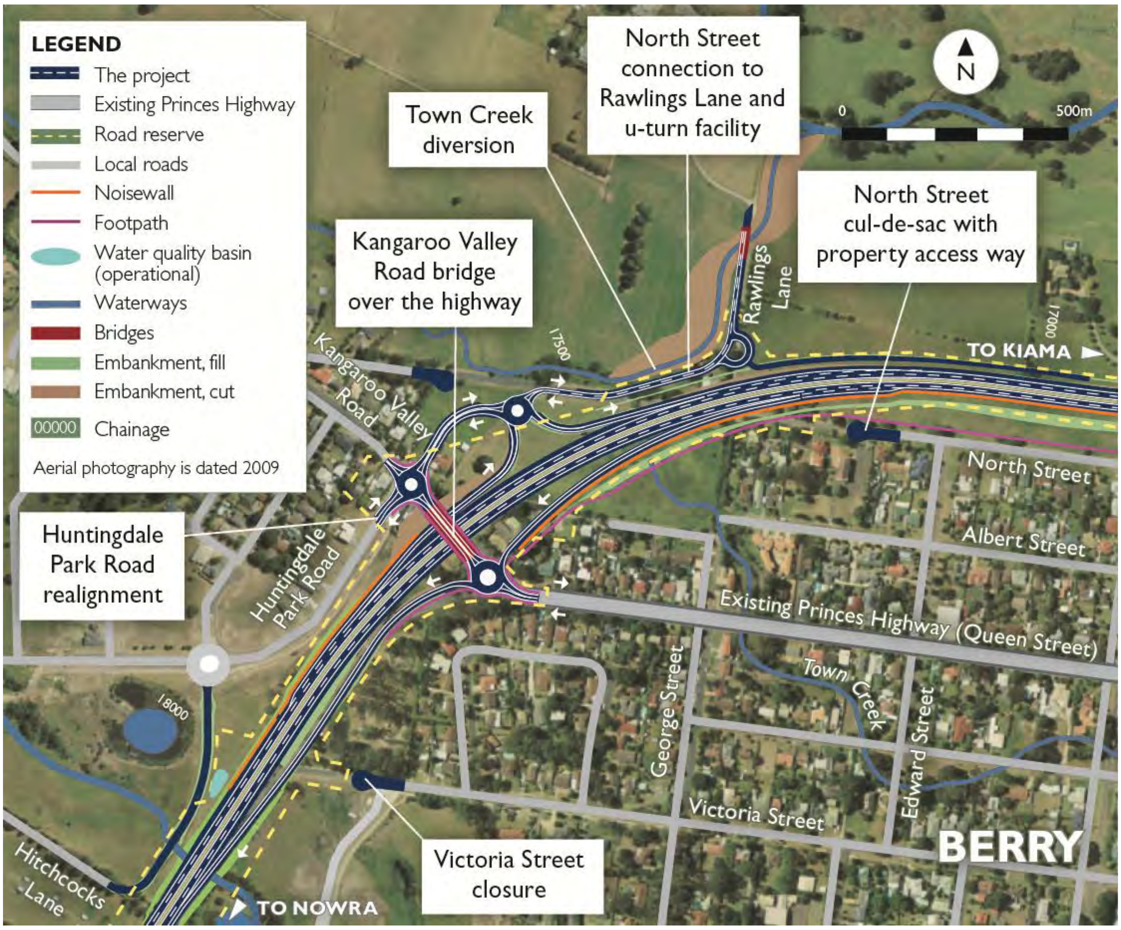

Figure 4-11 Southern interchange for Berry

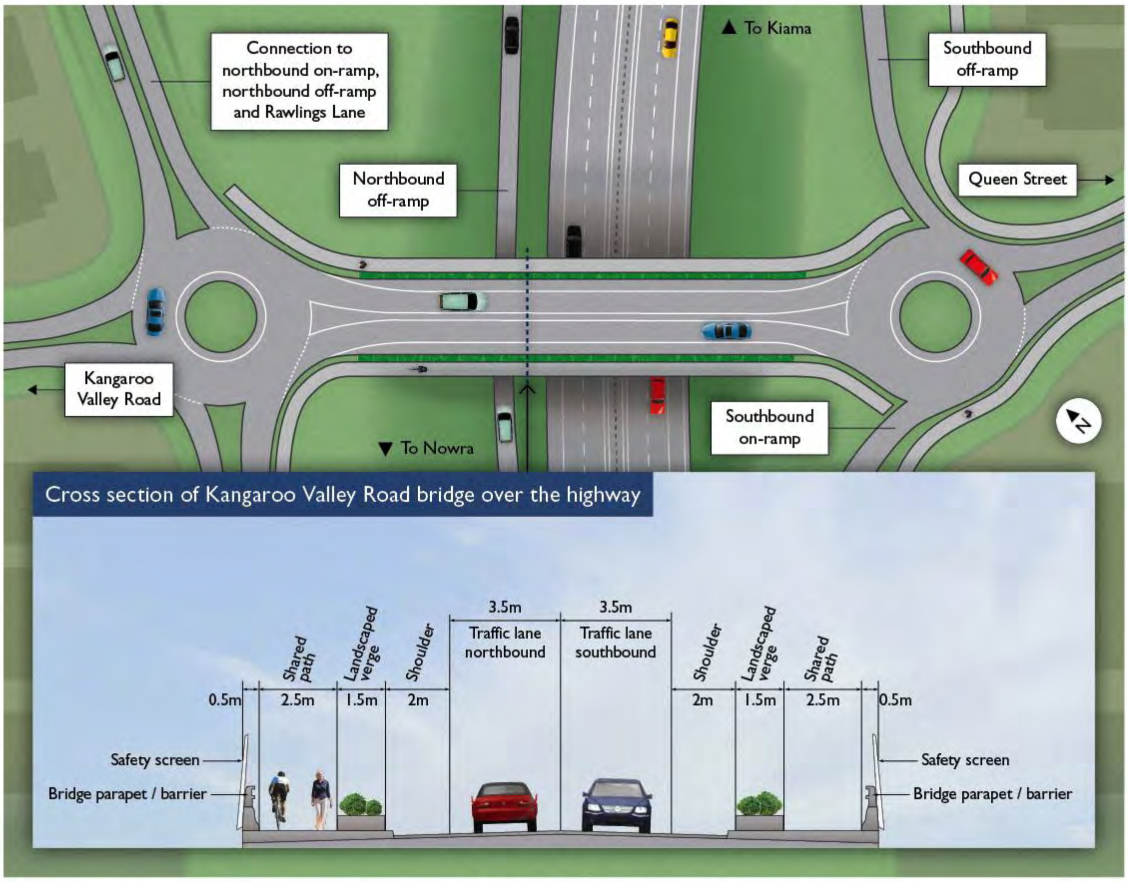

Figure 4-12 Bird's eye view and cross section of the Kangaroo Valley Road bridge at the southern interchange

Figure 4-13 Artist's impression of Kangaroo Valley Road and southern interchange precinct Image by CM+ (2012)

Schofields Lane junction

The Schofields Lane junction would be relocated about 50 metres north of the existing junction of Schofields Lane and the current Princes Highway, preserving the current access to ‘Graham Park’. It would be restricted to a left-in left-out only movements with a deceleration lane provided (refer to **Figure 4-14**).

Figure 4-14 Schofields Lane junction

U-turn facilities at Austral Park Road interchange, Rawlings Lane and Mullers Lane

Austral Park Road interchange

Properties north of the project, west of the southbound on-ramp connection to the existing highway and east of the Tindalls Lane interchange would not be able to access the upgraded highway directly to travel south. These properties would be required to travel north and then perform a u-turn at the Austral Park Road interchange in order to travel south on the upgraded highway. The two way local road connecting to the southbound on-ramp would facilitate this u-turn movement (refer to **Figure 4-8**).

Rawlings Lane

A u-turn facility would be constructed as part of the realignment of Rawlings Lane. This facility would provide for garbage pick-up for the two properties on Rawlings Lane and has been design to cater for both light and heavy vehicles (refer to **Figure 4-11**).

Mullers Lane

Properties east of the project, south of Schofields Lane would only be able to enter the highway in a southerly direction at left-in left-out junctions. Traffic wishing to travel north would travel south on the Princes Highway, turn left into Mullers Lane and utilise the u-turn facility provided. A protected right hand turn on to the highway would be provided from Mullers Lane. The u-turn facility has been designed to cater for both light and heavy vehicles (refer to **Figure 4-14**).

4.2.6 Local roads

Some junctions and local roads would be modified as a result of the project.

Residual sections of the existing highway that would be retained for the provision of access would be reclassified as local service roads, and ownership transferred to Kiama Municipal Council and Shoalhaven City Council as appropriate. This handover would be conducted in accordance with RMS' standard project handover and finalisation processes, following completion of the project.

The project would require the closure of the intersection of the Princes Highway and Hitchcocks Lane. As a result, road access to Hitchcocks Lane would be provided from Huntingdale Park Road as part of the project. The existing intersection of Victoria Street and the highway would also be closed and access to the highway from Victoria Street would be provided via Queen Street and the southern interchange for Berry.

Proposed road closures and modification to local roads and intersections along the alignment are detailed in **Table 4-1**.

Table 4-1 Proposed changes to local roads

Local road	Description of change
Toolijooa Road	Toolijooa Road would be realigned as part of the nearby interchange and a new bus stop installed (refer to **Figure 4-7** and **Section 4.2.4** for details).
Austral Park Road	Extension and realignment of Austral Park Road to provide access to properties in the vicinity of the Austral Park Road interchange (refer to **Figure 4-2**).
	Construction of a cul-de-sac at the western end of Austral Park Road extension. Construction of an access road between Austral Park Road and the southbound on-ramp to provide access to the project.
	Change from privately leased public road reserve to a formed public road.
Gembrook Lane	Movement of the current junction with the highway about 200 metres south.
Woodhill Mountain Road, Berry	Construction of a new roundabout to facilitate u-turn manoeuvres at the junction of Woodhill Mountain Road with the existing Princes Highway in Berry (refer to **Figure 4-10**).
North Street	Severance of North Street into two sections by the project. Construction of a cul-de-sac with property access on the eastern side of the upgraded highway, where the alignment would cross North Street. Construction of a cul-de-sac on the western side of the upgraded highway. Connection of North Street on the western side of the project to Rawlings Lane would be via Kangaroo Valley Road and the new southern interchange (refer to **Figure 4-11**).

Local road	Description of change
Queen Street	Change from being part of the Princes Highway to a local road.
Rawlings Lane	Removal of the current junction of North Street and Rawlings Lane.
	Realignment of Rawlings Lane to connect to the new Kangaroo Valley Road (southern) interchange. Construction of a u-turn facility (for trucks) and garbage collection facility at the southern end of Rawlings Lane (refer to **Figure 4-11**).
Kangaroo Valley Road	A new bridge on the existing grade would allow Kangaroo Valley Road traffic to cross over the new highway (refer to **Figure 4-11**).
Huntingdale Park Road	Construction of a roundabout at the junction of Huntingdale Park Road and Kangaroo Valley Road.
Victoria Street	Closure of the western end of Victoria Street with the construction of a cul-de-sac with a property access tied into the cul-de-sac.
Hitchcocks Lane	Closure of the intersection with the highway. Construction of a property access connection between Hitchcocks Lane and Huntingdale Park Road that would become a local road.
Schofields Lane	Movement of the current junction with the highway about 50 metres north (refer to **Figure 4-14**).
Mullers Lane	Construction of a u-turn facility (refer to **Figure 4-14**).

4.2.7 Bridges

Four new major highway bridges, three overbridges and one highway underpass are proposed. These are summarised in **Table 4-2** and a typical cross section is shown in **Figure 4-5**. Each highway bridge has been designed with consideration of the 'Bridge Aesthetics: Design guidelines to improve the appearance of bridges in NSW' (RTA, 2003) and would comprise of:

- Four 3.5 metre wide lanes.
- Three metre wide outer shoulders.
- 2.5 metre wide inner shoulders.

The exception to this is the bridge at Berry, where the shoulders would be three metres wide on the outside adjacent to the bridge barriers and would vary up to three metres in width on the inside, depending on the sight distance. Provision for an additional third lane in each direction would be constructed as part of the project. It would be accommodated by reducing shoulder widths should additional capacity be required.

Crash barriers are proposed at all bridges, with safety throw-screens provided at overbridges with formalised pedestrian access. Formalised pedestrian and cyclist access is only proposed at Kangaroo Valley Road overbridge. No pedestrian or off road cyclist access is proposed along the bridge at Berry.

Maintenance bays would be provided to access abutments at all bridges. A maintenance bay is proposed at the southern end of the bridge at Berry, with access at the northern end available via the on-ramp.

Table 4-2 Proposed bridge structures

Chainage (km)	Description	Type	No. spans	Length (m)	Width (m)	Maximum height (m)	Piers
7700	Toolijooa Road underpass, as part of the Toolijooa Road interchange	Continuous super T[a]	1	32	25	8.5	0
9900	Broughton Creek bridge 1	Continuous super T	4	170	25	9	6
10650	Broughton Creek bridge 2	Continuous super T	3	75	25	8	4
11125	Broughton Creek bridge 3	Continuous super T	6	190	25	13	10
11500	Austral Park interchange overbridge	Cast *in situ* post tensioned voided slab	1	55	10	8.5	0
14300	Tindalls Lane interchange overbridge	Cast *in situ* post tensioned voided slab	1	60	13	9	0
15800	The bridge at Berry	Continuous super T	19	600	25	12	54
17675	Kangaroo Valley Road overbridge	Cast *in situ* post tensioned voided slab	1	48	20	7.5	0

[a] – A type of precast concrete bridge girder.

4.2.8 Property access

Direct property accesses would not be provided where the project would deviate from the existing highway alignment. Residents within these sections would continue to access their properties from the existing highway, which would be reclassified as a local road, or via the existing local road network. Detailed impacts to individual property accesses as a result of the project are provided in **Section 7.9**.

Three highway underpasses at chainage 8400 and 9475 and 15100 (box culverts) would be provided where properties would be severed from the existing highway by the project, or where access to the project cannot be provided. Alternative accesses to two North Street properties within Berry affected by the North Street road closure would be provided from the North Street cul-de-sac. Alternative access to the properties on the northern side of North Street would be provided from Rawlings Lane.

Where the project follows the existing highway alignment, direct property access would be provided or consolidated via property access roads where feasible. Direct connections to the highway would include a deceleration lane and signposting, but would be restricted to left-in left-out movements. **Figure 4-15** shows an indicative representation of this arrangement.

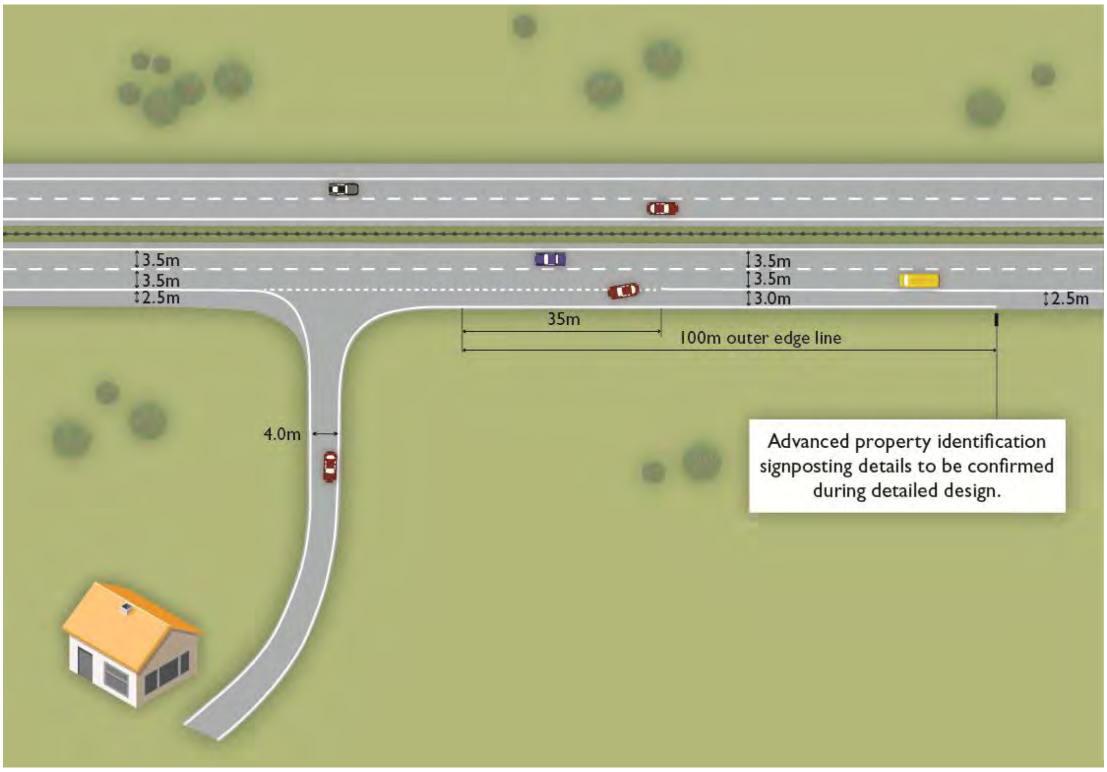

Figure 4-15 Typical rural property access (lengths shown are indicative only)

A central wire rope median barrier would provide significant safety benefits in line with the project objectives by preventing right turn movements across traffic. Motorists wishing to turn right from their properties would be required to turn left onto the proposed highway, and change direction at the nearest interchange or u-turn bay. u-turn bays are provided at Mullers Lane, Rawlings Lane and the Austral Park Road interchange. **Figure 4-16**, **Figure 4-17** and **Figure 4-18** illustrate the property access arrangements for these affected motorists.

Where the current access point could not be maintained, entrances to properties would be relocated. This could include direct access to the upgraded highway at a new location, or to an existing local road (eg at the upgraded Austral Park Road), or to a service road or via a right of way across a private property.

Consultation with property owners about their individual property accesses has been undertaken and is summarised in **Chapter 6** and assessed in **Section 7.9** of this environmental assessment.

From	Properties in and north of Schofields Lane to the southern interchange for Berry accessed via northbound carriageway.
To	Princes Highway southbound.
Traffic circulation	Requires northbound travel on the Princes Highway and u-turn at the southern interchange for Berry.
Maximum additional travel (typical conditions)	2.8 km (2.3 minutes).
From	Properties south of Victoria Street accessed via southbound carriageway.
To	Princes Highway northbound.
Traffic circulation	Requires southbound travel on the Princes Highway and u-turn at Mullers Lane.
Maximum additional travel (typical conditions)	2.8 km (2.4 minutes).

Figure 4-16 Property access arrangements between Austral Park Road and Tindalls Lane

From	Properties north of the northern interchange for Berry to Tindalls Lane accessed via northbound carriageway.
To	Princes Highway southbound.
Traffic circulation	Requires northbound travel on the Princes Highway and u-turn at Tindalls Lane interchange or via underpass/Queen Street.
Maximum additional travel (typical conditions)	3.1 km (2.9 minutes).
From	Properties south of Tindalls Lane to the northern interchange for Berry accessed via southbound carriageway.
To	Princes Highway northbound.
Traffic circulation	Requires southbound travel on the Princes Highway and u-turn at Woodhill Mountain Road.
Maximum additional travel (typical conditions)	2.6 km (2.9 minutes).

Figure 4-17 Property access arrangements between Tindalls Lane and the northern interchange for Berry

From	Properties in and north of Schofields Lane to the southern interchange for Berry accessed via northbound carriageway.
To	Princes Highway southbound.
Traffic circulation	Requires northbound travel on the Princes Highway and u-turn at the southern interchange for Berry.
Maximum additional travel (typical conditions)	2.8 km (2.3 minutes).

From	Properties south of Victoria Street accessed via southbound carriageway.
To	Princes Highway northbound.
Traffic circulation	Requires southbound travel on the Princes Highway and u-turn at Mullers Lane.
Maximum additional travel (typical conditions)	2.8 km (2.4 minutes).

Figure 4-18 Property access arrangements between the southern interchange for Berry and Schofields Lane

4.2.9 Property acquisition

The highway alignment has been designed to restrict land acquisition and to limit the severance of private properties. Based on the concept design, the project would require acquisition of around 63.8 hectares of land over and above land previously acquired by RMS, affecting 51 private properties or properties owned by Shoalhaven City Council. Twelve properties would be severed by the project to create two or more allotments. Five of the twelve properties have already been acquired by RMS (refer to **Section 7.9** and **Section 7.10**). A table showing all properties that have been or would be acquired has been provided in **Section 7.9**.

Where partial acquisitions are required, RMS would realign private property fencing as part of preliminary construction work.

The total area that would be acquired for the project may change as the project alignment is refined during the detailed design phase of the project, or in response to any changes resulting from the exhibition of this environmental assessment and any conditions of approval issued by the Minister for Planning and Infrastructure.

All partial and full property acquisition would be undertaken in accordance with the 'Land Acquisition Information Guide' (RTA, March 2011) and the *Land Acquisition (Just Terms Compensation) Act 1991*. Consultation with all affected property owners has been undertaken at all stages of the project development (refer to **Chapter 6**) and would continue to occur during detailed design.

4.2.10 Drainage structures and fauna crossing structures

Drainage and fauna crossing structures would include:

- 16 pipe culverts.
- Five box culverts, including one dedicated drainage culvert, two dual use culverts for drainage and fauna passage and two dedicated fauna underpasses.

Drainage structures

The project includes 19 drainage structures, including three box culvert structures and 16 pipe culvert structures. Two of these box culverts would have a dual purpose as fauna underpasses and are discussed further in the fauna crossing structures section below. Existing drainage structures would be replaced and upgraded to satisfy the project design requirements.

Cuttings, embankments, bridges and pavements would each have drainage systems to collect surface water runoff. These would comprise gutters, pits, berms and catch drains and pipes. Surface drainage at bridges would be collected and conveyed longitudinally to the main highway drainage system rather than discharging directly into the receiving waterway.

The final design and configuration of the culverts, scour protection measures and drainage systems would be confirmed during the detailed design phase of the project.

Permanent water quality basins

Runoff would be discharged to water quality basins and associated grass swales at various locations along the length of the project (refer to **Section 7.4**). Water quality basins would be within the project footprint. The size of water quality basins would be based on providing 300 cubic metres of working volume per hectare of catchment. The locations of the basins would also be based on avoiding and protecting sensitive receiving environments. Biofiltration systems would also be considered during detailed design and would be used to protect sensitive receiving environments along the project alignment (refer to **Section 7.4.4**).

Fauna crossing structures

Four box culverts would be provided to serve as fauna underpasses (refer to **Section 7.3**). Two of the culverts would be dedicated to fauna movement only and two would serve a dual drainage and fauna movement function. The location and dimension of these structures are provided in **Table 4-3**.

Table 4-3 Dimensions of fauna underpasses

Chainage	Location	Type	Width	Length
8450	Toolijooa Ridge	Dedicated fauna underpass box culvert	1.5 metres	45 metres
12800	Western end of the Austral Park Road extension (1200 metres east of Tindalls Lane)	Dual use box culvert	1.5 metres	60 metres
13320	600 metres east of Tindalls Lane	Dual use box culvert	1.5 metres	50 metres
13680	300 metres east of Tindalls Lane	Dedicated fauna underpass box culvert	1.5 metres	55 metres

Fauna 'furniture' such as rocks, piping, raised log railings and refuge poles would be included within the dedicated dry passage part of the culverts. The new highway bridges would also act as fauna underpasses.

In addition to the box culverts that would provide fauna underpasses, 17 rope bridges would be located at all creek crossings, on Toolijooa Ridge, east of Tindalls Lane and at the bridge at Berry. Rope bridges would cross over the project, under the new highway bridges, adjacent to the project and over the existing highway. Fauna crossing structures locations and design have been identified through ecological investigations, consultation with NOW, OEH and Southern Rivers Catchment Management Authority and in conjunction with local environment groups, such as local Landcare groups (refer to **Section 7.3** and **Figure 4-1** to **Figure 4-3**).

4.2.11 Town Creek diversion

Town Creek is a small ephemeral watercourse that passes directly through the Berry township. Upstream from the area around North Street, Town Creek is a degraded channel through highly modified grazing lands that only flows during or following a rainfall event, An open channel would be constructed to divert the section of Town Creek above North Street into Bundewallah Creek north of the project (refer to **Figure 4-3**).

Diverting Town Creek enables the proposed alignment in the vicinity of North Street and the Kangaroo Valley Road interchange to be lowered resulting in a lower apparent height of the proposed noise barrier along North Street. The diversion would also provide flood protection up to the 1 in 100 year flood event to the highway and the access into Berry at the southern interchange.

Flows would be diverted up to the 1 in 100 year flood event and the diversion channel would be sized to accommodate this flood event. The start of the diversion would be formed close to where the creek currently crosses North Street. The channel would run along the western edge of Rawlings Lane before crossing under the lane at a bridge. It would then run along the eastern edge of Rawlings Lane before joining Bundewallah Creek and include a meander as part of the design.

The length of the diversion would be about 400 metres and the width of the impacted area would be between 20 metres and 50 metres and this includes the batters that would be constructed on either side of the channel. One side of the diversion would be steeper than the other side with gradients between 2:1 and 10:1. This would allow for both revegetation of the steeper slope and grazing on the gentler slope. The diversion would be constructed to provide a balance between agricultural activities, weed maintenance and biodiversity values and would be grassed and planted with native vegetation. The design of the diversion would include scour protection, at the bends of the diversion, to prevent erosion and scour during high flow periods. The design of the diversion, including the width of the channel in low flows and the overall footprint would be confirmed during the detailed design in consultation with relevant stakeholders. The creek diversion is discussed further in **Section 7.3** and **Section 7.5.**

Town Creek currently flows through the Berry township and joins Broughton Mill Creek south of Berry. The diversion of Town Creek would be designed so that there is no net loss of flow from the Broughton Mill Creek system.

Typically a creek diversion would require an approval under section 91 of the *Water Management Act 2000*, however due to section 75U(1)(h) of *EP&A Act 1979* this approval is not required. This is discussed further in **Section 5.3.1**.

4.2.12 Utility services

The major utilities that would be impacted by the project are shown in **Figure 4-19,** and include the Eastern Gas Pipeline (operated by Jemena), fibre optic cables (operated by Optus and Telstra), a low voltage electricity distribution network (operated by Endeavour Energy), and sewage and water pipelines (operated by Shoalhaven Water). The utility providers have been consulted in relation to the project and feedback, where provided, is summarised in **Chapter 6**.

The areas where utilities cross the project corridor would be either excavated for cuttings or filled to create embankments due to the construction requirements of the project. At these locations, utilities would either require protection and/or relocation to cater for the project and to ensure the continuation of services during construction.

Where sections of the existing highway would be upgraded, any existing minor utilities would be relocated as required to suit the new alignment. Temporary utility diversions may also be undertaken should the new permanent alignment be located within the active construction footprint.

These works would occur during the pre-construction stage of the project and would be supported by a detailed survey of the proposed alignment to identify all utilities affected. Modifications to the affected utilities would be in accordance with the design and construction methods approved by the relevant service authorities.

Eastern Gas Pipeline

The most significant gas asset in the project area is the Eastern Gas Pipeline, which is owned and operated by Jemena. The Eastern Gas Pipeline was constructed in 2000 and runs from northern Victoria to western Sydney. It is a 450 millimetre diameter 15 MPa main pipeline buried at a depth between 0.9 metres and 1.2 metres below ground level. The gas main broadly follows the entire project within a 1.5 kilometre margin either side, crossing under the existing highway in the vicinity of Tindalls Lane, to the north of Berry.

Preliminary consultation with Jemena indicated that the construction of an embankment at this location would be feasible. However, further consultation would be required during detailed design. This would determine the appropriate protection measures required to maintain the integrity of the pipeline during construction and operation. This would likely include the encasement of the pipeline in accordance with Jemena’s specifications.

Electrical transmission lines

Endeavour Energy operates a number of electrical transmission lines in the area including:

- An overhead 132 kV transmission line that traverses the western side of Berry.
- A 33 kV transmission line that generally follows the South Coast Railway line from the northern extent of the project area to Berry.
- An overhead 11 kV network and local low voltage distribution network which corresponds to the local road network over the entire project area.

Adjustments to the alignment and associated infrastructure of Endeavour Energy’s low voltage electricity network would be required, both where the existing highway alignment would be widened, and along local roads within Berry which would be modified as part of the project. The 11 kV distribution lines along Woodhill Mountain Road would require adjustment due to the construction of the bridge at Berry. The preferred options would be to bury the lines underground and under the bridge. The final option for this adjustment would be determined in conjunction with the service provider.

Sewer and water pipelines

Shoalhaven Water operates a sewer and water network in the Shoalhaven local government area (LGA), which includes Berry. Water is provided to Berry from reservoirs located in the vicinity of Kangaroo Valley Road, around 400 metres west of the intersection with Bundewallah Road. Two asbestos cement mains pipes leave the reservoir and run along Kangaroo Valley Road to the intersection with North Street and then along North Street to the intersection with George Street. Another runs south west from Kangaroo Valley road, along Hitchcocks Lane to George Street. It then runs south west along the rail line. The sewer network in Berry extends as far east as Pulman Street, and culminates at the Berry Wastewater Treatment Plant off Wharf Road, south of Berry. The Berry Wastewater Treatment Plant discharges to Broughton Creek.

During the pre-construction stage of the project, the following would be completed for these utilities in consultation with Shoalhaven Water:

- Adjustment of the Shoalhaven Water sewer main along Kangaroo Valley Road, aligning the main between Kangaroo Valley Road and North Street to avoid the cutting at the southern interchange at Berry.
- Concrete encasement of the Shoalhaven Water sewer and water mains along North Street and Hitchcocks Lane, where the highway would cross the sewer alignment.
- Relaying Shoalhaven Water's water mains within ducts in the new Kangaroo Valley Road overbridge.

Telecommunications

Optus operates a fibre optic cable between Sydney and Melbourne. South of Berry, this cable traverses the project on a similar alignment to the Eastern Gas Pipeline and Endeavour Energy's 132 kV transmission line. North of Berry, the cable alignment is similar to the Eastern Gas Pipeline alignment and crosses under the existing highway around 1.5 kilometres east of Tindalls Lane.

The major Telstra asset located in the vicinity of the project is a fibre optic cable that runs between Sydney and Melbourne. This cable follows the southern side of the South Coast Railway Line through the project area.

Telstra also owns and operates fibre optic inter-exchange network cables between telephone exchanges which carry high volumes of data between Berry and Kangaroo Valley and between Berry and Nowra.

During the pre-construction stage of the project, the following would be completed for these utilities:

- Realignment of the Optus fibre optic cable, where it traverses the eastern side of the corridor north of Berry for around 800 metres, and encasing the cable where it crosses the highway around 1.5 kilometres north of Tindalls Lane.
- Relaying of the Telstra fibre optic cable and Shoalhaven Water's water mains within ducts in the new Kangaroo Valley Road overbridge.

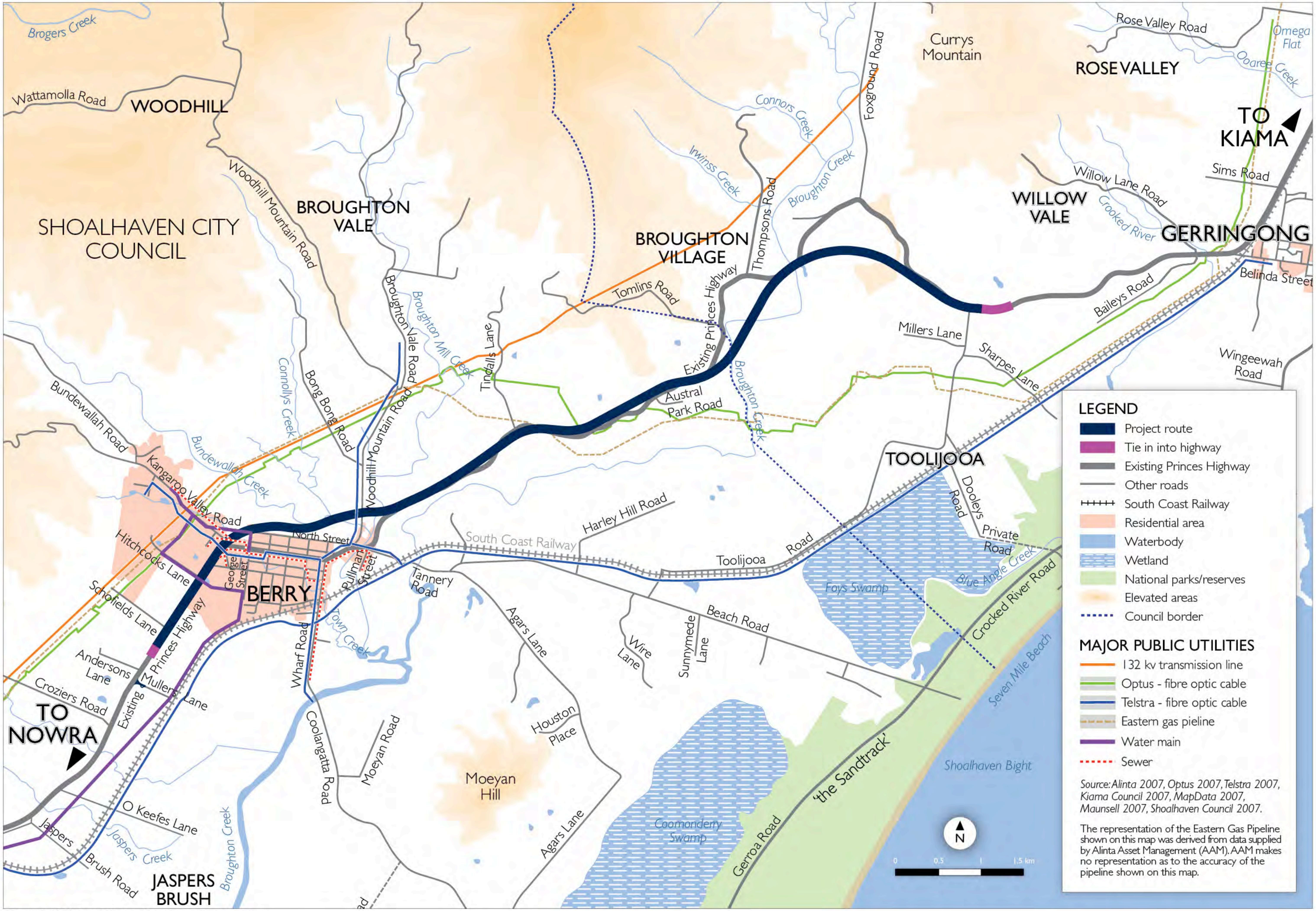

Figure 4-19 Major utiities within the project corridor

4.2.13 Emergency facilities

An emergency u-turn facility would be provided between the interchanges at Toolijooa Road and Austral Park Road (chainage 10950). The proposed median barrier would be discontinued and a permanent gap would be provided. Signposting would denote that the facility is for use by emergency vehicles and RMS vehicles only. A lay-by with an emergency telephone would be provided on both sides of the highway.

Dedicated at-grade public u-turn facilities are not proposed on the highway on the basis that the frequency of grade-separated interchanges and off line u-turn facilities included as part of the project minimises the need for such facilities.

In the case of a significant traffic incident that blocks all lanes, the emergency u-turn facility would be used to redirect traffic to contra flow under emergency services control. The continuous median safety barrier would also have the ability to be 'dropped' at key locations when a u-turn facility is needed.

The 'Sandtrack' would also be maintained as an alternative route during major incidents, as currently identified in the 'Incident Response Plan for HW1 Princes Highway within Kiama Municipal Council boundaries' (RTA, 2010) and 'Incident Response Plan for HW1 Princes Highway within Shoalhaven City Council boundaries' (RTA, 2010).

4.2.14 Service centres

The project would not include the provision of land or services for a future service centre.

The proposed signage strategy would direct motorists to Gerringong, Berry and Bomaderry for fuel and refreshments and other services.

4.2.15 Heavy vehicle rest areas

The project would not include the provision for heavy vehicle rest areas for northbound or southbound traffic.

Upgrades of existing heavy vehicle rest areas north and south of the project area are currently being planned and are proposed by RMS within the scope of other projects. These upgrades would also be likely to reduce the occurrence of fatigue related crashes. Further details are provided in **Chapter 3**.

4.2.16 Operational ancillary facilities

A permanent ancillary facility site would be provided at the Tindalls Lane interchange, utilising excess land in between the highway and a modified section of the existing highway (refer to **Figure 4-2**). The site would be about 0.8 hectares in area and would be accessed from the existing highway. It would be used for the interim storage of materials and equipment required for road maintenance, and would be jointly used by the RMS, Shoalhaven City Council and/or their contractors. The volume of material stored at the site would vary depending on maintenance requirements. The layout of the facility would be subject to detailed design, but would include site fencing, silt fences, screening and permanent stormwater detention and treatment facilities. A description of construction ancillary facilities is provided in **Section 4.4.7**.

4.2.17 Pedestrian and cyclist facilities

Dedicated pedestrian and cyclist facilities would not be provided along the main alignment of the project, but pedestrians and cyclists would be able to safely use the 2.5 metre wide outer shoulder of the highway. Under the ultimate three lane scenario, the shoulders on the bridge at Berry would be reduced to accommodate the additional traffic lanes and cyclists approaching Berry from either direction would be directed through Berry as the bridge at Berry would no longer provide cycling facilities.

A 2.5 metre off-road shared pedestrian/cycle path would be provided on both sides of the Kangaroo Valley Road overbridge. A shared pedestrian/cycle path would also be provided south of the southern interchange for Berry, connecting Kangaroo Valley Road to Queen Street and Mark Radium Park. Another path would be provided east of the interchange, connecting Kangaroo Valley Road to Queen Street and the North Street corridor. This path would extend along the northern edge of North Street to the Berry sportsgrounds.

Connections to adjoining pedestrian and cyclist networks would be considered during detailed design and with consideration to the existing pedestrian access mobility plans for the township of Berry (refer to **Section 7.6**).

4.2.18 Street furniture and Berry entry statements

Roadside furniture elements would be included along the length of the project for safety reasons, indicating delineation, directional guidance, fauna exclusion and for security purposes. Indicative details on the street furniture are provided in **Table 4-4** and the location and design of these elements would be further refined during detailed design. All roadside furniture elements would be designed in accordance with the urban design objectives set out in **Section 4.3.2**.

The new Berry access points would be landscaped with plants consistent with the landscape character of Berry. Signs would be designed legibly to allow road users to transition from the highway into town in a safe manner (refer to **Section 7.6**).

As the northern interchange for Berry would be visually separated from the township (when travelling southbound), relocation of the existing Alexander and David Berry memorial to the Berry interchange would be considered in consultation with Shoalhaven City Council. Existing Kiama Municipal Council area and Shoalhaven City Council area entry statements would also be relocated in consultation with the two councils, where they are affected by the project.

South of Berry, between Schofields Lane and the southern interchange for Berry and Schofield's Lane a permanent variable message sign (VMS) for northbound traffic would be installed on the western side of the project (refer to **Table 4-4**). If appropriate this VMS may be installed early in the construction phase to provide advice on traffic network changes, safety and travel time advice to motorists during the construction period.

Southbound traffic would be serviced by the use of a proposed, permanent VMS just north of Belinda Street and would be constructed as part of the Gerringong upgrade.

Table 4-4 Street furniture

Item	Indicative details
Safety barriers	A range of safety barriers (with the appropriate transitions) would be provided to protect vehicles from potential collision hazards and would be tailored depending on safety requirements. This would include wire rope barriers, concrete barriers and steel beam barriers where appropriate.
Line marking	Line marking would be in accordance with RMS standards and would include reflective lines and raised pavement markers. Additional delineation would be provided by way of standard reflectors on safety barriers and guideposts.
Traffic signs	Traffic signs would be provided to ensure the legibility, consistency and compatibility between the project and the State road network, and would satisfy regulatory requirements. The signposting scheme would be developed in accordance with RMS guidelines and in consultation with relevant stakeholders.
VMS	A VMS would be installed to provide up-to-date, real time road safety and travel information for motorists, including information on alternative routes or diversions in the event of a major incident, or information on the condition of other regionally significant roads (such as Kangaroo Valley Road). The VMS would face northbound traffic and be located within the road reserve south of the off-ramp at the southern interchange for Berry. A minimum height clearance of 5.5 metres from the roadway would be provided. The proposed location for the VMS would be between chainage 18650 and 18700. This location ensures the VMS would be located outside of areas of environmental sensitivity such as threatened species habitat. The site would be selected to avoid significant impacts to residences, businesses or local accesses.
Lighting	Highway lighting would be limited to grade-separated intersections which would generally have ramp terminals, merge/diverge, and weaving areas lit in accordance with AS/NZS 1158 Code of Practice for Public Lighting.
Fencing	Fencing would be provided along the boundary of the road reserve and private land to demarcate land ownership. Temporary security fencing may be utilised during construction, however it would not be required for operation and would be removed on completion. Dedicated fauna exclusion fencing would be provided to prevent fauna accessing the highway. It would be located around 200 metres on either side of fauna underpasses, and along the northern side of the western abutment of the bridge at Berry (refer to **Section 7.3**).
Council area entry statements	Entry statements for the Municipality of Kiama and Shoalhaven City would be provided along the project alignment in proximity to the LGA boundary in accordance with the applicable council standard. The location and design would be determined in consultation with each council.

4.2.19 Noise attenuation

Noise attenuation would be considered during detailed design and in consultation with affected landowners to reduce road traffic noise levels at the residential properties located along Huntingdale Park Road and the North Street corridor. The indicative locations of proposed noise barriers are shown in **Figure 4-3**.

The proposed North Street noise barrier would be on the southern side of the project. It would extend from the western end of the bridge at Berry to the southern interchange for Berry and would be around four metres in height above the road surface. The barrier would likely consist of a precast concrete barrier with low level landscaping at the base of the barrier on the side of the project, where feasible. A landscaped embankment would be built close to the top of the barrier on the North Street side to minimise the visual impact.

The proposed Huntingdale Park Road noise barrier would likely be located along the northbound off-ramp for the southern interchange for Berry and based on the proposed design, would be around four metres in height and around 200 metres long. The final details of height and length would be determined during detailed design. Noise barriers constructed as part of the project would be designed in accordance with the RMS ‘Noise wall design guidelines: Design guidelines to improve the appearance of noise walls in NSW’ (RTA, 2007).

In addition to the noise barriers, some isolated residences would be considered for architectural treatments where project noise limits would be exceeded. Low noise pavement and low noise bridge joints would also be considered.

Treatments would be determined where feasible and reasonable in consultation with affected landowners and in accordance with the *Road Noise Policy* (OEH 2011) and the Environmental Noise Management Manual (RTA, 2001) during the detailed design stage of the project. Noise attenuation requirements are discussed in **Section 7.2**.

4.3 Design

4.3.1 Design criteria

The project has been designed in accordance with the ‘Road Design Guide’ (RTA, 1998) and has considered subsequent amendments to the guide. The design criteria applied to the project is provided in **Table 4-5**.

Table 4-5 Design criteria

Criteria	Requirement
Highway alignment and cross section	
Design speed	Horizontal 110 kilometres per hour Vertical 100 kilometres per hour
Minimum “K” value [a]	Crest 66 Sag 33.4[b]
Stopping sight distance	Reaction time 2.5 seconds Horizontal 210 metres Vertical 175 metres
Horizontal radius	On line upgrade minimum 600 metres Off line construction minimum 750 metres
Upgrade lanes (in each direction) Ramps	2[c] 1
Climbing lanes	Loss of truck speed to 40 kilometres per hour and LoS D 20 years after construction
Grade	Desirable maximum 6 per cent[d] Absolute maximum 8 per cent
Lane width (including interchange ramps and auxiliary lanes)	3.5 metres

Criteria	Requirement
Shoulder width	Nearside (outside) 2.5 metres Offside (median) minimum 1 metre
Median width [e] – No right turn bay	With wire rope barrier 5 metres With Type F concrete barrier 2.6 metres
Median width [e] – Right turn bay treatment required	10 metres
Clearance to boundary	Minimum 6 metres
Flood immunity	1 in 100 year storm event for new structures. A minimum of 1 in 20 year storm event if an existing structure can be utilised subject to structural capacity adequate for new design life.
Batters	Fill < 1.5 metres high – 4:1 (maximum slope) Fill > 1.5 metres high – 2:1 (maximum slope) Cut 2:1 or flatter – 7 metres maximum between benches Cut steeper than 2:1 – 10 metres maximum between benches
Design vehicle highway	25 metre B-double 12.5 metre single unit truck (emergency vehicle u-turn bays) 19 metre semi-trailer (access u-turn bays)
Design vehicle local road	19 metre semi-trailer (unless designated a B-double access)
Design vehicle – property access	19 metre semi-trailer (farm residence and paddock access by negotiation with the land owner)
Bridges[f]	
Outside shoulder	2.5 – 3 metres (to match approach shoulder width)
Median shoulder	Minimum 1 metre
Vertical clearance – over highway	5.3 metres
Vertical clearance – over regional and local road	4.6 metres

Notes:

a. *The K value is a geometric design term used to determine the length of vertical curvature along a road between two varying grades.*

b. *Refers to sag vertical curves which are concave upwards. This is used to determine headlight and comfort criteria.*

c. *Provision for future widening on the outside would be included. The climbing lanes would occupy the ultimate third lane at Toolijooa Ridge.*

d. *No criteria applies regarding maximum length of grade.*

e. *Measured edgeline to edgeline.*

f. *The details of Kangaroo Valley Road bridge have been provided in **Section 4.2.4** with respect to pedestrian and cyclist access and widths.*

4.3.2 Urban design principles and objectives

As discussed in **Chapter 2 and Chapter 3**, the project objectives are supported by six urban design objectives, which have been considered during the development of the concept design and form the basis of the landscape and visual assessment documented in **Section 7.6** and **Appendix I**. The detailed design of the project would be in accordance with the following objectives:

Objective 1 – Provide a flowing highway alignment that is responsive and integrated with the natural landscape

- Respond to the grain of the landscape in route selection, including following the edge of valleys and hills and avoiding disruption to vegetation stands, including both natural vegetation and cultural plantings.
- Integrate cut and fill embankments with surrounding terrain by grading out and varying slopes.
- Consider independently grading carriageways.
- Preserve cultural patterns in the landscape.
- Avoid significant features of the areas through which the alignment passes as much as possible.
- Vary the gradient of the earthworks to provide visual interest and reflect the characteristics of the surrounding landform and landscape.
- Grade cuttings and embankments wherever practicable to best fit the characteristics of the local landform, returning the land to either its former use or replacing vegetation lost to the project.

Objective 2 – Protect the natural systems and ecology of the corridor

- Avoid areas of natural vegetation, particularly those containing threatened species and communities.
- Minimise disruption to natural drainage patterns both through route selection and road design.
- Minimise the number of crossings of Broughton Creek and other creeks in the study area.
- Use medians and road verges to maximise habitat value and maintain pollination paths and wildlife movement patterns where feasible.
- Highway corridor landscape qualities and characteristics should respond to and be integrated with the areas through which it passes.
- Integrate water quality basins with the landscape form and character.

Objective 3 – Protect and enhance the heritage and cultural values of the corridor

- Avoid items of identified European and Aboriginal heritage and cultural value.
- Acknowledge and respond to the heritage and cultural values of the rural landscape.
- Acknowledge and respond to Aboriginal value placed on the broader landscape.
- Reduce the visual and noise impact of the highway through the design of the project.
- Consider the important value of the productive landscape within the landscape.

Objective 4 – Respect the communities and towns along the highway

- Minimise the impact of the project on the amenity of Berry residents.
- Provide effective and efficient access to Berry.
- Design new town access points as an important and integral part of the town, ensuring a clear and consistent access way.
- Minimise the disruption and loss of amenity to rural communities in the study area.

Objective 5 – Provide an enjoyable, interesting highway with strong visual connections to the immediate hinterland and the mountains to the west

- Acknowledge the role of this section of Princes Highway as an important part of a longer scenic drive along the NSW south coast.
- Maximise opportunities for high quality and varied views of the coast, the rural landscape and adjacent mountain ranges.
- Provide visual connections and easy, well marked access to the towns along the route.
- Use landscape treatments to soften the road appearance for the road user without compromising opportunities for key views.
- Consider the heritage of the highway in the upgrade so that where practicable, road users may experience it.

Objective 6 – Develop a simple and unified palette of elements and details that are easily maintained

- Develop a consistent approach to bridge development along the project. Urban design principles to be consistent with those outlined in the ‘Bridge Aesthetics: Design guidelines to improve the appearance of bridges in NSW’ (RTA, 2003).
- Develop a consistent approach to the design of noise barriers along the project. Urban design principles to be consistent with those outlined in the ‘Noise wall design guidelines: Design guidelines to improve the appearance of noise walls in NSW’ (RTA, 2007).
- Develop an integrated strategy for the avoidance, minimisation and improved appearance of shotcrete as outlined in the ‘Shotcrete Design Guidelines: Design guidelines to avoid, minimise and improve the appearance of shotcrete’ (RTA, 2005).
- Develop a consistent approach to the design of soft landscape along the project. Planting design principles to be consistent with those outlined in the ‘Landscape Guideline: Landscape design and maintenance guidelines to improve the quality, safety and cost effectiveness of road corridor planting and seeding’ (RTA, 2008).

4.3.3 Landscape framework

A landscape framework has been developed for the project which would provide the structural layout for the future landscape design of the project while being responsive to the design objectives. It responds to the four key landscape character precincts identified within the project. These landscape character precincts reflect the natural and built environments, and are referred to as the Toolijooa Ridge, Broughton Creek, North Berry and Berry Township landscape character precincts (refer to **Section 7.6**).

The landscape treatment details would be finalised during detailed design and subject to consultation with relevant stakeholders.

4.3.4 Design refinement

The project description presented in this environmental assessment represents the project concept design. Sufficient flexibility has been provided in the design to allow for its refinement during detailed design or in response to any submissions received following the exhibition of the environmental assessment or to minimise environmental impacts. The final design may therefore vary from the concept design presented in this chapter. This would include, but is not limited to, the flattening of cuttings and embankments at the Toolijooa Ridge cutting and the Broughton Creek floodplain, design of noise attenuation measures (in consultation with affected property owners), the appearance of the entry into Berry, the design of the Kangaroo Valley Road overpass, access arrangements (in consultation with landowners), the diversion of Town Creek and the design of the space between the proposed highway and North Street, including landscaping and pedestrian and cyclist access.

4.4 Construction activities

4.4.1 Overview of construction activities

Details of the proposed pre-construction and construction activities are provided in **Table 4-6.**

The methods used to construct the project would be conventional techniques employed on major road projects, adapted to account for project-specific environmental and social constraints. Local access requirements and the geotechnical conditions would influence the final choice of construction techniques to ensure the project is constructed in a safe, operationally functional, and efficient manner. The types of equipment and plant requirements would be refined during detailed design and during the development of the construction methodology by the construction contractor.

Table 4-6 Potential pre-construction and construction activities

Component	Typical activities	Typical plant, equipment and materials
Site establishment	• Fencing of the road corridor. • Implementation of initial environmental safeguards. • Establishment of construction site facilities and access. • Additional surveys and geotechnical investigations, as required. • Installation of temporary traffic controls and line marking.	Fences, portable sheds, portable toilets and fuel storage tanks.
Relocation/ protection of services	• Consultation with relevant service providers on service relocation. • Relocation or protection of services.	Trucks, cranes, excavators, elevated work platform vehicle, backhoes and trenchers and small equipment.

Component	Typical activities	Typical plant, equipment and materials
Site preparation	• Vegetation clearing and grubbing. Processing (including recycling) of various materials for use in fencing or landscaping activities. • Installation of site sediment and erosion controls and pollution management measures. • Stripping and stockpiling of topsoil for reuse. • Construction of internal haulage and access routes. • Adjustment of some property accesses. • Construction of temporary creek crossing structures.	Trucks, bulldozers, scrapers, excavators, backhoes and small equipment.
Earthworks and bridge construction	• Removal and stockpiling of spoil and unsuitable material. • Earthworks, including blasting and movement of materials along the alignment from cutting to fill embankment areas. • Ground improvements for soft soils (refer to Section 4.4.3). • Batter treatments. • Bridge construction, including abutments and delivery of pre-cast elements and installation of piers.	Piling rigs, trucks, bulldozers, excavators, scrapers, graders, water carts, compactors, rollers, blasting equipment, rock crushing equipment and elevated work platform vehicle.
Drainage and fauna crossings	• Preparation of construction diversion drains and sedimentation ponds. • Construction of road drainage structures, including culvert extensions and permanent sediment basins.	Concrete pumps, cranes, excavators, trucks, trenching equipment, small equipment and elevated work platform vehicle.
Pavements	• Construction of pavement layers including selected material, sub-surface drainage, sub-base and base layers and surfacing.	Trucks, graders, water carts, compactors, trenching equipment, bitumen sprayers, asphalt paver, vibratory rollers and rubber-tyre rollers.
Improvements to existing highway	• Earthworks. • Construction of pavement layers including selected material, sub-surface drainage, sub-base and base layers and surfacing as required.	Graders, backhoes, trucks, water carts, vibratory compactors, trenching equipment, bitumen sprayers, vibratory rollers and rubber-tyre rollers.

Component	Typical activities	Typical plant, equipment and materials
Other works	• Installation of safety barriers, lighting, fencing and roadside furniture. • Line marking and raised pavement markers. • Sign posting. • Landscaping. • Installation of noise barriers. • Relocation of property accesses.	Trucks, fencing and barrier materials, landscaping materials, cranes, line markers and small equipment.
Finishing works	• Removal of temporary works. • Progressive rehabilitation of disturbed areas. • Restoration and landscaping of temporary sites. • Site clean-up and disposal of all surplus waste materials.	Trucks and landscaping materials.

4.4.2 Pre-construction

Post approval surveys would likely include:

- Pre-clearing and habitat surveys to delineate buffer or no go zones.
- Geotechnical surveys, as required.
- Heritage surveys and salvage works, as required.

4.4.3 Earthworks

Fill batters would be generally sloped at 2:1 horizontal to vertical. Cut batters would vary from around 2:1 to1:1 or steeper where geological conditions permit. The typical batter slope satisfies the short and long-term stability requirements of the fills, and may be flattened to accommodate urban design objectives (such as, flattening batters from 2:1 to up to 10:1 where appropriate) and constraints such as maintenance and road safety. Vertical or steep cuts in soils and highly weathered rock along the project may require soil nailing, rock bolting or retaining structures to satisfy short and long-term stability requirements.

Cut and fill batters within the road reserve would be revegetated with native trees, shrubs and groundcovers, consistent with roadside clearance and sight line requirements and in accordance with the landscaping design described in **Section 7.6.**

Based on the concept design, the total earthworks volume is estimated at around 1.3 million cubic metres. It is envisaged the majority of this material would be generated from excavating cuttings and processed for use in embankments and road foundations.

Around 1.0 million cubic metres of material would be used as embankment fill and around 70,000 cubic metres of material required for the select material zone (SMZ) could be sourced from cuttings. The SMZ is a foundation layer for the road pavement which needs material with higher strength qualities.

It is predicted that including an allowance for unsuitable material of around 100,000 cubic metres the earthworks cut to fill balance would be within 50,000 cubic metres (refer **Section 4.4.5**).

Soft soils and acid sulfate soils

Soft soils are present along the floodplains of Broughton Creek and the floodplain to the east of Berry near Broughton Mill Creek, Bundewallah Creek and Connollys Creek. Acid sulfate soils are also potentially present within these areas.

Ground improvements would be required to ensure areas of soft ground are sufficiently stable for the construction of the project and the long-term durability of the completed project. There are a number of methods that can be applied to address this issue, and it is possible that a combination of methods would be applied. These could include:

- Removal of the unsuitable alluvial soils and replacement with a suitable fill to remove the soft soils.
- Preloading or surcharging of embankments. Preloading refers to the placement of a temporary embankment to cause the compression of the soft soils ahead of the construction of the project. The temporary embankment would be equal to or greater in weight to the final structure. Surcharging refers to an additional load to an embankment to make allowance for soil settlement following construction.

Other measures, such as the installation of wick drains, stone columns or deep soil mixing are not currently considered necessary due to the limited extent and impact of soft soils on this site.

However, the methods applied to treat areas of soft soil and the time taken to treat the soft soils would be determined during the detailed design. It would also be considered in the context of corresponding areas of potential acid sulfate soils (refer to **Section 8.1**).

Ground improvement works would typically commence during the earthworks and bridge construction stage of the project. However, the staged treatment of soft soils and the monitoring of soil settlement may be required over the duration of the construction period. This would depend on the findings of the further geotechnical work undertaken to inform the detailed design and method chosen.

Blasting

Construction of the cutting at Toolijooa Ridge may require the use of explosives, with typically one blast occurring per day. It is also proposed that simultaneous blasts may be undertaken. Simultaneous blasts would reduce both the number of blasts and the duration of construction at Toolijooa Ridge. It is expected that vibration limits would be complied with however overpressure is likely to exceed the appropriate levels.. Further details are provided in **Section 7.2**.

Dewatering

Deep excavations and cuttings may require temporary localised dewatering during the construction phase to artificially lower the watertable in order to maintain dry working conditions within excavations. Dewatering may also be required during construction of bridge footings. Construction site dewatering would be managed through a work method statement prepared in accordance with the ‘Technical Guidelines for the Environmental Management of Construction Site Dewatering’ (RTA, 2011). Refer to **Section 7.4** for further details.

4.4.4 Construction materials

Construction would require various materials and pre cast elements including, but not limited to, the following:

- General fill (of varying quality) for use in earthworks.
- Pavement materials, including verge material and road base and sub-base.
- Materials for lining drainage channels.
- Aggregate for use in concrete and asphalt.
- Sand for use as backfill around pipes and for asphalt and concrete.
- Cement and concrete.
- Bitumen.
- Steel for use in reinforcement of bridges and structures.
- Wood for use in formwork and other temporary structures.
- Safety barriers, signage and other road furniture.
- Lighting poles and lamps.
- Geotextiles and geofabrics.
- Fencing.
- Utility materials.
- Topsoil.
- Water.
- Pre-cast pits, pipes, culverts, and headwalls for drainage works.
- Pre-cast barriers, noise attenuation, and other road furniture.
- Pre-cast bridge girders, decks, piles, and abutments.

The quantities of the key natural resource materials required are provided in **Section 4.4.6**.

Material sources

Materials for the select fill would preferably be sourced from the deeper cuttings throughout the project, where the material is of suitable quality. This would minimise the need for imported fill material. Cut or other material that is deemed unsuitable or is excess would be stockpiled and stabilised until needed as part of the landscaping or possibly used as visual screening or for noise mounds during construction. Further investigations would be undertaken to determine the availability of quality fill and select material.

Additional construction materials would be sourced off site. This may include fill or select material to address shortfalls in required volumes in the event that material won by the project is found to be unsuitable. The majority of raw and manufactured materials would be hauled from quarries and batch plants located to the north of the site at Shellharbour, Dunmore, Albion Park, and Bombo (refer to **Table 4-7** for further detail).

Local sources of construction materials would be used where practical to minimise haul distances. Although the South Coast Rail line is near the project, it is unlikely to be economically viable to haul by rail and therefore materials would likely be transported via the Princes Highway. Pre-cast elements would be transported along existing road and internal haul roads directly to the work site.

Table 4-7 Indicative sources of construction material

Material type	Source
Fill*	Various, Dunmore, Albion, Albion Park, Bombo
Select material*	Various, Tomerong, Falls Creek
Base and sub-base	Tomerong, Shellharbour, Dunmore, Bass Point, Port Kembla
Bitumen	Clyde, Kurnell
Sand	Kurnell, Mittagong, Shellharbour, Dunmore, Bass Point, Port Kembla
Aggregate	Shellharbour, Dunmore, Bass Point, Port Kembla, Dunmore
Cement	Berrima, Port Kembla
Steel	Various
Specialist pre-cast concrete elements	Sydney and Newcastle metropolitan area
Asphalt	Various suppliers within the region
Concrete	Various suppliers within the region

** Required in the event that material obtained as a result of earthworks is not suitable.*

4.4.5 Spoil and waste disposal

Waste streams would be generated during the construction phase of the project, including the following:

- Waste from existing structures that require demolition, such as bricks from residences.
- Excavated soil and rock which is unable to be reused within backfilling or restoration.
- Contaminated soils or acid sulfate soils that may be exposed during construction, and if exposed, would require off-site disposal (refer to **Section 8.1**).
- Surplus material from construction and general site reinstatement, such as fencing, sediment, concrete, steel, formwork, and sand bags.
- Packaging materials from items delivered to site, such as pallets, crates, cartons, plastics and wrapping materials.
- Vegetative waste from clearance and grubbing.
- Plant and vehicle maintenance waste, such as oil containers.
- General office wastes generated by onsite personnel, such as paper, cardboard, beverage containers and food wastes.
- Sewage waste generated through the use of personnel facilities.

A management strategy to limit the extent of excess spoil generated by the project and methods to dispose of excess spoil would be implemented. This may include the following options:

- Reduction of spoil volume through detailed design refinement or use within the project.

  Further geotechnical investigation during detailed design may lead to design refinements that reduce the predicted volume of excess spoil.

  The flattening of embankment slopes where space is available.

  Consideration of engineering, geotechnical, urban design and land take of the major cut at Toolijooa Ridge to limit the amount of excess material generated.

  Formation of noise mounds.

  Use of material for any preloading of soft soils.

  Excess spoil could be used for preloading activities, however the required volume is not expected to be substantial.

- Provision of excess spoil to adjoining landowners, Shoalhaven City Council or other parties requiring spoil.

  This may include the provision of excess spoil to Shoalhaven City Council to provide stock mounds in flood prone areas as part of its flood mitigation works in the Broughton Creek floodplain, which are still under investigation by the council.

  Any provision of excess spoil to a third party would be dependent on the demonstration by the third party that it has obtained the necessary approvals for the use of the spoil (such as a development consent from the local council or a licence under Section 143 of the *Protection of the Environment Operations Act 1997*). Appropriate environmental controls would be installed at sites where excess spoil would be delivered.

4.4.6 Natural resource consumption

The indicative quantities of raw materials required for project construction are identified in **Table 4-8**.

Table 4-8 Indicative resource quantities required for construction

Resources	Amount
General fill (obtained from site, if suitable)	1,300,000 m^3
Select material zone (SMZ)	70,000 m^3
Steel	13,000 tonnes
Cement (for in situ components)	28,000 m^3
Asphaltic concrete	47,000 m^3
Road base	85,000 m^3

There are a number of suppliers in the region capable of providing resources for the project. These quarries can provide soft rock materials such as sand, aggregate and hard rock materials such as blue metal and road base.

A number of major quarries in the region have recently had or are in the process of having project applications assessed by the NSW Department of Planning and Infrastructure for major expansions to their operations. Major expansions have occurred or are proposed to occur at the Bass Point quarry, Gerroa sand quarry and Nowra brickworks quarry. These quarries are within about 40 kilometres of the project area and would be capable of supplying most types of materials required for the construction of the project.

Indicative water requirements for various activities during construction are identified in **Table 4-9**. It has been estimated that around 100 megalitres per year of construction water would be required. Construction water would be sourced as follows in order of priority:

- Recycled effluent from the tertiary treatment plant at Gerringong Gerroa and/or Berry.
- Surface water, sourced from on-site detention basins.
- Surface water, sourced from watercourses where it would not be detrimental to the aquatic environment of the waterway.
- Potable water, supplied by Shoalhaven Water.
- Groundwater, sourced from de-watering that may be required at the Toolijooa Ridge cutting.

These sources and quantities would be subject to refinement during the detailed design phase of the project. However, the extraction of water (from watercourses or groundwater sources) and the use of potable water are not currently proposed. In the event there is an identified need for groundwater and potable water, their use would be the subject of a separate impact assessment process.

Table 4-9 Indicative water volumes required for construction

Activities	Volumes
Compaction of earthworks	18 litres per cubic metre for compaction 70 litres per cubic metre for stabilisation
Dust suppression	As required, but average 70,000 litres per day.
Planted vegetation maintenance	120,000 litres per day in extreme weather

4.4.7 Ancillary facilities

During site preparation works, compound sites (administration, road and bridge construction compounds), temporary stockpiling sites, mobile crushing and screening plants, bridge girder casting yards and sedimentation detention basins would be established to support construction.

A number of potential ancillary facility site locations have been selected, as illustrated in **Figure 4-20** based on the criteria listed in **Table 4-10**. Properties that are currently owned by RMS have been preferentially assessed. Typical works undertaken within ancillary facilities would include site establishment and landscaping, stockpiling, earthworks, pavement construction, drainage construction, street furniture installation and site restoration. The typical equipment used during these stages has been presented in **Table 4-6**. The environmental impacts of activities and plant are separately assessed in **Chapter 7**. The description of typical activities that would be undertaken at the ancillary facilities is described later within this section.

Alternative or additional sites may be identified during detailed design or at a later stage during construction. The selection of any additional or alternative site compounds, bridge compound and temporary stockpile sites would also be considered against the site selection criteria detailed in **Table 4-10**.

Table 4-10 Selection criteria for ancillary facility sites

Selection criteria
Location
Locate within the project alignment or directly adjacent to the project.
Preferably located on land that is in RMS ownership. If RMS owned land is not available or suitable for use, ancillary construction facilities are to be located (in order of preference) on: • Sites that can be leased from Council. • Sites that can be leased from private owners.
Stockpiling sites are not to be located on slopes with a gradient greater than 2:1 horizontal to vertical.
Locate other compound sites on relatively level ground.
Provide a minimum one to two hectares to cater for the ancillary facility.
Services
Locate compound sites where they can be easily serviced with electricity and potable water.
Locate stockpile sites where they can be easily serviced/supplied with the appropriate quality of water.
All ancillary sites are to have direct and safe access to the road network.
Access points are to be at a distance from residences (to avoid traffic conflicts) where practicable.
Environmental
Wherever possible, sites are to be located above the 1 in 100 year flood level. If sites cannot be located above the 1 in 100 year flood level, they could be located above the 1 in 20 year flood level subject to the implementation of appropriate mitigation measures to reduce flood risk and impacts on the surrounding environment (such as provision of a sufficient freeboard for storage areas).
Locate facility more than 50 metres from watercourses*.
No clearing of Endangered Ecological Communities (EECs), threatened flora species or threatened fauna habitat.
No substantial vegetation clearing. Ancillary sites are to be located on land of existing low conservation significance for flora and fauna.
No exceedance in air quality targets for construction, as discussed in **Section 8.1.4** and provided in **Table 8-1**.
Wherever possible, sites are to be located and designed to satisfy noise and vibration management levels, relevant to the noise catchment area, and vibration goals at the sensitive receiver (or building, in the case of vibration). If noise management levels or vibration goals cannot be met, feasible and reasonable mitigation measures, the restriction of hours of operation and/or negotiated agreements with affected parties would be considered.
Heritage
Locate on sites that have a low likelihood of having Aboriginal or non-Aboriginal heritage significance and/or potential.
Sites or areas of moderate to high Aboriginal and/or non-Aboriginal heritage significance and/or potential, including known sites, potential archaeologically sensitive areas and areas of Aboriginal cultural significance, are not to be used for ancillary facilities except where the impact is authorised and managed by a relevant approval or an approved Heritage Management Plan.

** Refers to the working footprint of the facility. The property on which the site is located may encompass or may extend within the 50 metre buffer to the watercourse.*

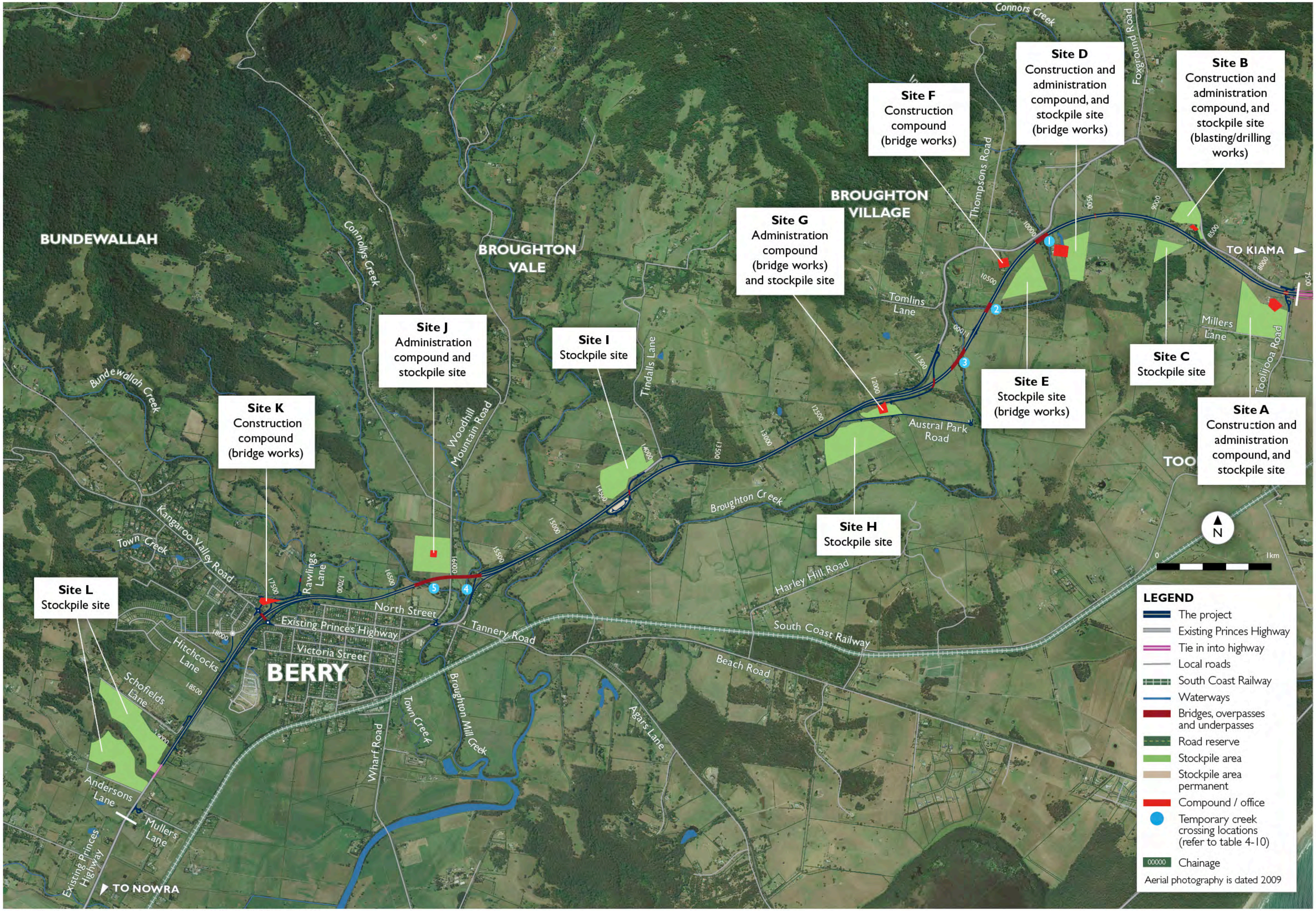

Figure 4-20 Locations of potential construction ancillary facilities

Site compounds

Three types of site compounds would be required for the project:

- Administration compounds – These would be the centre for project coordination and communication, and provide employee and visitor amenities and car parking.
- Construction compounds – These would vary in size and provide a supporting role to the administration compounds. They would be used to enclose machinery and materials, including chemicals, to be used in the works. A construction compound may also be provided to cast bridge girders on site, temporarily store pre-cast concrete components, aggregates and mobile machinery for asphalt production and rock crushing.
- Bridge compounds – These would be similar to construction compounds but would specifically support bridge construction works.

Site compounds may provide a mix of services, and provide both construction and administrative support. Site compounds may also be co-located with stockpile sites.

The establishment of site compounds would form part of the site establishment works, and would include:

- Erection of site fencing, and establishment of erosion and sediment control measures.
- Clearing and levelling the site to facilitate drainage.
- Construction of hard stand areas, including dedicated hard stand for plant and equipment, plant inspection and maintenance, vehicle wash down, and bunded storage areas for fuels and chemicals.
- Construction of pre-fabricated or purpose built temporary offices, crib sheds and storage sheds, which may be supplemented by existing dwellings if present on the site.
- Establishment of temporary utility connections, if not pre-existing, or sewerage storage and pump out facility if no sewerage connection can be made.

The location and layout of site compounds would be designed with consideration for the natural and built environment, and the location of sensitive receivers. Environmental mitigation and management measures would be established, implemented and monitored throughout the course of construction.

Stockpile sites

Construction stockpile sites would temporarily store materials for construction, or materials generated from within the construction site. This could include road base constituents, stripped topsoil, pre-cast concrete components, rock crushing and screening machinery, crushed rock and excess spoil unsuitable for project use.

Site establishment activities for all stockpile sites would include the erection of site fencing and establishment of sediment and erosion control measures. The sites would be managed in accordance with the 'Stockpile Site Management Procedure' (RMS, 2011).

Sedimentation detention basins

Sedimentation detention basins would be required when the project alignment is cleared of vegetation. Sedimentation basins would be excavated at low-lying areas adjacent to the formation, close to natural watercourses, and may be incorporated as a permanent part of the drainage works.

All sedimentation detention basins would be sized in accordance with the requirements of 'Managing Urban Stormwater; Soils and Construction' Volume 1 4th Edition (Landcom, 2004) and 'Volume 2D – Main Road Construction' (DECCW, 2008).

Potential locations for sedimentation detention basins have been identified and the final number and location for sediment basins would be determined during detailed design in accordance with relevant policies and procedures. Temporary construction sedimentation detention basins may be constructed at the proposed location(s) of the operational water quality basins. These temporary sedimentation detention basins could be converted into permanent operational water quality basins if appropriate (refer to **Section 4.2.10**).

Details of the temporary erosion and sediment controls would be included in the erosion and sediment control plan, within the construction environmental management plan (refer to **Section 8.1**).

4.4.8 Temporary works

Construction would require temporary works and facilities to:

- Support or facilitate the construction of the project, such as temporary creek crossings.
- Divert traffic or services around various construction stages.
- Minimise the impact on the natural environment.

The temporary works and facilities listed below may be required to construct the project, and would be dependent on the construction methods selected by the construction contractor.

Any area required in addition to that permanently acquired may be temporarily leased from the property owner, following consultation and negotiation.

Temporary creek crossings

Temporary creek crossings would be provided near each proposed bridge structure during the construction period to maximise the efficiency of construction activity around bridges and reduce travel on the highway by construction vehicles. The type and location of each temporary creek crossing is generally described in **Table 4-11** and shown on **Figure 4-20**.

The preferred locations and design of the temporary creek crossing have been identified to minimise potential impacts to water quality, terrestrial ecology and aquatic ecology. The final design and location would be determined during detailed design, however all crossings would be designed with consideration to ‘Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings’ (Fairfull and Witheridge, 2003) and to minimise afflux.

Following completion of construction activities, the riparian areas at the temporary creek crossings would be rehabilitated. Offsets would also be provided for the loss of River Flat Eucalypt Forest at these locations, which is listed as an EEC under the *Threatened Species Conservation Act 1995* (refer to **Section 7.3.4** and **Appendix J**).

Table 4-11 Temporary creek crossings

ID no.	Temporary creek crossing location	Description
1	Broughton Creek, immediately downstream of the proposed Bridge 1 crossing of Broughton Creek	Bridge
2	Broughton Creek, east of the proposed bridge structure, about 20 metres upstream	Bridge
3	Broughton Creek, south of the proposed bridge structure, about 10 metres downstream	Bridge
4	Broughton Mill Creek, south of the proposed bridge structure, about 25 metres downstream	Bridge or an arch structure
5	Bundewallah Creek, east of the proposed bridge structure, about 20 metres downstream	Bridge or an arch structure.

Side tracks

Where construction works would interact with the existing road network, traffic diversions would be built to enable off line construction. Side tracks would be generally sealed and temporary line marking and traffic control devices used to maintain existing road network functionality during construction.

Temporary traffic facilities

Where significant volumes of traffic would be generated by site activities, temporary traffic facilities, would be required to ensure safe and efficient entry and egress for construction vehicles: These would include:

- Right turn bays.
- Traffic signals.
- Roundabouts.

Tie-ins

A temporary tie-in with Toolijooa Road and the existing highway would be provided as part of the Gerringong upgrade. It would be about 800 metres in length and would remain in place until the completion of the Toolijooa Road interchange.

A tie-in would also be constructed south of Schofields Lane, where the project finishes, to safely transition highway traffic from the four lane configuration back to the existing two lane highway configuration. The tie-in would be about 230 metres in length and would remain until the proposed future upgrade of the highway south of the project (the Berry to Bomaderry upgrade) is completed.

Temporary utility diversions

Construction staging may be such that utilities would need to be removed from their current alignment and placed on a temporary alignment for a significant duration of the works (refer to **Section 4.2.10**).

Haulage roads

Where possible, the proposed alignment would be used for mass haulage of materials. Once the alignment is cleared of vegetation, internal haulage routes would be established to link excavation sites and construction compounds to the various work areas. The location of haulage roads would be limited to the proposed alignment and corridor, including where the new alignment would utilise the existing road corridor. This may require the introduction of temporary traffic management measures.

The existing highway would be used by construction traffic and local roads including Woodhill Mountain Road and Kangaroo Valley Road may be used to access ancillary facilities. This is discussed in **Section 7.1**.

4.4.9 Construction work hours

Standard construction hours in NSW are between:

- 7am and 6 pm Monday to Friday
- 8am and 1pm Saturday.

RMS is seeking approval for standard construction hours plus additional time at the start and end of each day (extended construction hours). Extended construction hours would apply across the project, except in close proximity to the Berry township. Targeted consultation has already been undertaken with affected residents.

Out of hours works would also be required. Work outside of standard construction hours and extended construction hours would be undertaken in accordance with approvals and notification requirements of any Environmental Protection Licence for construction of the project.

Extended construction hours and out of hours works are discussed further below.

Extended work hours

When required, certain activities would be undertaken during extended construction hours as follows:

- Between 6am and 7pm Monday to Friday for the noise catchments including Toolijooa cut, Broughton Creek floodplain to about Tindalls Lane; and major bridge works (outside Berry township).
- Between 8am and 5pm on Saturdays for the noise catchments including Toolijooa cut, Broughton Creek floodplain to about Tindalls Lane; and major bridge works (outside Berry township).
- Outside of known likely major traffic peaks (such as avoiding the Friday evening prior to a public holiday long weekend).

It is not proposed to undertake work during extended working hours in close proximity to the Berry township. Construction work hours, extended working hours and out of hours work are discussed further at **Section 7.2.4**.

Activities that would be undertaken during these extended construction periods are as follows, and potential noise impacts are described and assessed in **Section 7.2**.

- Compound operation and general office duties.
- Maintenance activities.
- Deliveries of materials, such as large pre-cast concrete components.
- Haulage of material.
- Concrete works including pouring, curing and concrete cutting where required.
- Pile driving and/or boring at bridges, excluding bridge at Berry.
- Finishing works.
- Earthworks, including haulage placement and compaction.
- Drilling, haulage and rock crushing activities associated with blasting activities at Toolijooa Ridge.
- Completion of tie-ins at interchanges, temporary traffic facilities and traffic switches to enable highway traffic flows to be maintained during construction.
- Placement of bridge girders where proposed bridges cross operating roadways.
- Utility adjustments where required

Extended construction hours at the start and finish of each working day are considered to be in the public interest as they would:

- Shorten the overall construction period by approximately three months or 10 per cent. This would minimise the disruption to the Princes Highway and improve access to the NSW south coast. It would also minimise impacts to local businesses that may be experienced during the construction period.
- Reduce the publics' exposure to a substandard and inefficient road, reducing the potential for crashes.
- Potentially reduce the overall cost of construction.

Consultation with affected residents would be undertaken prior to work commencing as part of the Construction Noise and Vibration Management Plan. Consultation was undertaken in September 2011, in which feedback generally supported extended hours. The outcome of the consultation is discussed further in **Chapter 6** and **Section 7.2** of this environmental assessment.

Out-of-hours work

Some construction activities would also be undertaken outside of the standard and extended construction hours in the following circumstances:

- If works do not cause construction noise to exceed the noise management levels.
- For the delivery of materials or oversized structural elements such as pre-cast bridge elements, required outside these hours by the police or other authorities for safety reasons.
- Where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm.
- As agreed through negotiations between RMS and potentially affected sensitive receivers. Any such agreement would be recorded in writing and a copy kept on-site for the duration of the works.
- As agreed by the EPA for a specific activity, determined on a case-by-case basis.

Specific activities are described in **Table 4-12**. These would need to be undertaken outside of normal and extended construction hours to ensure road safety, minimise disruption to regional and local traffic flows and/or for technical and timetabling reasons.

A Construction Noise Management Plan and Community Consultation Plan would be prepared to provide a framework for managing out of hours work. This would be implemented in conjunction with the Environment Protection Licence for the project, and would ensure appropriate notification periods are utilised.. All feasible and reasonable mitigation measures would be implemented to ensure that the potential for adverse impact on the local community is minimised.

Table 4-12 Possible out-of-hours construction work.

Activity	Justification
Completion of tie-ins at interchanges and temporary traffic facilities, and completion of temporary diversions and traffic switches.	Completing or installing these items at night when traffic flows on the Princes Highway are lower would minimise disruption to regional and local traffic and minimise any potential safety conflict between construction personnel and traffic.
Bridge girder placement where bridges cross operating roadways.	During construction, bridge girders would be placed across operating roadways. Due to the potential safety risks to road users and construction personnel associated with operating over the existing alignment, these works would need to be undertaken at night when there are lower traffic flows. Avoiding peak periods would also minimise the disruption to traffic.
Delivering large pre-cast concrete components, such as bridge girders.	To minimise disruption to highway and local traffic flows.

Activity	Justification
Concrete cutting	Concrete sampling for quality control purposes requires cutting of cores from the concrete pavement. Depending on the hardening rate of the concrete, core sampling may require cutting any time within four and 24 hours after the concrete pavement is laid. RMS specifications state the timing requirements for concrete sampling after it has been laid and this may need to be undertaken outside normal construction hours. Construction compounds would also need to be operational during this period to support these activities.
Concrete pouring/curing	Similar to the requirements for concrete cutting, RMS has specifications for the placement of concrete that relate to temperature and rainfall. Specifically, concrete pouring and curing cannot occur when the temperature is below 5˚C or above 38˚C, and concrete, when curing, cannot be exposed to rain. Average temperatures for the region do not fall below or above these temperatures, however the frequency of rain events may require more intensive concrete pour/curing activity during periods of good weather.
Utility adjustments	Utility adjustments typically need to be undertaken during out of hours work periods to minimise the impact on consumers, road traffic and ensure the safety to improve the safety of workers involved.
Refuelling operations and maintenance	To maximise the plant and machinery operations during the recommended standard hours, and thus reduce the overall duration of the project, refuelling operations of plant and machinery are proposed at: • 5am to 7am Monday to Saturday or • 6pm to 9pm Monday to Friday or • 1pm to 9pm Saturday.

4.4.10 Staging

The construction activities required for the project would pose a number of staging challenges. Sections involving the widening or duplication of the existing highway pose greater construction and road user management challenges. They would require the widening of road shoulders, temporary ramps and traffic switches to enable the highway to remain open during construction.

Other than the partial use of completed sections of the highway during construction, it is not intended that completed sections of the project would be opened prior to the completion of the full project.

As a result of these challenges, a number of staging options have been developed. There are currently three potential staging options for the construction of the project which differ in the sequence of construction events but would ultimately deliver the project in the same manner.

The first option would be to deliver the project in four stages based on whether construction would occur on line or off line. The four stages would be based around the following geographical areas:

- Toolijooa Road to Austral Park Road (off line).
- Austral Park Road to the bridge at Berry (on line).
- The bridge at Berry to Kangaroo Valley Road (off line).
- Kangaroo Valley Road to Schofields Lane (on line).

The second option would be to deliver the project in two stages with discrete construction zones within each stage. The zones would be developed with the aim to achieve an earthworks balance (cut equal to fill) across each stage. The two stages would be:

- Toolijooa Road to the eastern end of the bridge at Berry.
- The bridge at Berry to Schofields Lane.

The third option would be to deliver the project through a series of early works packages followed by a remaining road works package. The road works package would be delivered in a similar way to option two, with stages and construction zones developed to achieve balanced earthworks:

- Construction of the Toolijooa Road interchange.
- Construction of all bridges.
- Remaining road works:
  - Toolijooa Road interchange to the eastern end of the bridge at Berry.
  - The bridge at Berry to Schofields Lane.

Further details of each staging option are provided in the concept design report for the project which is available on the project website (www.rms.nsw.gov.au/fbb). The final staging strategy would be determined prior to construction.

5 Assessment process

5.1 Approval framework

5.1.1 Environmental Planning and Assessment Act 1979

RMS is seeking project approval for the proposed Foxground and Berry bypass section of the Princes Highway upgrade under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

The Minister for Planning and Infrastructure declared under the then Section 75B of the EP&A Act, by Order published in NSW Government Gazette No. 114 on 10 September 2010, that development for the purpose of the Foxground and Berry bypass is a project to which Part 3A of the EP&A Act applies. A copy of the order is in **Appendix B**.

The NSW Government repealed Part 3A of the EP&A Act on 1 October 2011 and put in place Part 5.1 of the EP&A Act with associated transitional arrangements. The transitional arrangements under Schedule 6A of the EP&A Act provide that the project is a transitional major project to which Part 3A of the EP&A Act continues to apply.

On 24 October 2012 the *Environmental Planning and Assessment Amendment (Transitional Part 3A Projects) Regulation* 2012 came into force. This amendment introduces a revised cut-off date for an environmental assessment report to be submitted, failing which a project ceases to be a transitional Part 3A project. Revisions to the period for a response to issues raised in submissions, for preferred project reports and for a revised statement of commitments were also made.

The Director-General's environmental assessment requirements (DGRs) for the project were issued on 11 February 2011, prior to the repeal of Part 3A.

The approval of the Minister for Planning and Infrastructure is required to carry out the project.

The approval process is illustrated in **Figure 5-1**.

5.2 Environmental planning instruments

5.2.1 State Environmental Planning Policies (SEPPs)

The repealed Section 75R(3) of the EP&A Act continues to apply to transitional major projects. This section excludes the application of the provisions of environmental planning instruments (other than State Environmental Planning Policies (SEPPs)) to approved projects.

However, in deciding whether or not to approve the carrying out of a project, the Minister for Planning and Infrastructure may (but is not required to) take into account the provisions of any environmental planning instrument that would not (because of section 75R) apply to the project if approved. These include:

State Environmental Planning Policy (Infrastructure) 2007

State Environmental Planning Policy (Infrastructure) 2007 (ISEPP) aims to facilitate the effective delivery of infrastructure across the State. Clause 94 of ISEPP permits development on any land for the purpose of a road or road infrastructure facilities to be carried out by or on behalf of a public authority without consent. However the project was declared to be subject to Part 3A of the EP&A Act and will require project approval from the Minister for Planning and Infrastructure.

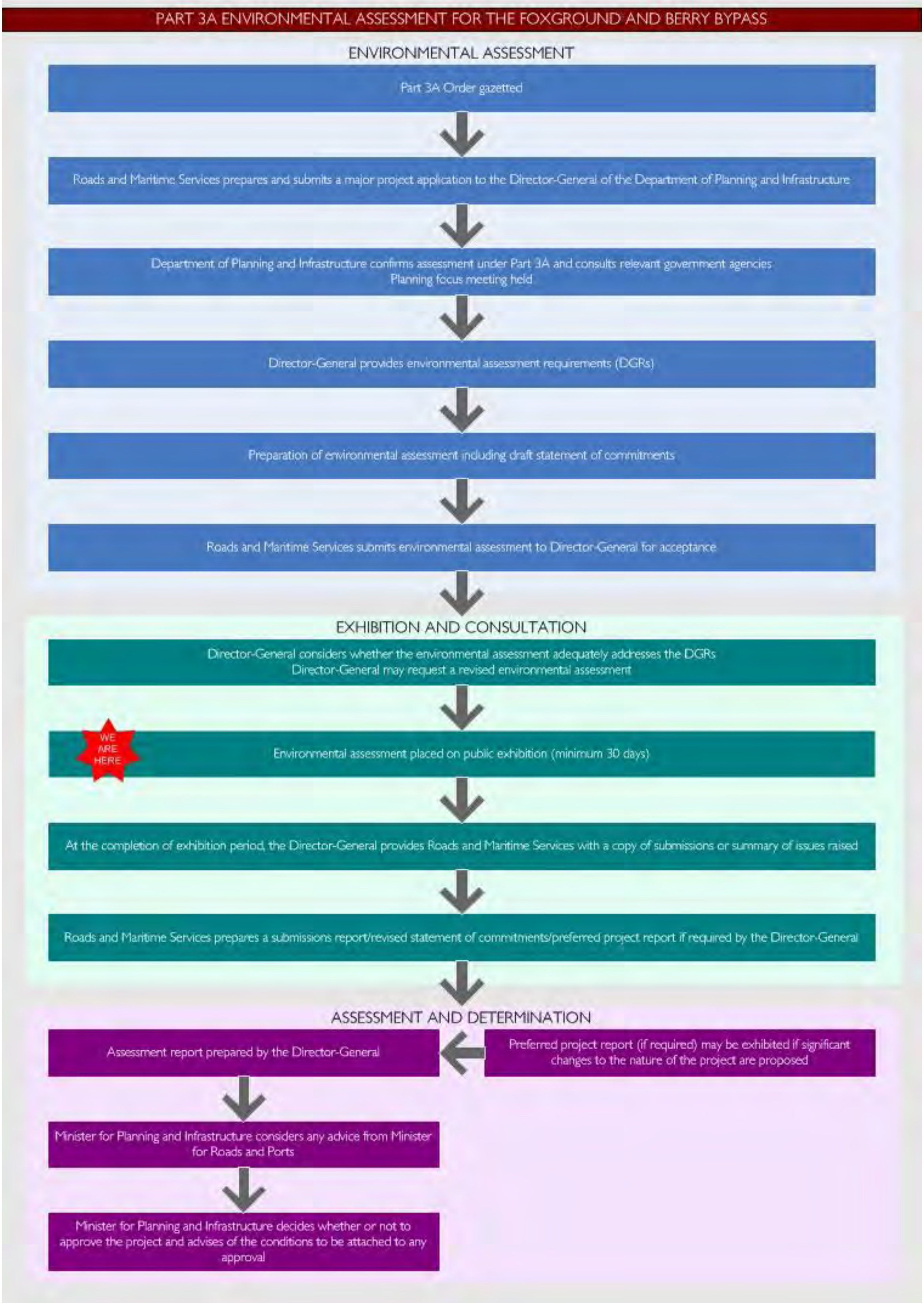

Figure 5-1 Environmental assessment process for the project

State Environmental Planning Policy (Rural Lands) (2008)

While the SEPP does not apply to the consideration of a Part 3A project, the principles in clause eight have been considered in this report in **Section 7.9**. The project is considered to be generally consistent with these principles.

State Environmental Planning Policy No. 44 – Koala Habitat Protection

State Environmental Planning Policy No 44 – Koala Habitat Protection (SEPP 44) does not apply to the project as the project does not require development consent from council. However in accordance with best practice SEPP 44 has been considered. The Minister for Planning and Infrastructure may take into account SEPP 44 when deciding to approve the project. SEPP 44 is considered further in **Section 7.3.**

Illawarra Regional Environmental Plan No. 1 (now a deemed SEPP)

The *Illawarra Regional Environmental Plan No.1*, a deemed SEPP, applies to land in the Kiama and Shoalhaven local government areas (LGAs). The aim of the SEPP is to maximise the opportunities for the people of the region and the State to meet their individual and community, economic and social needs. As the project is a transitional Part 3A project, this SEPP is not applicable. However the impacts on biodiversity and the visual landscape have been considered in **Section 7.3, Section 7.4 and Section 7.6**. Impacts on rural lands have been considered in **Sections 7.9** and **7.10**.

5.2.2 Local Environmental Plans and draft Local Environmental Plans

Local environmental plans (LEP) do not apply in respect of an approved Part 3A project. The Minister for Planning and Infrastructure may take into account the provisions of the LEPs when deciding whether to approve the project under Part 3A. The project lies within two LGAs, the Kiama LGA to the north and the Shoalhaven LGA to the south.

The relevant provisions of the following LEPs are considered in **Section 7.9**.

- *Kiama LEP 2011.*
- *Shoalhaven LEP 1985.*
- *Draft Shoalhaven LEP 2009.*

Under these LEPs and draft LEPs, roads are permitted with consent in all land use zones through which the project passes.

The Minister for Planning and Infrastructure may take into account the objectives of the LEPs when deciding to approve the project.

Environmental planning instruments are further discussed in **Section 7.9** - Land use and property.

5.3 Other legislation

5.3.1 NSW legislation

A number of approvals are not required for a transitional project approved under Part 3A of the EP&A Act (EP&A Act s.75U). These include:

- A permit under section 201, 205 or 219 of the *Fisheries Management Act 1994.* These types of permit would be required for a project (that is not subject to Part 3A of the EP&A Act) where dredging or reclamation and/or impacts to marine vegetation are proposed as part of a project. It would also be required where fish passage would be temporarily blocked.

  Although these permits are not required for this project, the assessment of potential impacts on aquatic species and habitats are discussed further in **Section 7.3**.

- An approval under Part 4 or an excavation permit under section 139 of the *Heritage Act 1977.* An excavation permit would be required for a project (that is not subject to Part 3A of the EP&A Act) where there is the potential to impact on relics not listed on the State Heritage Register or protected by an Interim Heritage Order.

  Although this type of permit is not required for this project, the potential impacts on relics by the project are discussed further in **Section 7.8.**

- An Aboriginal heritage impact permit under section 90 of the *National Parks and Wildlife Act 1974.* A permit would be required for a project (that is not subject to Part 3A of the EP&A Act) where there is the potential to impact a specified Aboriginal place or object.

  Although this type of permit is not required for this project, the impacts on Aboriginal places and objects by the project are discussed further in **Section 7.7**.

- A water use approval under section 89, a water management work approval under section 90 or an activity approval (such as creek or stream diversion) under section 91 of the *Water Management Act 2000.* Water use approvals would be required for a project (that is not subject to Part 3A of the EP&A Act) where the use of water for a particular purpose at a particular location is proposed. Likewise, a water supply, a drainage supply and/or a flood work approval would be required for a specified work at a specified location, or where aquifer interference activities would be required as a result of a project.

  Although this type of permit is not required for this project, the impacts on surface water and groundwater by the project are discussed further in **Section 7.4**.

Approvals under other NSW legislation that may apply to the project include:

- An environmental protection licence for road construction under Chapter 3 of the *Protection of the Environment Operations Act 1997*. In accordance with section 75V(1) of the EP&A Act, such a licence cannot be refused for an approved project and is to be substantially consistent with the Part 3A approval. This is discussed further in **Chapter 4**, Description of the project.

Other legislation that may apply to the project includes:

- *Land Acquisition (Just Terms Compensation) Act 1991* – applies to the acquisition of any land required for the project. Acquisitions are further discussed in **Section 7.9**.

5.3.2 Commonwealth legislation

Under the *Environment Protection and Biodiversity Act 1999* (EPBC Act) proposed 'actions' that have the potential to significantly impact on matters of national environmental significance, the environment of Commonwealth land or that are being carried out by a Commonwealth agency must be referred to the Commonwealth Government. If the Commonwealth Minister for Sustainability, Environment, Water, Population and Communities determines that a referred project is a "controlled action", the approval of that minister would be required for the project in addition to the NSW Minister for Planning and Infrastructure's approval.

An assessment of this project's potential impact on threatened species and migratory species (as discussed in **Section 7.3**) found that there is unlikely to be a significant impact on this matter of national environmental significance. The project would not significantly impact any other matter of national environmental significance or the environment of Commonwealth land. Accordingly, the project has not been referred to the Commonwealth Government Department of Sustainability, Environment, Water, Population and Communities.

6 Consultation

This chapter provides an overview of the consultation activities that have been, and will continue to be, carried out for the project. It also addresses the Director-General's requirements (DGRs) for community consultation which are shown below.

Director-General's requirements	Where addressed
Undertake an appropriate and justified level of consultation with relevant parties during the preparation of the EA, including:	Section 6.2 Table 6-1 Appendix C
• *Local, State or Commonwealth government authorities and service providers, including the NSW Office of Environment and Heritage, the NSW Office of Water, the Department of Trade and Investment, Regional Infrastructure and Services, Shoalhaven City Council, Shoalhaven Water and Kiama Municipal Council*	Section 6.2 Table 6-2 Table 6-3 Section 6.2.3 Appendix C
• *Specialist interest groups including Local Aboriginal Land Councils*	Table 6-5 Table 6-6 Section 6.2.3 Section 6.2.4 Appendix C
• *The public, including affected landowners*	Section 6.2 Table 6-4 Appendix C
The EA must describe the consultation process, document all community consultation undertaken to date and identify the issues raised (including where these have been addressed in the EA).	Chapter 6 Appendix C

RMS considers that meaningful and engaging community consultation is an essential component of the project. Community and stakeholder engagement for the project has been prepared in accordance with:

- *Community participation and communications: A resource manual for staff 2010* (RTA, 2010).
- *Guidelines for Major Project Community Consultation* (Department of Planning, 2007).
- *IAP2 Spectrum of Public Participation* (International Association for Public Participation, 2007).
- DGRs for the project (issued on 27 May 2011).

Community and stakeholder engagement commenced in March 2006, during the route option development process for the Princes Highway upgrade from Gerringong to Bomaderry. Following the announcement of the preferred route in June 2009, community consultation for the project has included:

- Public display of the preferred option and preferred Berry township access arrangements.
- Meetings with government agencies including NSW Office of Environment and Heritage (OEH), Industry and Investment NSW (I&I (now Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS)), Department of Planning and Infrastructure (DP&I), NSW Office of Water (NOW) and Southern Rivers Catchment Management Authority (CMA).
- Consultation with the local fishing community about potential impacts on recreational fishing access and opportunities in Broughton Creek, Broughton Mill Creek and Bundewallah Creek, including consultation with 13 local fishing clubs via letter and invitation to comment.
- Interviews with potentially directly affected and potentially indirectly affected property owners to discuss the development of Berry township access options (43 interviews), potential impacts of construction noise / proposed extended working hours (37 interviews), the review of the Berry bypass alignment / Berry (south) interchange (27 interviews) and potential impacts on individual properties (21 interviews).
- Sixteen Aboriginal Focus Group (AFG) meetings.
- Meetings with specialist interest groups, including:
  - Berry Landcare.
  - Southern Rivers CMA.
  - National Trust of Australia.
  - Berry and District Historic Society.
  - Shoalhaven Historical Society.
  - Berry Chamber of Commerce.
  - Camp Quality.
  - Berry Rural Co-operative Society.
  - PHocus task force of the Southern Councils Group.
  - Berry Alliance.
  - Better Options for Berry.
  - North Street Corridor Amenity Group.
  - Residents of Huntingdale Park and surrounds.
  - Berry Equestrian Club.
- Seven meetings with a community review group (see **Section 6.2.3** for details) which included about 20 representatives from:
  - Better Options for Berry.
  - Berry Chamber of Commerce.
  - North Street Corridor Amenity Group.
  - Representative of the local member for Kiama, Gareth Ward.
  - Landowners in the study area identified at the start of the review process.
  - Shoalhaven City Council.
  - South Coast Dairy.

- Publication of the *Berry bypass alignment issues report* in January 2012 summarising issues raised by the community during the public display of the revised Berry bypass alignment and Berry (south) interchange.
- Telephone calls to residents on Huntingdale Park Road and Kangaroo Valley Road to advise them of amendments to Berry (south) interchange.
- Community meeting to discuss the revised Berry bypass alignment.
- Public display and comment period for the revised Berry bypass alignment.
- A total of 13 meetings with four separate community working groups (see **Section 6.2.3** for details) on community and design issues for the Foxground and Berry bypass:
  - North Street precinct (three working group meetings).
  - Austral Park Road interchange and heavy goods vehicle rest area working group (two working group meetings and, one site meeting and a site visit to review wildlife corridors).
  - Berry north interchange and the bridge at Berry (three working group meetings).
  - Kangaroo Valley Road interchange and Victoria Street precinct (five working group meetings).
- Costing review for a southern Berry bypass option (see **Section 6.2.3** for details).
- Telephone calls to potentially directly affected property owners and potentially indirectly affected property owners to advise NSW Government's decision to progress with a northern alignment for the Berry bypass.
- Distribution of community updates and 'letters to the householder'.

6.1 Consultation objectives and strategy

6.1.1 Consultation objectives

Community and stakeholder engagement aims to provide genuine opportunities for community and stakeholder involvement. Throughout all stages of the project, the objectives are to:

- Support and maintain the current RMS community involvement process.
- Ensure an open, accountable and transparent community involvement process.
- Ensure potentially directly affected property owners and interested stakeholders are provided with sufficient information about the project and the likely impacts so that they can provide informed input.
- Ensure appropriate and direct communication with property owners in relation to access to and investigations on landholdings within the project by study team members.
- Encourage community involvement in the project to facilitate better and more generally accepted outcomes through innovative communication methods such as 3D animations incorporating fly over and drive throughs of the project.
- Provide a range of accessible opportunities for stakeholders, interest groups and the wider public to contribute to the project through issues identification and information provision, including staffed displays, community information sessions, workshops, and print and web based information materials.
- Build an ongoing relationship with the community and stakeholders to gain long-term support for the project.

6.1.2 Consultation strategy

Community involvement has been an integral component in the development of the project. At each stage, RMS has proactively engaged with the community and stakeholders with the aim of increasing public understanding of, and participation in, the development of the project. The project has benefited from the input of local knowledge and priorities, which has helped to identify issues, potential mitigation strategies and opportunities to improve project outcomes.

6.2 Consultation process and activities to date

6.2.1 Stakeholders

Stakeholders were identified from consideration of the project's potential direct and indirect impacts and from records of past and current contact with relevant government bodies, Princes Highway upgrade stakeholders and interest groups.

Stakeholders were grouped into the following categories:

- Potentially directly affected property owners.
- Interest groups, such as community and business owners and business groups.
- The Aboriginal community and Local Aboriginal Land Councils.
- Government and non-government agencies.
- The broader community.

A list of stakeholder groups that have been consulted is provided in **Appendix C**, **Table C16**.

6.2.2 Consultation program tools

The following is a summary of the communication and consultation tools established for use across the life of the project. RMS selected and designed these tools guided by consultation with the community from the commencement of consultation at the initial May 2006 workshops. RMS tailored the use of these tools to meet the specific needs of the project. They include:

- Permanent shop front for information at the project office at Broughton Court, 3/113 Queen Street, Berry. During staffed information displays, the project office is generally open from 10am-5pm Monday to Friday. During the remainder of the year it is staffed on Fridays from 10am-5pm or by appointment.
- Toll free community information contact line (1800 506 976).
- Project email (foxgroundandberrybypass@rms.nsw.gov.au).
- Project website (www.rms.nsw.gov.au/fbb).
- Project database to record all correspondence relevant to the project, including contact details and issues raised during the life of the project.
- Registered stakeholder database.
- Quarterly community update newsletter or correspondence.
- Community information sessions and public workshops.
- Targeted focus group workshops.
- Interest group meetings.
- Face-to-face meetings with individual owners / residents of properties that may be directly affected by the project.

- Information displays (staffed and un-staffed).
- Advertisements in the local press.
- Local radio announcements.
- Mail-outs (addressed and un-addressed).
- Letterbox drops.
- Community feedback forms.
- Variable message signs.

Key activities for consultation

An overview of the process and key consultation activities carried out to date is provided in **Table 6.1**. Details for these consultation activities, including dates, locations and times can be found in **Section C1.0** of **Appendix C**.

Table 6-1 Overview of consultation process and activities to date

Project phase	Activity undertaken by RMS	Outcomes
Gerringong to Bomaderry Princes Highway upgrade - March 2006 to August 2007 **Project familiarisation and route option development**	• Consultation conducted for project familiarisation included: **March 2006** - the first community update announced the commencement of the Princes Highway upgrade between Gerringong and Bomaderry and invited community involvement in the options and route selection process. **May 2006** - the first workshops and displays for the project focused on working with the community and stakeholders to establish a set of principles to guide the consultation process and the selection of communication tools. **September 2006** - a planning focus meeting was held attended by representatives of key government agencies, local councils, utility companies and the emergency services. • Consultation conducted as part of the route options selection study included: **February 2007** - community information sessions. **February 2007** and **March 2007** - meetings with Illawarra, Nowra and Jerrinja Local Aboriginal Land Councils. **April 2007** - interest group workshop. **April 2007** - meetings with Kiama Municipal and Shoalhaven City councils. **August 2007** - specialist information sessions. (Specific activity details are reported in Appendix C, Table C-1)	• Consultation identified local priorities for the Princes Highway upgrade between Gerringong and Bomaderry and what was valued by the community. The results are documented in the *Community Consultation Report* (RTA, 2006). This report is available on the project website. • The community and stakeholder perspectives of the options and selection of the short list of options are documented in the *Route Options Development Report* (RTA, 2007). This report is available on the project website.

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Project phase	Activity undertaken by RMS	Outcomes
Project phase	**Activity undertaken by RMS**	**Outcomes**
Gerringong to Bomaderry Princes Highway upgrade - November 2007 to July 2008 **Route options display and value management workshop**	• **November 2007** - the shortlisted route options between Gerringong and Bomaderry were displayed for public comment from 26 November 2007 to 29 February 2008. • **May 2008** - representatives of key government agencies, local councils, the emergency services, the Aboriginal community and the Berry urban and rural communities attended the route options value management workshop attendees reviewed the outcomes of investigations undertaken to date and recommended a direction for further investigation to progress the project development. (Specific activity details are reported in Appendix C, Table C-2)	• Community participation during the public display period resulted in 996 submissions being received. These are documented in the *Route Options Submissions Report* (RTA, 2008). This report is available on the project website. • Community feedback from the public display highlighted the importance of the Berry access arrangements. As a result, a commitment was made to undertake community consultation on the access options for Berry and a value management study to assist in the development and selection of the Berry access arrangements. • Workshop details are published in the *Value Management Workshop Report* (RTA, 2008). This report is available on the project website.
Gerringong to Bomaderry Princes Highway upgrade - October 2008 to December 2008 **Preferred option and Berry access options display and value management workshop**	• **October 2008** - the NSW Government announced the preferred option between Gerringong to Bomaderry and the Berry access options. These were placed on public display from 13 October 2008 to 13 November 2008. The preferred option excluded a section through Toolijooa Ridge which required further investigation. • **November 2008** - an access value management workshop was held with key stakeholders and community members. The workshop was attended by representatives of key government agencies, local councils, the Aboriginal community and the Berry urban and rural communities. • **December 2008** - a meeting was held with representatives from the emergency services to discuss the outcomes of the Berry access value management workshop. (Specific activity details are reported in Appendix C, Table C-3)	• Community participation during the public display period resulted in 303 submissions being received which are documented in the Access Options Submissions Summary Report (RTA, 2009). This report is available on the project website. • The community highlighted the importance of flood free access north and south of Berry during the access value management workshop. Details of the workshop are documented in the Access Value Management Workshop Report (RTA, 2009). This report is available on the project website.

Project phase | Activity undertaken by RMS | Outcomes

Project phase	Activity undertaken by RMS	Outcomes
Gerringong to Bomaderry Princes Highway upgrade - June 2009 **Preferred option and preferred access options announced**	• June 2009 - the preferred option with the preferred access arrangements for Berry was finalised. • The finalised preferred option was publicly displayed from 15 June 2009 to 26 June 2009. (Specific activity details are reported in Appendix C, Table C-4)	• A summary of design developments for the Berry access arrangements (arising since the access value management workshop) was published in the Gerringong and Berry Preferred Access Arrangements Report (RTA, 2009). The report is available on the project website. • A summary of findings on the investigations and analysis of the Toolijooa Ridge options was published in the *Toolijooa Ridge Preferred Option Report* (RTA, 2009). This report is available on the project website.
Foxground and Berry bypass - December 2010 **Proposed changed access arrangement at Kangaroo Valley Road** **Proposed changes to Berry access arrangements**	• December 2010 - project team telephoned 25 residents whose properties may be potentially directly affected or potentially indirectly affected by the proposed four way arrangement at Kangaroo Valley Road. These property owners were offered a meeting with the project team. • Representatives of Shoalhaven City Council and Berry Alliance were also contacted. • Additionally, each property owner was mailed a copy of the community update. • Posters were displayed in the Berry project office. • December 2010 – The then Local Member announced the revised proposed four way movement arrangement at Kangaroo Valley Road intersection which would replace the proposed Alexander Street off-ramp. • A community update showing the old and new proposed access arrangements was published. • Posters were displayed in the Berry project office • Project update emails were sent to 400 stakeholders registered on the project database.	• Concerns from 19 residents, including property access, proximity of traffic to dwellings, increased traffic and noise as a result of the proposal were noted. • These issues were fed into the community review group process (see Section 6.2.3).

Project phase	Activity undertaken by RMS	Outcomes
Project phase	**Activity undertaken by RMS**	**Outcomes**
Foxground and Berry bypass - May to July 2011 **Development of the environmental assessment for Foxground to Berry bypass**	• **May 2011** - a letter was sent to 13 recreational fishing clubs in the area requesting information on access and opportunities for recreational fishing in Broughton Creek, Broughton Mill Creek and Bundewallah Creek in the vicinity of the Princes Highway. Some of these clubs were sourced from the NSW Department of Primary Industries Fishing and Aquaculture. (Specific activity details are reported in Appendix C, Table C-5)	• Responses were received from Illawarra Fishers' Club, Gerringong Hotel Fishing Club and Southern Bass Fishing Club and the NSW Department of Primary Industries Fishing and Aquaculture. • (Issues raised in submissions are reported in **Section 6.2.5**).
Foxground and Berry bypass - August to November 2011 **Berry bypass community review group process and meetings**	• **August 2011** - RMS invited interested members of the community to be part of a new Berry bypass community review group. • Between **August and November 2011** seven community review group meetings were held to examine the Berry bypass design and consider how to improve it. Further information about the group and process is contained in the *Community Review Group Option Review Report,* 6 December 2011. This report is available on the project website. • Statements from each of the meeting proceedings were published on the project website and placed in the *South Coast Register* and *Berry Town Crier*. (Specific details of the community review group activities are reported in Appendix C, Table C-7)	• The community review group process was a key component of the revised alignment and design for the Berry bypass. (Issues raised in submissions are reported in **Section 6.2.3**).
Berry bypass revised alignment	• **September 2011** - Distribution of 3500 'letters to the householder' to inform Berry residents of the Berry bypass alignment review and process. This letter is available on the project website.	• The broader community were kept informed regarding the community review group, the process for reviewing the Berry bypass alignment and next steps.

Project phase	Activity undertaken by RMS	Outcomes
Foxground and Berry bypass - September 2011 **Development of the environmental assessment for the Foxground to Berry bypass**	• **September 2011** - a total of 49 privately owned properties from Toolijooa Road to northern Berry were identified as being potentially impacted by construction noise. The project team contacted 44 property owners by telephone, and sent letters to five properties with no telephone numbers listed. The project team has met with 37 individual property owners to discuss potential impacts of construction noise and proposed extended working hours. (Specific activity details are reported in Appendix C, Table C-6)	• Potential construction impacts included property access, noise, vibration and dust. (See **Section 6.3.3**).
Foxground and Berry bypass - November 2011 **Berry bypass revised alignment and Berry (south) interchange**	• **1 November 2011** - Telephone calls were made to 38 residents along North Street to offer an interview with the project team to discuss the revised alignment. • **8 November 2011** - 'Letters to the householder' were distributed to residents of the North Street precinct to provide an update regarding a proposed series of urban design workshops. • **30 November 2011** - Telephone calls were made to 17 residents of Huntingdale Park Road and Kangaroo Valley Road to advise of revised alignment announcement and offer a meeting with the project team.	• 19 one-on-one interviews were held by the project team with residents from North Street to discuss individual property issues. • The broader community were informed of the proposed process for urban design elements associated with the North Street precinct. • Two one-on-one interviews were held by the project team with residents from Kangaroo Valley Road to discuss individual property issues.
Foxground and Austral Park Road interchange	• **25 November 2011** - meeting with residents of Broughton regarding issues related to Austral Park Road and the heavy vehicle rest area that was part of the project.	• Information obtained regarding residents' views on issues related to the heavy vehicle rest area that was part of the project and Austral Park Road realignment. Some design changes developed.

Project phase	Activity undertaken by RMS	Outcomes
Project phase	**Activity undertaken by RMS**	**Outcomes**
Foxground and Berry bypass - December 2011 to January 2012 **Public announcement and display of Berry bypass revised alignment and Berry (south) interchange**	• **1 December 2011** – Distribution of 'letters to the householder' to residents of Huntingdale Park Road and surrounds regarding the proposed changes to Huntingdale Park Road interchange. This letter is available on the project website. – Publication and distribution of community updates announcing details of the community meeting and the revised Berry bypass alignment. This community update is available on the project website. – Project update emails were sent to 400 stakeholders registered on the project database. – The project website was updated to include details of the revised alignment, community meeting and public display period.	• On 11 January 2012 the preferred alignment and design for the Berry bypass and the Berry (south) interchange was updated as a result of the last six months work. • The RMS published the *Berry bypass alignment issues report* (RMS, 2012) summarising the issued raised during the display. The report is available on the project website. (Specific details of the issues raised in submissions are reported in **Section 6.3.3**)
Public display	• **1 December to 14 December 2011** - Public display of the revised alignment at the Berry project office from 10am to 5pm Monday to Friday (extended to 8pm on 7 December) and 10am to 2pm Saturdays.	
Community meeting	• **30 November to 7 December 2011** - Electronic message signs were placed at the northern and southern ends of Berry to advertise the date, time and location of the community meeting. • **2 December to 5 December 2011** - Newspaper advertisements announcing the community meeting were placed in the *South Coast Register*, *Nowra News* and the December issue of *Berry Town Crier*. • **1 December to 6 December 2011** - Radio advertising on i98FM, 96.5FM, 2ST AM and PowerFM announcing community meeting.	

Project phase | Activity undertaken by RMS | Outcomes

Project phase	Activity undertaken by RMS	Outcomes
Foxground and Berry bypass - December 2011 to January 2012 **Community meeting cont'd** **Announcement of the update to the Berry bypass preferred alignment and Berry (south) interchange posted**	• **3 December 2011** - door knocking of residences along North Street and adjacent streets to advise date and time of community meeting. • **6 December 2011** - Community meeting to discuss the revised Berry bypass alignment opened by the Member for Kiama at the Berry School of Arts from 6.30pm to 8.30pm. More than 250 attendees. • **11 January 2012** - Community update announcing the update to the Berry bypass preferred alignment and Berry (south) interchange posted on the project website. – Email alerts sent to registered stakeholders on the project database – Publication of the *Berry bypass alignment issues report* January 2012 on the project website.	
Foxground and Berry bypass – January 2012 to August 2012 **Establishment of community working groups**	• **20 January 2012** - RMS invited members of the community to register interest in attending working groups to review community and design issues relating to the Foxground and Berry bypass. Invitations to join the working groups were advertised on the project website, by email to registered stakeholders, in the project office and in the *South Coast Register* and *Berry Town Crier.*	• Presentation material, handouts and meeting notes from each of the working group meetings were published on the project website. (Specific details of the issues raised during the working group meetings are reported in **Section 6.3.3**)

Project phase	Activity undertaken by RMS	Outcomes
Project phase	Activity undertaken by RMS	Outcomes
Foxground and Berry bypass – January 2012 to July 2012 **Community working group meetings**	• **8 February 2012** - The first working group meeting was held with registered stakeholders. Four separate working groups were formed. – North Street precinct working group. – Austral Park Road interchange and heavy vehicle rest area working group. – Berry north interchange and the bridge at Berry working group. – Kangaroo Valley Road interchange and Victoria Street precinct working group. • RMS convened four separate working groups of registered community members with meetings held on: – **29 February, 2 April and 14 May 2012**, North Street precinct working group. – **5 March and 16 April 2012**, Austral Park Road interchange and heavy vehicle rest area working group. – **7 March, 28 March and 2 May 2012**, Berry bridge and northern interchange working group. – **8 March, 29 March, 17 April, 16 May and 25 July 2012**, Kangaroo Valley Road and Victoria Street precinct working group. – **10 March 2012**, meeting and site visit by RMS and residents to review wildlife corridors located near the Austral Park Road interchange. • Advertisements for each working group were posted on the project website, sent by email to registered stakeholders and advertised in the project office. (Specific activity details are reported in Appendix C, Table C-8)	

Project phase	Activity undertaken by RMS	Outcomes
Foxground and Berry bypass – December 2011 to July 2012 **Southern Berry bypass cost review**	• **December 2011** – RMS received a community submission for a southern alignment suggestion. • **February 2012** – The Minister for Roads and Ports requested RMS conduct a detailed cost evaluation of a southern Berry bypass route. • **February to June 2012** – RMS undertook technical investigations in its preparation of two feasibility estimates, during which the following community question and answer sessions were held: – **16 February 2012,** Question and answer session #1. – **1 March 2012,** Question and answer session #2. – **19 March 2012**, Question and answer session #3. – **30 April 2012,** Question and answer session #4. – **3 July 2012,** Question and answer session #5. • **25 June 2012** – The Minister for Roads and Ports announced the preferred northern alignment as the Berry bypass route. This announcement was followed by the fifth community question and answer session held **3 July 2012**. – Email alerts sent to registered stakeholders on the project database. – The project website was updated to include details of the preferred alignment. (Specific activity details are reported in Appendix C, Table C-9)	• Presentation material, handouts and meeting notes from each of the question and answer sessions were published as part of weekly project website updates. • Review details and findings were published in the *RMS report on route feasibility comparative cost estimates*, June 2012 and the *Report on external review of the technical investigation group findings*, June 2012. These reports are available on the project website.

6.2.3 Review of the Berry bypass

Community review process – Berry bypass alignment and Berry (south) interchange

In August 2011, the Member for Kiama announced a review of the Berry bypass section of the project in the area immediately north of Berry.

RMS committed to a re-examination of the concept design in this area in collaboration with the community and commenced a process of consultation to re-examine the Berry bypass alignment to the north of Berry. The process is outlined in **Figure 6-1**.

A community review group was formed on 24 August 2011, comprising some 20 individuals considered by RMS to be directly impacted by the alignment. RMS contacted individuals by telephone to invite them to the first community review group meeting. Nominations were accepted by RMS for inclusion in the group prior to and during the first meeting. The community review group was composed of directly affected landholders, community members and representatives from community and stakeholder groups including:

- Better Options for Berry.
- Berry Chamber of Commerce.
- North Street Corridor Amenity Group.
- Representative of the local member for Kiama, Gareth Ward.
- Landowners in the study area identified at the start of the review process.
- Shoalhaven City Council.
- South Coast Dairy.

Communication and consultation activities undertaken

The objectives of the consultation activities undertaken during the review of the Berry bypass alignment were to:

- Inform the community that RMS was committed to a process to re-examine the Berry bypass route to the north of Berry in collaboration with the local community.
- Work with the local community to identify and address the issues of a bypass in the study area.
- Work collaboratively with the community to examine the design from just south of Tindalls Lane to the Kangaroo Valley Road interchange and consider how to improve it.
- Engage the local community and stakeholders in the process and discuss next steps in developing a revised alignment.
- Offer the community and stakeholders an opportunity to provide feedback, ask questions and identify areas of concern with respect to the Berry bypass.

Detailed information about the Berry bypass community review group and the collaborative process undertaken to revise the alignment is in the *Report on Princes Highway upgrade Berry bypass, community review group option review* dated 6 December 2011. This report is available on the project website.

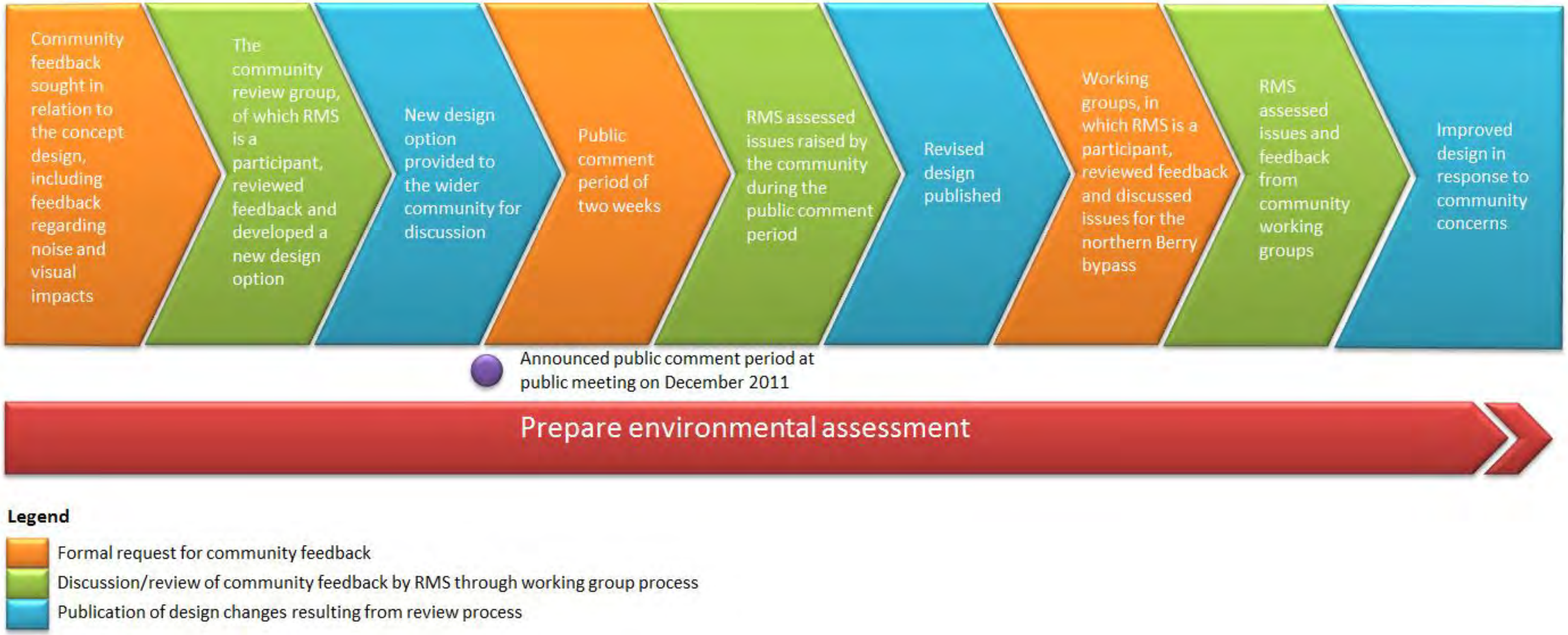

Figure 6-1 Community consultation process undertaken during the review of the Berry bypass alignment August 2011 to June 2012

Between August and November 2011, seven community review group meetings were held to examine the design of the Berry bypass and consider how to improve it. RMS worked closely with the community review group to develop options in detail. The meetings focussed on improving the aesthetics and form of the bridge at Berry, keeping the overall alignment as low as feasible and increasing the buffer zone between Berry and the bypass as much as possible, in order to minimise environmental and community impacts.

The review considered input from technical studies, independent experts and written submissions from the community. Updates documenting the meeting proceedings were published to inform the wider community. The review process also included two separate one-day workshops to carry out a detailed independent specialist review of the alignment and design of the bridge at Berry and the northern interchange. The review was attended by representatives of RMS, independent industry experts and representatives from the community review group. The independent specialists were from Mott McDonald, Conybeare Morrison, Aurecon, Baulderstone and Evans and Peck.

Consultation activities were undertaken from 11 August to 14 December 2011 to provide information about the alignment review process and subsequent public display period for the revised alignment. Complete details of the consultation activities can be found in **Appendix C**, **Table C-7**.

A summary of issues raised and the location of relevant discussion in this environmental assessment is provided in **Section 6.3.3**.

Further information can be found in the *Berry bypass alignment issues report*, December 2011 which is available on the project website.

Community working groups – Foxground and Berry bypass

In January 2012, RMS invited community members to register their interest in attending a series of working group meetings to review community and design issues relating to the northern Berry bypass alignment. The working groups were formed to progress and develop community issues raised in the *Berry bypass alignment issues report*, January 2011.

On 8 February 2012, the first working group meeting was held with registered stakeholders. Invitations to join the working group were advertised on the project website, sent by email to registered stakeholders, displayed in the project office and published in the *South Coast Register* and the *Berry Town Crier*. Four separate working groups were formed with the following meetings held between February 2012 and August 2012:

- Five working group meetings to discuss the Kangaroo Valley Road interchange and Victoria Street precinct.
- Three working group meetings to discuss the North Street precinct.
- Three working group meetings to discuss the Berry north interchange and bridge at Berry.
- Two working group meetings to discuss the Austral Park Road interchange and the heavy vehicle rest area.

Discussions held during these meetings included ideas which were considered by RMS' design team during the comparative cost analysis of the southern route (see below).

Meeting notes were published on the project website to inform the wider community and a summary of the discussions and ideas from the meetings was published in the *Berry Town Crier*.

A summary of issues raised and the location of relevant discussion in this environmental assessment is provided in **Table 6.3.3.**

Southern Berry bypass costing review

In February 2012, RMS was directed by the Minister for Roads and Ports to undertake a cost evaluation of a southern Berry bypass route following a suggestion submitted by a community member. The community member suggested that a bypass to the south would provide a direct cost saving and numerous qualitative benefits to Berry over the preferred northern bypass alignment. The proposal suggested that the southern route is a true bypass whereas the northern route divides the older part of Berry from the new development area to the north-west.

RMS formed a group of technical experts to investigate the southern route suggestion. RMS prepared two route feasibility cost estimates for the whole Foxground and Berry bypass project, one incorporating a bypass to the north of Berry and one incorporating a bypass to the south of Berry.

During the investigation process which was carried out between February 2012 and June 2012, RMS carried out the following community consultation activities:

- Held four community question and answer sessions (16 February, 1 March, 19 March and 30 April). Meeting notes were published on the project website.
- Published weekly website updates; including a Regional Manager's message, meeting notes from the technical investigation group, frequently asked questions and a meeting register.
- Published an issues actions and outcomes register which tracked all of the critical technical questions being raised by the community with actions and outcomes.
- Published monthly progress summary advertisements in the *Berry Town Crier* magazine.

On 25 June 2012, the Minister for Roads and Ports announced the northern alignment as the preferred route for the Foxground and Berry bypass project.

The review findings were published in the *Foxground and Berry bypass - Route Feasibility Comparative Cost Estimates* (RMS, June 2012) and the *Foxground and Berry bypass - Route Comparison, External Review of the Technical Investigation Group Findings* (SMEC Australia Pty. Ltd., June 2012). A fifth community question and answer session was held on 3 July 2012, at which subject matter experts, an independent reviewer and the project team were available to answer questions.

A number of design improvements, resulting from community discussions held during the working group meetings were considered during the southern Berry bypass review and incorporated into the preferred northern alignment design.

6.2.4 Aboriginal community and Local Aboriginal Council involvement

RMS has undertaken Aboriginal community consultation and investigation from project commencement in 2006 until November 2011. Up until April 2010, this consultation was undertaken in accordance with the requirements of the *Procedure for Aboriginal Cultural Heritage Consultation and Investigation* (Roads and Traffic Authority (RTA), 2008) and the *Interim Guidelines for Aboriginal Community Consultation* (Department of Environment and Conservation (DEC), 2005).

In April 2010, the OEH published the *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW, 2010). These replaced the *Interim Guidelines for Aboriginal Community Consultation* (DEC, 2005).

In consultation with OEH, RMS transitioned to and has substantially complied with the 2010 guidelines since their commencement. For example, the 2010 guidelines contain some different and additional requirements for consultation, including different advertising and notification requirements for inviting Aboriginal community involvement in the project. Consequently, in accordance with the 2010 guidelines, invitations were sent to the Aboriginal community and other relevant agencies and stakeholders (who hold cultural knowledge relevant to determining the significance of Aboriginal objects and/or places in the project area) to register their involvement in the consultation process.

Advertisements in the Illawarra Mercury (22 June 2011), the National Indigenous Times (23 June 2011), the South Coast Register (24 June 2011) and the Koori Mail (29 June 2011) enabled any new Aboriginal stakeholders in the project to join the AFG and to be included in the project.

RMS has undertaken an ongoing, open and public consultation program with Aboriginal stakeholders since 2006. There are over 110 listed stakeholders for the project, a number of which represent multiple people or groups. The stakeholder list has continued to grow as the project has progressed.

Throughout the life of the project, RMS has notified a variety of organisations about the project including:

- The planning and Aboriginal heritage section of OEH.
- The operations section of OEH.
- NSW National Native Title Tribunal.
- Department of Aboriginal Affairs.
- NSW Heritage Office.
- Southern Rivers CMA.
- Kiama Municipal Council.
- Shellharbour City Council.
- Shoalhaven City Council.
- Wollongong City Council.
- Illawarra Local Aboriginal Land Council.
- Nowra Local Aboriginal Land Council.
- Jerrinja Local Aboriginal Land Council.
- Merrimans Local Aboriginal Land Council.
- Ulladulla Local Aboriginal Land Council.
- Batemans Bay Local Aboriginal Land Council.
- New South Wales Aboriginal Land Council.
- Jerrinja Consultants Pty Ltd.
- South Coast Aboriginal Elders and Friends Group Organisation.
- South East Coast Gadu Elders Aboriginal Corporation.
- Walbunja Aboriginal Corporation.
- Native Title Service Provider for Aboriginal Traditional Owners in NSW (NTSCorp).

Aboriginal stakeholder involvement has included 16 AFG meetings since mid 2006, Aboriginal stakeholder representation at two value management workshops, specific consultation for women's business, targeted consultation with knowledge holders and site walk overs to gather cultural knowledge.

Aboriginal involvement continued through the site investigations and environmental assessment phases of the project and will continue as the project progresses.

Further details of the Aboriginal consultation process and activities, including dates, locations and times can be found in **Appendix C, Section C2.0**.

6.3 Summary of issues raised in relation to the project

Issues identified during the consultation process for the Foxground to Berry bypass by government agencies, local government, the community, Aboriginal community, Local Aboriginal Land Councils and special interest groups have informed the environmental assessment and the ongoing development of the project. A summary of these issues and the locations in the environmental assessment where they are addressed is included below.

6.3.1 Issues raised by government agencies

A list of government agencies consulted over the course of the project and during the preparation of this environmental assessment, and their key issues and requirements are detailed in **Table 6-2**. **Table 6-2** also identifies the section of this environmental assessment that addresses each issue.

Table 6-2 Issues raised by government agencies

Issue category	Details	EA section
Office of Environment and Heritage (OEH) / Environmental Protection Authority (EPA)OEH		
Project description	Describe the construction process.	Chapter 4
Licensing functions	Address the requirements of Section 45 of the *Protection of the Environment Operations Act 1997*.	Chapter 5
Biodiversity	Impacts of the project on threatened species and their habitat, endangered ecological communities.	Section 7.3
Aboriginal cultural heritage	Aboriginal cultural heritage values.	Section 7.7
Environmental impacts	Describe the environmental impacts of the project.	Chapter 7 Chapter 8
	Describe all discharges and emissions to the environment.	Chapter 7 Chapter 8
Mitigation measures	Actions that would be taken to avoid or mitigate impacts or compensate to prevent unavoidable environmental impacts.	Chapter 7 Chapter 8
Environmental impacts	Consider air, noise and vibration, water quality, contaminated land, waste and chemicals, soil contamination, threatened species, Aboriginal cultural heritage and cumulative impacts.	Chapter 7 Chapter 8
Guidelines	Identify industry codes of practice and best practice management guidelines to be used as appropriate.	Chapter 7 Chapter 8

Issue category	Details	EA section
Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS)		
Aquatic ecology and water quality management	Potential impacts to the aquatic environment within the development area, during both construction and operational phases.	Section 7.3
	Measures to mitigate, rehabilitate or compensate for impacts should be detailed in accordance with the *Fisheries Management Act 1994* (Parts 7 and 7A) and the associated *Policy and Guidelines for Aquatic Habitat Management and Fish Conservation* (1999) to ensure that there is 'no net loss' of aquatic habitats.	Section 7.3
Aquatic ecology and water quality management	Describe aquatic and riparian environments in the vicinity of the development.	Section 7.3
	Analysis of any interactions of the proposed road works with aquatic and riparian environments and predictions of any impacts upon aquatic and riparian environments from the road works.	Section 7.3
	Describe proposed environmental compensation measures to offset permanent loss of riparian habitats in Broughton Creek, Broughton Mill Creek and Bundewallah Creek.	Section 7.3
	Describe potential impediments to fish passage as a result of the works and possible mitigation measures.	Section 7.3
	Safeguards to mitigate any impacts upon aquatic species, environments and water quality during construction and operation.	Section 7.3 Section 7.4
	Predictions of impacts upon water quality, including in Broughton Creek, Broughton Mill Creek and Bundewallah Creek.	Section 7.4
	Water quality management should be designed to achieve no net increase in pollutant runoff to Broughton Creek, Broughton Mill Creek and Bundewallah Creek.	Section 7.4
Land use and property	Relevant land use planning and development guidelines.	Section 7.9
Socio economic	Assess impacts on recreational fishing in the area, particularly in relation to fishing access arrangements.	Section 7.10
	Farm access and maintaining agricultural activities in the study area.	Section 7.10
Department of Planning and Infrastructure (DP&I)		
Traffic and transport	Local traffic movement changes resulting from the project.	Section 7.1
Terrestrial ecology	Department of Primary Industries, Fisheries to be contacted for input into relocation of Town Creek.	Section 7.3
Aquatic ecology and water quality management	Aquatic habitat impacts from the northern Berry bypass alignment and redirection of Town Creek and proposed compensation offsets.	Section 7.3
Landscape character and visual amenity	Request for visual montages to be provided in the environmental assessment.	Section 7.6

Issue category	Details	EA section
Department of Planning and Infrastructure (DP&I)		
Aboriginal heritage	Consultation with Aboriginal community for input into the relocation of Town Creek.	Section 7.7
Non-Aboriginal heritage	NSW Heritage Office to be contacted for input.	Section 7.8
Socio-economic	Pedestrian connectivity between Kangaroo Valley Road and Berry to be maintained.	Section 7.10

6.3.2 Issues raised by local government

Issues raised by local government during the consultation process are detailed in **Table 6-3**. **Table 6-3** also identifies the section of this environmental assessment that addresses each issue.

Table 6-3 Issues raised by local government

Issue category	Details	EA section
Kiama Municipal Council		
Traffic and transport	Local property access during construction and post construction, with consideration of the need for service lanes.	Section 7.1
	Impact on the local road infrastructure during construction and post construction.	Section 7.1
	Detailed traffic modelling of construction and post construction conditions and the necessary provision of traffic management devices on the local network to accommodate changes.	Section 7.1
	Provision of adequate turning opportunities for emergency service vehicles.	Section 7.1
Noise and vibration	Construction activity issues – noise, vibration and transport.	Section 7.2
Terrestrial ecology – flora and fauna	Broughton Creek is an important wildlife corridor and crossed three times by the current alignment. Consideration of the provision of cattle / wildlife underpasses to maintain the corridors.	Section 7.3
	Impacts on areas of high conservation of threatened species (flora and fauna).	Section 7.3
Flooding	Impact on the local drainage infrastructure during construction and post construction.	Section 7.5
	Impact of filling on drainage paths and potential flooding of local properties.	Section 7.5
	Impact on flood levels for one in 100 year ARI flood events from the new highway alignment over Broughton Creek and effects on properties (change in extent and change in flood levels), structures and property accesses (existing and proposed).	Section 7.5

Issue category	Details	EA section
Kiama Municipal Council		
Landscape and visual amenity	Highway/street lights and impacts on adjacent residents.	Section 7.6
Aboriginal cultural heritage	Impacts on Aboriginal sites.	Section 7.7
Land-use and property	Minimise acquisition of viable agricultural land.	Section 7.9
	Severance of properties and impact on building entitlements.	Section 7.9
	Impact on agricultural land due to the severance of natural groundwater flows eg at the Toolijooa Ridge cut.	Section 7.9
Socio economic	Relocation of existing or provision of additional 'Welcome to Kiama' monument. To be considered in consultation with Kiama Municipal Council.	Section 7.10
Air quality	Management of air quality impacts during construction and post-construction.	Section 8.2
Waste	Disposal of excess material (location and quantities).	Section 8.4
Asset transfer	Road asset and safety audits and/or upgrade of redundant highway sections prior to transfer to council.	Section 4.2.5
Shoalhaven City Council		
Traffic and transport	Alternative arrangement to the proposed turnaround area at CH10950, between Broughton Creek crossing number two and crossing number three.	Section 7.1
	Intersection arrangement at Schofields Lane, south of Berry, to ensure acceptable sight distances. Detail whether the crest would be removed or an acceleration lane provided for traffic exiting Schofields Lane.	Section 7.1
	Inclusion of an acceleration lane at the intersection of Tindalls Lane with the new highway north of Berry for traffic exiting Tindalls Lane, to address sight distance concerns.	Section 7.1
	Suitable bus and garbage truck turnaround area where North Street would connect to Rawlings Lane.	Section 7.1
	Construction impacts on local traffic patterns.	Section 7.1
	Left turn access at Toolijooa Road onto the highway, or to the highway provided to accommodate development at the Toolijooa Road interchange to avoid a reduced level of local road access.	Section 7.1
	Two off-ramps to Berry for traffic entering from the south would be required, including a northbound exit to Berry at Woodhill Mountain Road and a southbound access to the highway from Woodhill Mountain Road, to ensure the traffic impacts from the off-ramp into Huntingdale Park are minimal and Berry through traffic is removed.	Section 7.1

Issue category	Details	EA section
Shoalhaven City Council		
Traffic and transport	Provision of a roundabout at the Tannery Road intersection.	Section 7.1
	Interchange arrangement located at Austral Park Road to be moved further south.	Section 7.1
	Potential for increased traffic on local roads.	Section 7.1
	Traffic model data to be provided highlighting changes in traffic volumes on local roads.	Section 7.1
Socio economic	Shared path connections to Kangaroo Valley Road and Queen Street and along the northern side of the highway connecting back to town under the highway near Berry Sports complex.	Section 7.10
	Inclusion of a separated pedestrian / cycle bridge over the highway for continuity of access along North Street.	Section 7.10
	Consideration of three properties directly affected by the proposed cul-de-sac in North Street.	Section 7.10
	Inclusion of two way access between Queen and Victoria streets to ensure maintenance of access to Mark Radium Park.	Section 7.10
	Identify existing infrastructure that would be impacted and measures to relocate or mitigate these impacts.	Section 7.10
	Relocation of or provision of additional ‘Welcome to Shoalhaven’ monument and the relocation of the David and Alexander Berry memorial at the northern end of town.	Section 7.10
	Signposting for the town of Berry to be linked into Shoalhaven Tourism’s Master Plan.	Section 7.10
Shoalhaven Water (A division of Shoalhaven City Council)		
Water and waste water	All works in close proximity/over Shoalhaven Water assets would need to be approved by Shoalhaven Water prior to construction and any protection/relocation works are to be at RMS’ expense.	Chapter 4
	Minimum horizontal and vertical clearances from Shoalhaven Water assets are to be in accordance with Water Services Association WSA code for water supply and sewage.	Chapter 4
	Written application for a Certificate of Compliance under section 305 of the *Water Management Act 2000* should be made to Shoalhaven Water after determination of the project and prior to work commencement.	Chapter 4

6.3.3 Issues raised by the community

Issues raised by community members and local businesses during the consultation process are detailed **Table 6-4**. **Table 6-4** also identifies the section of this environmental assessment that addresses each issue.

Table 6-4 Issues raised by the community

Issue	Details	EA section
Design	Alignment should be a direct route, minimising curves and gradients to improve capacity, safety and fuel efficiency.	Section 2.3
	The project should be convenient and efficient to travel on.	Section 2.3
	The original North Street road reserve was proposed in the 1960's and is not relevant to today's traffic volume or township growth.	Chapter 3
	The proposed Berry bypass is too large for the current township.	Chapter 3
	Continued consultation / community engagement during detailed design and construction detailing RMS process and accountability for these phases.	Chapter 4
	Changes in government and allocation of funding will impact on the road design and construction eg lower quality sound proofing, bridge joints etc.	Section 1.1
	Alternative traffic management measures should be considered at the Kangaroo Valley Road interchange to assist in reducing the footprint of the interchange.	Chapter 3
	Minimise the interchange infrastructure while maintain the same level of functionality.	Chapter 3
	A tear drop or oval style interchange at Kangaroo Valley Road, similar to the Leura interchange on the Great Western Highway, should be adopted.	Chapter 3
	The Kangaroo Valley Road interchange should be relocated south of Berry.	Chapter 3
	Request for alternative designs for the alignment along North Street to be considered eg tunnel.	Chapter 3
	The alignment of the Berry bypass should be moved further north or completely relocated to the south of Berry along the railway line.	Chapter 3
Consultation process	There was an unsatisfactory level of community consultation about Huntingdale Park Road prior to the announcement of the off-ramp realignment to avoid Huntingdale Park Road. RMS only contacted the owners of properties who would be physically impacted, and should have extended contact to include all property owners adjacent to the alignment.	Section 6.4
	Representatives from Berry Public School, Shoalhaven City Council and the local MP should be included in ongoing consultation to ensure the best outcomes for the broader community.	Section 6.4

Issue	Details	EA section
Consultation process	The community review group process should be continued.	Section 6.4
	Computer generated images of the alignment along North Street were misleading in depicting the distance of the road from North Street.	Section 6.4
	Consultation for the wider Foxground and Berry bypass project has been neglected while the review of the alignment north of Berry was undertaken.	Section 6.4
	The community should be consulted on and involved with the long-term use of the buffer strip between North Street and the revised alignment.	Section 6.4
	RMS needs to consult to greater length and more closely regarding the Kangaroo Valley Road interchange design and on design issues relating to Mark Radium Park.	Section 6.4
	The need for ongoing consultation and a complaints hotline during construction.	Section 6.4
	The two-way movement from Victoria Street to Queen Street was a Council addition and was added with no consultation with residents and the community.	Section 6.4
Transport and traffic	Potential impacts of increasing the speed limit on the upgraded highway from 80 km/h to 100 km/h.	Section 7.1
	Potential impacts if increased traffic (from 1200 cars per day to 27,000 cars per day in 2020) occurs following the completion of Main Road 92.	Section 7.1
	Access for emergency vehicles to the upgraded highway.	Section 7.1
	Impacts of changed traffic patterns on pedestrians, businesses, and traffic volumes, particularly in Queen Street and Victoria Street.	Section 7.1
	Local access should accommodate slower vehicles entering high speed lanes.	Section 7.1
	Safety of the intersection of Tannery Road and the Princes Highway.	Section 7.1
	Width of Victoria Street from George Street to the Princes Highway and between the entry to the Arbour retirement village in Berry and the Princes Highway is unsuitable and unsafe.	Section 7.1
	A dedicated interchange to service Huntingdale Park Estate via Schofields Lane should be adopted.	Chapter 3
	Access to Huntingdale Park Road estate to be via Ford Street.	Chapter 3
	Angle of the junction of Victoria and Queen Street is dangerous.	Section 7.1
	The project will result in the majority of traffic, including heavy vehicles, heading southbound out of Berry from areas south of Queen Street, using Victoria Street.	Section 7.1

Issue	Details	EA section
Transport and traffic	Increases to future traffic volumes on Kangaroo Valley Road as a result of the future development of Huntingdale Park.	Section 7.1
	Kangaroo Valley Road being the sole access point into Berry from areas north-west of the alignment, limiting access in the event of an incident on the proposed Kangaroo Valley Road bridge over the highway.	Section 7.1
	Reconsidering the need for two roundabouts on Kangaroo Valley Road interchange.	Section 7.1
	Provision of a third roundabout, this one at the junction of the revised junction of Kangaroo Valley Road and Huntingdale Park Road.	Section 7.1
	Provide safe pedestrian / cycle access to Berry from Kangaroo Valley Road crossing over the highway.	Section 7.1
	Potential safety issues related to entering the southbound on-ramp (two way movement) from Victoria Street due to traffic accelerating to join the highway from Queen Street. Vehicles turning right will have to cross in front of fast southbound traffic. Vehicles turning left will risk being ‘rear ended’ by accelerating traffic.	Section 7.1
	Belief there will be increased traffic using Victoria Street to access the highway via the southbound on-ramp.	Section 7.1
	The southbound on-ramp will be on flat ground as it passes the Victoria Street exit. Drivers entering here will not have the advantage of the downward slope from Kangaroo Valley Road and will require more vehicle acceleration, adding to increased noise and fuel consumption.	Section 7.1
	A second on-ramp at the end of Victoria Street is superfluous considering the close proximity to Queen Street.	Section 7.1
	A second northbound off-ramp should be provided in case the southern interchange exit is missed. Without a second off-ramp the first opportunity to turn around is at Tindalls Lane which is too far away.	Section 7.1
	Land for a second northbound off-ramp connecting the alignment to Woodhill Mountain Road should be reserved now, for future provision.	Section 7.1
	A second northbound off-ramp is required at Woodhill Mountain Road to relieve the potential pressure on the local road system resulting from the proposed intersection arrangement at Kangaroo Valley Road.	Chapter 3 Section 7.1
	RMS to provide property owners with details on access arrangements during construction.	Section 7.1
	Traffic management plan to be developed for the construction period.	Section 7.1
	Traffic travelling west accessing the southbound on-ramp along Victoria Street will be a potential hazard for school children accessing Berry primary school.	Section 7.1

Issue	Details	EA section
Transport and traffic	Potential for increased traffic on local roads resulting from vehicles exiting at the Kangaroo Valley Road interchange or from the proposed closure of Victoria Street.	Section 7.1
	Appropriate traffic calming measures to be introduced along Victoria Street to control vehicle speeds.	Section 7.1
	Cul-de-sac Victoria Street at the western end near the Arbour.	Section 7.1
	Southbound on-ramp from Victoria Street to be restricted to left turn only, making Queen Street one-way from Kangaroo Valley Road.	Section 7.1
	Southbound on-ramp from Victoria Street to retain left turn and right turn movements, making Queen Street two-way between Kangaroo Valley Road and Victoria Street.	Section 7.1
	Boundary Road should be reconnected with Tindalls Lane. The Tindalls Lane intersection could then act as the main intersection for this area.	Chapter 3
Noise and vibration	Proximity of the alignment to Berry and the design of the bridge over Broughton Mill Creek will create operational noise impacts for the township and rural properties to the north of Berry.	Section 7.2
	Potential noise and vibration impacts on residents during construction.	Section 7.2
	Potential operational noise and vibration impacts from the bridge over Broughton Mill Creek and Woodhill Mountain Road.	Section 7.2
	Optimise the design of the bridge at Berry over Woodhill Mountain Road to minimise the number of expansion joints and utilise low noise pavement.	Section 7.2
	Mitigate potential noise impacts from the bridge over Broughton Mill Creek by lowering the vertical alignment of the roadway adjacent to Berry.	Section 7.2
	Solid concrete barriers rather than part concrete / part rails should be adopted on the bridge at Berry to reduce noise.	Section 7.2
	Clear Perspex infill between the rails on the crash barrier on the bridge at Berry should be adopted to reduce noise.	Section 7.2
	Use best practice road surface materials to minimise noise impacts.	Section 7.2
	Horizontal alignment of the bypass between Alexandra Street and Edwards Street to be lower by an additional two metre from design presented on 6 December 2011.	Chapter 3
	Detail the noise assessment process and potential noise impacts for outdoor residential and rural areas adjacent to the project.	Section 7.2

Issue	Details	EA section
Noise and vibration	Describe evaluation of loud noise events and the interaction between loud noise events and the proposed road incline.	Section 7.2
	Potential noise and head light glare impacts on residents adjacent to the realigned Huntingdale Park Road entrance.	Section 7.2
	The 40 metre buffer between North Street and the edge of the noise wall is inadequate.	Section 7.2
	Potential noise impacts on the residents of North Street resulting from traffic travelling at 100km/h.	Section 7.2
	The start of the southbound off-ramp should be moved as far as practical south to further ameliorate the noise and visual impact on North Street.	Chapter 3
	Request for information regarding proposed noise mitigation on the north side of the bypass.	Section 7.2
	Potential for increased noise impacts following the upgrade from traffic using Victoria Street to access the highway via the southbound on-ramp.	Section 7.2
	Potential noise impacts on residents in the Mark Radium Park area from sound emanating from the highway and the southbound on-ramp.	Section 7.2
	Increased noise impacts during and post construction on residents of the Bupa aged care facility at the southern end of Berry.	Section 7.2
	Potential noise impact on residents along Bong Bong Road due to the adjustment of the alignment over Woodhill Mountain Road which moves the bridge 95 metres further north.	Section 7.2
	Lack of noise mitigation on the bridge and potential noise impacts on residents at the north side of town from traffic travelling along the bridge.	Section 7.2
	Potential noise impacts from southbound trucks braking as they travel towards Tindalls Lane.	Section 7.2
	General construction activity and machinery noise and vibration eg blasting, noise from rock grinding machinery and fumes from bitumen works.	Section 7.2 Section 8.2
	Pre-arranged construction breaks / quiet time periods each day to allow residents time to undertake quiet activities.	Section 7.2
	Livestock reactions to blasting and construction noise.	Section 7.2
	Provision of some form of noise mounding to reduce noise travelling across farm land.	Section 7.2
	Demonstration of current and future predicted noise level differences at locations along the Foxground and Berry bypass project.	Section 7.2

Issue	Details	EA section
Terrestrial ecology	Maintenance of wildlife corridors, wetlands and endangered ecological communities.	Section 7.3
	Additional fauna crossing should be included south of Austral Park Road between Gembrook Lane and the speed camera.	Chapter 4 Section 7.3
	The vegetated land bridge as referenced in the Preferred option – Toolijooa Ridge report, June 2009 should remain as part of the design.	Chapter 3 Section 7.3
	Local expertise and seed sources should be used during revegetation.	Section 7.3
	Potential impacts to the poplars on Woodhill Mountain Road.	Section 7.3
	Potential ecological (flora and fauna) impacts from the diversion of Town Creek.	Section 7.3
	Potential loss of the green corridor through the Berry township due to the diversion of Town Creek.	Section 7.3
	The flow along the current Town Creek alignment should be maintained to an ecologically sustainable level.	Section 7.3
Surface water and groundwater	Potential impacts on ground water levels to the south of the bypass, from lowering the bypass along North Street.	Section 7.4
	Construction and operational impacts on water catchment areas and ground or surface water sources (bores, springs, creeks and dams).	Section 7.4
	Dust resulting from construction activities contaminating water supplies eg creeks and individual property water tanks and solar panels.	Section 7.4
Flooding	Flood management and access into Berry in the event of a flood during construction and operation.	Section 7.5
	The length of the northern viaduct at 600 metres is too short to avoid flooding impacts.	Section 7.5
	Mechanical pumps should be used to enable the road alignment to be lowered further.	Chapter 3 Section 7.5
	The sedimentation basins should be moved to assist in lowering the vertical alignment of the highway along North Street.	Chapter 3 Section 7.4
	Mitigate flooding from Town Creek.	Section 7.5
	Realign the upper section of Town Creek to facilitate lowering the alignment along North Street.	Section 7.5
	Potential flooding impacts along North Street and impacts of run-off from the highway.	Section 7.5
	Potential flooding impacts on other areas of Berry (northern end of town near the bowling club and around Woodhill Mountain Road), following the diversion of Town Creek.	Section 7.5

Issue	Details	EA section
Landscape character and visual amenity	The existing facilities at Nungarry should be upgraded as an alternative to building a new heavy vehicle rest area at Austral Park Road.	Chapter 3
	Residual land resulting from the straightening of the existing alignment along the Berry bypass should be handed over to Berry Landcare to manage.	Section 7.3
	Potential visual impacts, including headlight glare and interchange lighting on resident near Austral Park Road.	Section 7.6
	Impact on visual amenity of the proposed bridge crossing Broughton Creek at the north end of Berry, including bridge height.	Section 7.6
	Improve visual amenity by re-routing Woodhill Mountain Road to avoid the need for a high bridge.	Section 7.6
	Power lines located at Woodhill Mountain Road to be placed underground to enable the poplar trees to grow unrestricted to shield the town from the bridge structure.	Chapter 4
	Impacts on local scenery, including the escarpment, regional views and the overall visual amenity.	Section 7.6
	Potential loss of the view of the escarpment, particularly for residents of North Street.	Section 7.6
	High quality visual impact mitigation and urban design needed, particularly for, Kangaroo Valley Road, Huntingdale Park Road, North Street, Alexandra Street and the existing Princes Highway.	Section 7.6 Appendix I
	Impact of the project on the amenity of Berry.	Section 7.6
	Appearance and design of proposed noise attenuation.	Section 7.6
	Potential visual impacts, including headlight glare, on residents adjacent to the realigned Huntingdale Park Road entrance.	Section 7.6
	Potential amenity impacts on recreational walkers, runners, children, the elderly, cyclists and pedestrians using North Street.	Section 7.6
	The future use of RMS owned residual land along North Street and future maintenance of this land.	Section 7.6
	The residual strip between North Street and the bypass should be left as public space, planted to screen the noise wall.	Section 7.6
	North Street should not be open to traffic from either George Street or Kangaroo Valley Road and should be terminated in a cul-de-sac.	Section 7.6
	Loss of visual amenity and views to the escarpment in the area adjacent to the proposed noise wall.	Section 7.6
	Location of off-ramp signage and street lighting and associated potential visual and light spill impacts on residents.	Section 7.6
	Potential visual impact of the proposed bridge at Berry over Woodhill Mountain Road and Broughton Mill Creek.	Section 7.6

Issue	Details	EA section
Landscape character and visual amenity	Potential for the project to cut the Berry township off from its rural landscape.	Section 7.6
	Early planting of vegetation along the highway boundary with North Street so vegetation is well established when the upgrade occurs.	Section 7.6
Non-Aboriginal heritage	Impact on and preservation of historical landmarks and heritage assets and character of the area.	Section 7.8
	Retain integrity of the Berry entrance at the eastern end of town at the Pulman Street precinct.	Section 7.8
	The bridge at Berry should be designed in a manner that is sympathetic to the town's heritage values.	Section 7.6 Section 7.8
	The bridge at Berry should not be designed with any heritage input and should adopt a sophisticated sleek modern design.	Section 7.6 Chapter 4
	Impact of the highway upgrade on the character, heritage and integrity of Berry.	Section 7.8
	RMS should consider relocating the RMS owned building at 79 North Street.	Section 7.8
	The bridge at Kangaroo Valley Road should be sympathetic to the heritage values of Berry.	Section 7.8
	A roundabout at Tannery Road / Pulman Street is inappropriate for a heritage precinct and should be relocated to Woodhill Mountain Road.	Chapter 3 Section 7.8
Land use and property	Potential land impacts on agricultural land, farms and vineyards.	Section 7.9
Socio economic	Impacts on private properties affected by the project.	Section 7.10
	Access required from Kangaroo Valley Road to town and North Street, particularly for children riding and walking to school or the skate-park and playing fields.	Section 7.10
	Provision of dedicated bike routes and walkways.	Section 7.10
	The project should support the economic viability of the region, including business, agriculture and tourism.	Section 7.10
	Requests for alternative access option designs.	Section 7.10
	Visitors to Berry walk around town so pedestrian safety and parking are important.	Section 7.10
	Potential impacts on Berry Riding Club land.	Section 7.10
	Proximity of the project to Camp Quality Memorial Park.	Section 7.10
	Proximity of the project to residences.	Section 7.10
	Ability of the project to meet the future growth of Berry and surrounding areas.	Section 7.10
	Requests to protect the natural and rural environmental values which are considered key economic assets of the area.	Section 7.10
	Provision of improved parking, kerbs and guttering in Berry.	Section 7.10

Issue	Details	EA section
Socio economic	The northbound off-ramp at the south Berry interchange should continue beneath Kangaroo Valley Road bridge and reconnect to Kangaroo Valley Road on the opposite side to enable the estate entrance to remain at its current location and reduce the impact on two properties.	Chapter 3
	Possible loss of connectivity between Kangaroo Valley Road and North Street and the impact on both cyclists and pedestrians who currently use this route.	Section 7.10
	Potential severance of pedestrian access between Kangaroo Valley Road and Berry (shops, parks, sporting fields, showground, primary school and pre-school) via North Street as a result of the bypass alignment.	Section 7.10
	Two way pedestrian and cyclist access across the Kangaroo Valley Road bridge should be adopted.	Chapter 3 Chapter 4
	A pedestrian / cycle bridge connecting North Street should be adopted.	Chapter 3 Chapter 4
	A pedestrian / cycle bridge across the highway connecting Victoria Street to Huntingdale Park Road should be adopted.	Chapter Section 7.1
	Safety of pedestrians and cyclists from Huntingdale Park Road / Kangaroo Valley Road crossing over the highway via Kangaroo Valley Road into Berry.	Section 7.10
	Safety impacts resulting from traffic changes along Victoria Street on children at Berry Primary School, residents from the retirement village and pedestrians using Victoria Street to access Berry town centre, the railway station, show / sports ground and public swimming pool.	Section 7.10
	Decreased safety along Victoria Street as there are no footpaths and pedestrians are forced to use the road edge.	Section 7.10
	The alignment is too close to the church on North Street.	Section 7.10
	Potential impact on property values.	Section 7.10
	Location and frequency of bus stops along the project.	Section 7.10
	Potential impacts of construction staging on residents and businesses and proposed mitigation.	Section 7.10
	Provision of adequate access to Berry for both north and south bound travel.	Section 7.10
	Access arrangements for residents located along the existing highway just north of the north Berry interchange.	Section 7.1 Section 7.9
	Maintenance of access for local residents and tourists to Mark Radium Park and rest stop and other existing facilities.	Section 7.10
	Process and timing for property acquisition.	Section 7.10
	The direct impact on two property owners of moving the entrance to Huntingdale Park Road.	Section 7.10

Issue	Details	EA section
Socio economic	Documented evidence should be provided by RMS to substantiate the suitability or unsuitability of farming land considered for a land swap with the dairy farm.	Section 7.10
	Weight given on the future plans of the dairy farm and co-op when no documented evidence has been presented by RMS which supports the proposed plans.	Section 7.10
	The highway will cut Berry in half. The growth area of the town is to the west and the upgrade will isolate this part of town from the established township.	Section 7.10
	Removing the two-way access between Queen Street and Victoria Street will restrict access to Mark Radium Park, an important stop for many travellers / visitors to Berry and connectivity to the park should be maintained.	Section 7.10
	A two way movement from Victoria Street to Queen Street requires a larger road footprint, further impacting on Mark Radium Park and the duck pond, and reducing the buffer between the highway and residents of Windsor Drive.	Section 7.10
	Maintain a walking / cycling link from the western end of North Street to Mark Radium Park.	Section 7.10
	Closing Victoria Street and making the southbound on-ramp one way will reduce the impact on Mark Radium Park and the duck pond.	Chapter 3
	Access to Mark Radium Park from the roundabout at the end of Queen Street (new road down the east side of the arboretum directly off the roundabout).	Section 7.1
	Provision of bus access and parking within Berry.	Section 7.1
	Property and machinery security during construction.	Section 7.10
Air quality	Air quality during construction and operation.	Section 8.2
	The close proximity of the alignment to North Street will result in increased traffic, exhaust fumes and diesel gases which will impact North Street residents.	Section 8.2

Community involvement is an integral component in the development of the project. For example, community feedback highlighted the importance to the community of the Berry access arrangements. As a result, RMS committed to undertaking community consultation on the access options for Berry and a value management study to assist in the development and selection of the Berry access arrangements.

Additionally, in response to community and stakeholder consultation on the access options for Berry, the concept design was revised to include a flood-free four-way movement arrangement at Kangaroo Valley Road intersection rather than a flood free access ramp at Alexander Street, which was previously planned.

In response to community concerns and technical studies in relation to noise and visual amenity close to Berry, RMS reopened the investigation in this area. After working closely with members of the Berry community and Shoalhaven City Council, RMS revised the alignment and design of the Berry bypass to reduce noise and visual impact for the town of Berry.

6.3.4 Issues raised by the Aboriginal community and the Local Aboriginal Land Councils

The key issues identified by the Aboriginal community through the AFG forum and through individual and group submissions in relation to the project are detailed in **Table 6-5**. The table also identifies the section of this environmental assessment that addresses each issue.

Table 6-5 Issues raised by the Aboriginal community and Local Aboriginal Land Councils

Issue	Details	EA section
Aboriginal cultural heritage	Impacts to Toolijooa Ridge associated with the proposed deep cutting.	Section 7.7
	Management of impacts to Toolijooa Ridge.	Chapter 4 Section 7.7
	Avoidance of impacts to the Berry Encampment area.	Section 7.7
	Ongoing Aboriginal participation and employment as the project develops.	Section 7.7
	There should be a fair and equitable distribution of Aboriginal workers across the project.	Section 7.7
	Cultural knowledge should only be provided by the appropriate traditional owners of the land with proven genealogy within the project location.	Section 7.7
	Potential to encounter and impact Aboriginal burials, both generally and within areas with archaeological potential or areas remembered as sensitive in this regard.	Section 7.7
	Minimisation of damage to Dicky Woods Meadow battleground, which should be protected at all costs.	Section 7.7
	Aboriginal cultural heritage significance is placed on all artefacts.	Section 7.7
	Management of artefacts which remain on site after archaeological salvage is completed.	Section 7.7
	There is a need for Aboriginal representatives to monitor construction impacts and recover and/or manage artefacts *in situ*.	Section 7.7 RMS policy does not support monitoring of construction works.

6.3.5 Issues raised by specialist interest groups

Issues raised by specialist interest groups during the consultation process are detailed in **Table 6-6**. **Table 6-6** also identifies the section of this environmental assessment that addresses each issue.

Table 6-6 Issues raised by specialist interest groups

Issue	Details	EA section
National Trust of Australia		
Non-Aboriginal heritage	Protection of the historic environment of the Berry township.	Section 7.8
Camp Quality		
Socio-economic	Impact on the Camp Quality Park and the children's memorial. Provision of adequate access and signage.	Section 7.10
Shoalhaven Historical Society		
Non-Aboriginal heritage	Impact on Pulman Street and the heritage areas of Berry.	Section 7.8
Berry and District Historic Society		
Non-Aboriginal heritage	Impact on the Pulman Street heritage precinct.	Section 7.8
	RMS should consider relocating the RMS owned building at 79 North Street.	Section 7.8
Berry Landcare		
Consultation process	Request for ongoing consultation with Berry Landcare and Foxground Landcare.	Section 7.3
Terrestrial ecology	Impact on vegetation and wildlife corridors.	Section 7.3
	Revegetation should use local indigenous species.	Section 7.3
	Fauna connectivity measures between wildlife corridors segregated by the project.	Section 7.3
Landscape character and visual amenity	Minimise the impact of the project on the Berry landscape.	Section 7.6
	Location of a 10 bay heavy vehicle truck rest area in an area designated as "Corridors in Shoalhaven LGA".	Section 7.6
Berry Rural Co-operative Society		
Socio-economic	Reduce adverse impacts on dairy farms by maintaining economic viability and reducing land take.	Section 7.10
Berry Chamber of Commerce		
Landscape character and visual amenity	Visual appearance of the Broughton Creek bridge.	Section 7.6
Non-Aboriginal heritage	Impact on the Pulman Street heritage precinct.	Section 7.8
Socio-economic	Protect the country character and ambience of the Berry township.	Section 7.10

Issue	Details	EA section
PHocus and Shoalhaven Business Chamber		
Traffic and transport	Minimise access points leading directly onto the highway.	Section 7.1
	Minimise curves and grades.	Section 7.1
	Provision of incident management and emergency service vehicle access.	Section 7.1
	Provision of access points at both the north and south approaches to Berry.	Section 7.1
PHocus and Shoalhaven Business Chamber		
Flooding	Flooding impacts.	Section 7.5
Landscape character and visual amenity	Protect visual amenity	Section 7.6
Berry Alliance		
Traffic and transport	Berry needs the option of a second northbound off-ramp.	Section 7.1
	Opportunity to provide dedicated bike routes and walkways in the region.	Section 7.1
	The use of low noise pavement to reduce noise in the vicinity of the township.	Section 7.2
	Consideration of noise generated by bridge joints and careful design to reduce potential impacts.	Section 7.2
Noise and vibration	Noise and visual impact of the project on the township of Berry.	Section 7.2
Flooding	Flooding impacts on the township of Berry and diversion of Bundewallah Creek and Broughton Mill Creek.	Section 7.5
	Opportunity to mitigate flooding through Town Creek.	Section 7.5
Landscape character and visual amenity	Provision for a depressed roadway in the vicinity of the township of Berry.	Chapter 4 Section 7.6
	Woodhill Mountain Road to pass over the project (bridge) rather than under it.	Section 7.6
	A bridge design which is lowered, slender and as unobtrusive as possible.	Section 7.6
	Visual impact of the upgrade and loss of escarpment views for the township.	Section 7.6
Non-Aboriginal heritage	Important to retain the integrity of the old entrances and Pulman Street precinct.	Section 7.7
Socio-economic	Concern over the impact on Camp Quality Park and the Berry Riding Club.	Section 7.10

Issue	Details	EA section
Better Options for Berry		
Design	The Berry bypass section of the Foxground and Berry bypass project should be constructed prior to other sections of the project.	Section 4.4.10
Consultation	Concern over lack of community consultation / notice provided prior to the announcement of changes to the Berry (south) interchange.	Section 6.4
	Community to be consulted on the long-term use of the ‘buffer strip’ between the highway and North Street.	Section 6.4
Traffic and transport	RMS to reserve sufficient land now for additional second northbound exit.	Section 7.1
	Good level of access to Mark Radium Park to be maintained.	Section 7.1
	Pedestrian and cycle access to be provided across the highway for continuity of access along North Street.	Section 7.1
Noise and vibration	Design of the bridge at Berry to minimise construction joints and include low noise pavement.	Section 7.2
	Horizontal alignment of the bypass between Alexandra and Edward streets to be lower by an additional one metre from design presented on 6 December 2011.	Chapter 3 Section 7.2
	Earth mounding to extend the full height of the noise walls with low level endemic native vegetation planted on top.	Section 7.2
Landscape character and visual amenity	Earth mounding to extend the full height of the noise walls with low level endemic native vegetation planted on top.	Section 7.2 Section 7.5
Kiama State Emergency Services		
Traffic and transport	Access for emergency service vehicles.	Section 7.1
Berry Public School Parents and Citizens Association		
Traffic and transport	Cul-de-sac the end of Victoria Street near The Arbour.	Section 7.1
	Run the Queen Street southbound on-ramp directly to the highway, mirroring the Huntingdale Park off-ramp.	Section 7.1
	Construct a new entrance to Mark Radium Park off Queen Street.	Section 7.1
	Provide safe pedestrian / cycle access to Berry from Kangaroo Valley Road crossing over the highway.	Section 7.1
	Additional point of crossing / access over the highway to be provided.	Section 7.1
Recreational Fishers (Broughton Creek, Broughton Mill Creek and Bundewallah Creek)		
Socio economic	Angler access and private landholders' privacy concerns.	Section 7.10
	Increased access opportunities should be provided.	Section 7.10
	Continue to inform local anglers of access proposals.	Chapter 6 Section 7.10
	Broughton Creek has been used as a brood stock location for fish stocking.	Section 7.10

6.4 Future consultation

6.4.1 Continuing consultation up to the exhibition of the environmental assessment

RMS is committed to continued engagement with the community throughout the project design and environmental assessment. Specifically RMS will:

- Continue to use existing project contact and consultation practices including:
  - Opening the Berry project office on Fridays.
  - Regular fortnightly website updates.
  - Email notifications to registered stakeholders.
  - Monthly updates in the Berry Town Crier.
  - Householder letters, community updates, mailouts and letterbox drops.
  - Conducting stakeholder and property owner meetings on request.
  - Taking enquiries through the project information line and the project email.
  - Media releases.
- Consultation with potentially directly affected property owners on access arrangements and potential land acquisition requirements.

6.4.2 Consultation during the exhibition of the environmental assessment

The project team has encouraged community and stakeholder engagement through all phases of the project. Members of the project team have been readily accessible to meet or speak with community members as individuals or groups to understand and address their concerns and will continue to do so during ongoing community engagement as the project goes through to the environmental assessment display.

The environmental assessment will be advertised and placed on public exhibition for a minimum of 30 days and will be available for viewing at the following locations between **14 November 2012 and 14 December 2012**:

- **Kiama Municipal Council**, 11 Manning Street, Kiama.
  Open Monday to Friday 8.45am to 4.15pm.
- **Kiama Library**, 7 Railway Parade, Kiama.
  Open Mondays, Wednesdays, Thursdays and Fridays 9.30am to 5.30pm, Tuesdays 9.30am to 8pm and Saturdays 9.30am to 2pm.
- **Shoalhaven City Council**, 44 Bridge Road, Nowra.
  Open Monday to Friday 9am to 5pm.
- **Nowra Library**, 10 Berry Street, Nowra.
  Open Monday to Friday 9.30am to 7pm and Saturday 9.30am to 3pm.
- **Office of Gareth Ward** MP Member for Kiama, 125 Terralong Street, Kiama.
  Open Monday to Friday 9am to 5pm.
- **Gerringong upgrade Community Display Centre,** 446 Princes Highway, Gerringong.
  Open Monday to Friday 9am to 5pm.
- **RMS Wollongong office**, Level 4, 90 Crown Street, Wollongong.
  Open Monday to Friday 8.30am to 5pm.

- **RMS North Sydney office**, Level 9, 101 Miller Street, North Sydney.
  Open Monday to Friday 8.30am to 5pm.
- **Department of Planning and Infrastructure Information Centre**, 23-33 Bridge Street, Sydney. Open Monday to Friday 9am to 5pm.
- **Nature Conservation Council of NSW,** Level 2, 5 Wilson Street, Newtown.
  Open Monday to Friday 9am to 5pm.

Staffed displays and a series of informal topic specific community information sessions will be held during the exhibition of the environmental assessment to enable community representatives to ask questions and to provide further information for consideration in the assessment process. During the exhibition of the environmental assessment, the community, government agencies and other interested parties are invited to make written submissions on the project to the DP&I.

A staffed display will be at the following location:

- **Berry project office**, (Broughton Court) shop 3/113 Queen Street, Berry.
  Open Mondays, Tuesdays, Wednesdays and Fridays 10am to 5pm. Thursday 12pm to 7pm. Saturday (24 November) 10am to 2 pm. Saturday (1 December) 10am to 2pm.

A series of informal topic specific community information sessions will be held at the following locations:

- **Noise and vibration** – Berry School of Arts, Alexandra Street, Berry.
  20 November 2012, 6pm to 7.30pm.
- **Flooding** - Berry School of Arts, Alexandra Street, Berry.
  21 November 2012, 6pm to 7.30pm.
- **Traffic and transport** - Berry School of Arts, Alexandra Street, Berry.
  22 November 2012, 6pm to 7.30pm.
- **Urban design** - Berry School of Arts, Alexandra Street, Berry.
  27 November 2012, 6pm to 7.30pm.

RMS will inform the community on the staffed environmental assessment display and the topic specific community information sessions through: a community update, letters, telephone calls to potentially directly affected property owners and key stakeholders, e-mail notification to registered stakeholders, information on the project website and advertisements in the local media.

During the exhibition of the environmental assessment RMS will use the following consultation tools to inform the community: a 3D model of the proposed alignment, drive through animation sequences and interactive tablets showing flooding, noise and air quality levels at locations along the proposed alignment.

Following the exhibition of the environmental assessment, the DP&I will forward submissions received to RMS for consideration. RMS will summarise and respond to the issues raised in the submissions and provide the Director-General of the DP&I with a submissions report addressing the issues. The project may be modified during this process if deemed necessary to properly address issues raised and in this case RMS would prepare a preferred project report. The Director-General will then prepare a report to the Minister for Planning and Infrastructure recommending that the project be approved, subject to draft conditions contained in the report, or refused. The approval conditions will help to guide future community consultation during the detailed design, construction and operation of the project.

The Minister will then decide whether to approve the project and advise the approval conditions. The environmental assessment process is presented schematically in **Figure 5.1**.

6.4.3 Consultation following exhibition of the environmental assessment

Following the exhibition period, RMS will continue to identify and manage issues of interest or concern to the community during the assessment and approval process and, if the project is approved, during the detailed design and construction phases of the project. The aims of ongoing communications and consultation are to provide the community with:

- Accurate and accessible information regarding the processes and activities associated with the project.
- Information in a timely manner.
- Appropriate avenues for providing comment or raising concerns.
- A high level of responsiveness to their issues and concerns throughout development and delivery of the project.

6.4.4 Consultation during detailed design and construction

A community involvement plan would be developed and implemented prior to construction. This would set out the methods to be employed and stakeholders targeted as part of consultation and communication.

At a minimum, consultation during the detailed design and construction phases of the project would include:

- Ongoing consultation with Fire and Rescue NSW, Rural Fire Service, SES, NSW Ambulance Service and the NSW Police to comply with up-to-date emergency response procedures during construction and operation, and to ensure that the construction would not constrain emergency services response in the area.
- Ongoing consultation with Kiama Municipal Council and Shoalhaven City Council to manage and minimise any impacts on existing infrastructure.
- Ongoing consultation with the NSW OEH, the NOW and DTIRIS.
- Ongoing consultation with the AFG.
- Provision of regular updates to the surrounding community throughout the remainder of the planning and construction phases.
- Development and maintenance of a comprehensive community complaints register and response system.
- Ongoing consultation with landowners who may be potentially impacted by the project and nearby landowners, residents, business owners and community facility operators. This would include notification, as appropriate, before the commencement of construction activities, including out of hours work, to minimise any access disruption. Notices relating to road works and road network access changes would be issued as email alerts, placed in local newspapers and delivered to letterboxes at least five days before the change.
- Members of the project team will be available at the Berry project office which will be opened at least one day a week during construction from 10am to 5pm.

Further details of the communication and consultation proposed are provided in the draft Statement of Commitments in **Chapter 10**.

7 Assessment of key issues

This chapter provides an assessment of the key environmental issues for the project as nominated by the Director-General's environmental assessment requirements (DGRs).

For each key issue the existing environment is described, the potential impacts (both direct and indirect) of the project during construction and operation are assessed, the influence of relevant planning matters are considered and proposed management and mitigation measures are described. The proposed management and mitigation measures have influenced the development of the draft statement of commitments in **Chapter 10**.

Director-General's requirements	Where addressed
*An **assessment of the key issues,** including an assessment of the worst case and representative impact for each issue for all aspects of the project (including the proposed locations of and/or options for the ancillary facilities) with the following aspects addressed for each key issue (where relevant):*	Chapter 7 Technical papers (Appendix D to O)
• *Describe the existing environment.*	Chapter 7 Technical papers (Appendix D to O)
• *Assess the potential impacts of the proposal at both construction and operation stages, in accordance with relevant policies and guidelines. Both direct and indirect impacts must be considered including potential interactions with the existing Princes Highway (as relevant).*	Chapter 7 Technical papers (Appendix D to O)
• *Identify how relevant planning, land use and development matters, (including relevant strategic and statutory matters), have been considered in the impact assessment and/or in developing management/mitigation measures.*	Chapter 4, Chapter 7 Technical Papers (Appendix D to O)
• *Describe measures to be implemented to avoid, minimise, manage, mitigate, offset and /or monitor the impacts of the project and the residual impacts.*	Chapter 7 Technical papers (Appendix D to O)

The *worst case impact scenario* would see the project as described being undertaken but without the implementation of:

- Mitigation measures.
- On site management.
- Minimisation of impacts.
- Offsetting measures.
- Monitoring procedures.

It represents the project performing at its lowest potential environmental capacity.

The r*epresentative impact scenario* would see the project performing in the manner anticipated by RMS once proposed measures have been implemented such as:

- Mitigation measures.
- On site management.
- Minimisation of impacts.
- Offsetting measures.
- Monitoring procedures.

7.1 Traffic and transport

This chapter provides an assessment of potential traffic and transport impacts of the project, which was nominated in the Director-General's requirements (DGRs) as a key environmental issue for the project. It represents a summary of the *Traffic and Transport Technical Paper* (AECOM 2012), which was prepared for the project with consideration of the DGRs.

The technical paper is provided at **Appendix D**. The relevant extract from the DGRs is presented below.

Director-General's requirements	Where addressed
Traffic and Transport *– including but not limited to:*	
Construction traffic impacts, including identification of construction routes and the nature of existing traffic on these routes, quantification of traffic volumes (including for spoil haulage), potential impacts to regional and local road network (including safety and level of service), and potential disruption to existing public transport services, access/service lanes to local properties.	Section 7.1.3 Appendix D
Operational traffic and transport impacts to the local and regional road network including:	Section 7.1.3 Appendix D
Changes to access arrangements/service lanes to local properties.	Section 7.1.3 Appendix D
Changes to local road connectivity and access and impacts on local traffic arrangements and local road capacity/safety from traffic rerouting and modified access to the upgraded highway, including direct impacts from the replacement of the existing highway that currently passes through Berry. The assessment must take into account potential interactions with local traffic associated with the residential sub-division at Huntingdale Park, Berry (including future growth) and any severance impacts on local connectivity within Berry as a result of the proposed route. Consideration must be given to potential impacts of changed traffic arrangements on local and/or school bus services, access for emergency services and garbage truck routes.	Section 7.1.3 Appendix D
Traffic capacity of the project and its ability to cater for predicted growth. Consideration should be given to what effect potential major land use changes in the locality may have to the traffic assessment outcomes	Chapter 4 Section 7.1.1 Section 7.2.2 Section 7.1.3 Appendix D
Opportunity for the provision of cycle way connections along the highway and to adjoining communities.	Section 7.1.3 Section 7.6 Section 7.10 Appendix D

7.1.1 Methodology

A three stage traffic modelling and forecasting approach was used for the traffic impact assessment (refer to **Figure 7-1**). This approach established existing and future traffic conditions on the Princes Highway, the 'Sandtrack' and surrounding local roads and involved the use of:

- The TRACKS strategic transport model (the TRACKS model). This model provided current and future traffic demands and patterns both with and without the project. It factored in the influences of road network upgrades, population growth and employment growth in the local area and the wider region. It also provided the predicted split in traffic distribution between the Princes Highway and the 'Sandtrack', with and without the project (or other highway upgrades).
- Traffic forecasting spreadsheet modelling. This provided average daily traffic profiles within the vicinity of the project over time (such as peak hour volumes) using linear growth rates from the TRACKS model. In doing so, the spreadsheet re-forecast traffic volumes from the TRACKS model using traffic survey data from 2009 and 2011, so that the model results would be underpinned by the actual road network situation.
- Paramics micro simulation modelling. This focused on the operational performance of individual vehicle movements during key peak periods in the project area using traffic volumes from the forecasting spreadsheet.

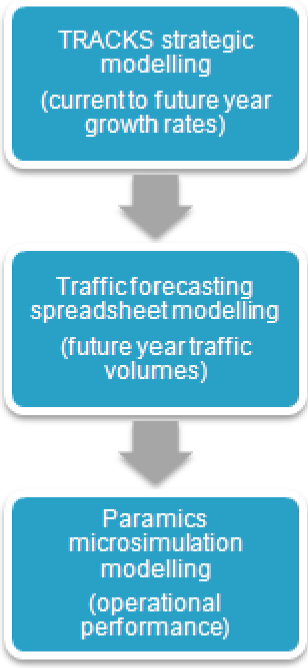

Figure 7-1 Overview of the three stage modelling approach

The Gerringong to Bomaderry sub-area TRACKS model was developed for the project using RMS' Illawarra regional TRACKS transport model. The TRACKS model factors in expected land use changes and proposed road network improvements in the region. This included:

- Upgrades to the Princes Highway between Gerringong and Bomaderry, including the project.
- Annual population growth for the Illawarra Region based on 2026 land use development projections. For the local area of the project, this included an additional 332 dwellings in Berry (which includes Huntingdale Park Estate) and 282 dwellings at Shoalhaven Heads. This equates to annual population growth rates of 2.4 per cent for Berry and 2.1 per cent for Shoalhaven Heads, resulting in traffic growth on key regional and local roads in the project area.
- Regional employment forecasts for 2026, including an additional 743 jobs in Gerringong and 915 jobs in Bomaderry.

The three stages of the modelling used local and regional traffic data to understand traffic volumes and patterns in and around Berry. This ensured that the models accurately replicated current operating conditions. Current and historic traffic data was used for the assessment, including:

- Traffic survey data collected in June 2011 to measure traffic volumes along Kangaroo Valley Road, Tannery Road and Woodhill Mountain Road.
- Traffic survey data collected for peak periods during the Easter and Anzac Day 2011 public holiday weekend This included origin-destination surveys, intersection turning counts and midblock counts. Site visits and observations were carried out to collect additional information about the layout and operation of the road network.
- Traffic survey data collected in May/June 2009 and April/May 2011 to measure traffic volumes at other key locations on the Princes Highway and the 'Sandtrack'.
- Traffic count data from RMS' permanent site on the Princes Highway north of Rose Valley Road (located north of Gerringong) between 2008 and 2010.
- Origin-destination survey data collected at nine locations between Gerringong and Bomaderry along the Princes Highway, the 'Sandtrack' and Beach Road. Surveys were completed between 7am-9am and 2pm-6pm on Thursday 15 February 2007, and particularly focused on measuring the proportion of through traffic and traffic stopping in Berry.
- Origin-destination survey data, midblock counts and intersection turning counts collected on Victoria Street, Berry during May 2012, during both weekday and weekend peak conditions, to determine existing traffic patterns and volumes.

As the Princes Highway (in the project area) is in a rural area and is a major route for tourism with significant peak period traffic during school holidays, it is not necessarily appropriate to focus the traffic and transport assessment of existing and future conditions on typical weekday morning and evening peak periods. Therefore, further analysis of existing traffic patterns and volumes was carried out to identify the true periods of peak travel demand and found that these usually occurred on the first evening of a holiday period southbound and the last afternoon of a holiday period northbound during a Public Holiday weekend. These have been referred to as the 'holiday peak' periods.

The following time periods have been selected to report existing and future traffic flows:

- Annual Average Daily Traffic (AADT).
- Average one hour during a typical morning (AM) peak between 7am–11am.
- Average one hour during a typical evening (PM) peak between 3pm–7pm.
- Holiday peak hour southbound that reflects traffic patterns in the project area recorded on Thursday 21 April 2011.
- Holiday peak hour northbound that reflects traffic patterns in the project area recorded on Tuesday 26 April 2011.

To assess the operational performance of the project, the traffic assessment considered the following scenarios:

- The performance of the existing highway and intersections within Berry based on 2011 volumes, to represent the existing scenario.
- Three different scenarios based on 2037 traffic volumes to assess the highway performance. The first being without the project ('do nothing'), the second being with the project (only) and the third being the entire Princes Highway upgrade program between Mount Pleasant and Bomaderry (refer to **Table 7-1**). The year of 2037 was selected to represent the design year of the project (being 20 years after opening to traffic in 2017).
- Two different scenarios based on 2037 traffic volumes to assess the performance of key intersections within the local road network at Berry (including interchange ramps), the first being without the project ('do nothing') and the second being the complete Princes Highway upgrade program.

The 'Princes Highway upgrade program' scenario was selected for the purposes of the intersection performance assessment, instead of 'the project' scenario, as it is considered to be a more representative (or most likely) scenario. There are no changes to the local road network between the two scenarios, other than a minor increase in traffic volumes associated with the 'Princes Highway upgrade program'. As such, the 'Princes Highway upgrade program' scenario would represent the ultimate performance of the network in the long term.

The assessment scenarios, and the assumptions associated with each, are described further in **Table 7-1**).

To assess construction impacts of the project, assessments of the worst case and representative (or most-likely) scenarios were completed (as described in **Table 7-2**). The worst case scenario would be 'ameliorated by the implementation of appropriate mitigation measures, as outlined at **section 7.1.4**. Both scenarios were assessed based on:

- Traffic volumes in 2017 (including construction traffic), which represents the last expected year of construction for the project.
- Gerringong upgrade being operational.
- The Berry bypass and the northern and southern interchanges not being operational, with all highway traffic continuing to travel through Berry.
- An 80 kilometres per hour construction zone speed limit throughout the project area (at locations where the posted speed is currently 80 kilometres per hour).
- Delays due to passing constraints along the existing highway caused by construction zones.

Table 7-1 Operational assessment scenarios

<table>
<tr><th>Road network scenario</th><th>Measure</th><th>Assessment year</th><th>Assessment period</th><th>Assumptions</th></tr>
<tr><td>Do nothing</td><td>To assess the consequence of no highway upgrade.</td><td>2011, representing the existing conditions of the project area.
2037, representing the project design year.</td><td></td><td>• No change to the existing regional and local road network, with traffic distribution patterns in and around Berry remaining roughly unchanged.
• Traffic would continue to grow at the current rate.
• A split of regional traffic between the Princes Highway and the ‘Sandtrack’ remaining unchanged, representing 55 per cent / 45 per cent north of Berry, and 60 per cent/40 per cent south of Berry.</td></tr>
<tr><td>The project</td><td>To assess the operational performance of the project (highway only).</td><td>2037, representing the design year of the project.</td><td rowspan="2">For the assessment of the impacts on the local road network within Berry, traffic volumes during the holiday peak northbound and southbound were selected to assess the performance of the intersections when traffic demand in the project area is at its greatest (being holiday peak periods).
For the assessment of the highway performance (or midblock), the following time periods were assessed:
• The AM and PM peak.
• The holiday peak hour northbound and southbound.</td><td>• The project and the Gerringong upgrade to the north of the project area would be completed by 2017. However, the Berry to Bomaderry upgrade proposal is not included in this scenario.
• Increase in traffic volumes on the Princes Highway above the current rate as a result of the transfer of traffic from the ‘Sandtrack’ to the Princes Highway at the completion of the project. This would result in a split of total traffic of around 81 per cent (Princes Highway) /19 per cent (the ‘Sandtrack’) at both locations in 2037.
• Changes to the local road network as a result of the project, being the removal of highway traffic within Berry, the operation of the northern and southern interchanges for Berry, and other minor road modifications that form part of the project.</td></tr>
<tr><td>The Princes Highway upgrade program</td><td>To assess the operational performance of the project, following the completion of all remaining highway upgrades.</td><td>2037, representing the design year of the project.</td><td>• Completion of the project and all remaining Princes Highway upgrades (being the Gerringong upgrade and Berry to Bomaderry upgrade proposal).
• Increase in traffic volumes on the Princes Highway above the current rate as a result of the transfer of traffic from the ‘Sandtrack’ to the Princes Highway. This would result in a split of total traffic of around 84 per cent (Princes Highway) /16 per cent (the ‘Sandtrack’) at both locations in 2037, as a result of the combined benefits of all three upgrades between Gerringong and Bomaderry on highway travel times, road safety and network efficiency.
• Changes to the local road network as a result of the project, being the removal of highway traffic within Berry, the operation of the northern and southern interchanges for Berry, and other minor road modifications that form part of the project.</td></tr>
</table>

Table 7-2 Construction assessment scenarios

Scenario	Assessment period	Assumptions
Representative	2017 AM peak and PM peak	• Existing highway layout (two-lane, two-way; no upgraded sections open to highway traffic). No transfer of traffic from the 'Sandtrack' to the Princes Highway. • At least one construction zone on the Princes Highway both north and south of Berry. • Temporary transfer of light vehicles from the Princes Highway to the 'Sandtrack', based on vehicles avoiding estimated delays associated with construction on the Princes Highway. It is expected that about three per cent of the combined traffic on both the Princes Highway and the 'Sandtrack' would divert to the 'Sandtrack' during construction. • Construction traffic generated by material and equipment deliveries, earthworks haulage and construction personnel travelling on the Princes Highway.
Worst case	2017 holiday peak northbound and southbound peak	• The completion and opening of some sections of the project, resulting in a transfer of traffic from the 'Sandtrack' to the Princes Highway. • No construction traffic travelling on the Princes Highway (consistent with the RMS commitment that construction would not occur during the holiday peak). • Existing highway layout (two-lane, two-way) on some sections of the Princes Highway north and south of Berry; a combination of upgraded and non-upgraded highway conditions throughout the project area. • At least one construction zone on the Princes Highway both north and south of Berry.

Further information on the methodology, inputs and assumptions can be found in the *Traffic and Transport Technical Paper* at **Appendix D**.

7.1.2 Existing environment

Regional and local road network

The Princes Highway is the main north-south regional road corridor between Sydney, the Illawarra and through the NSW south coast to Victoria. Within the project area, the highway serves as a:

- Commuter route between Sydney, Wollongong and Nowra.
- Local route for residents travelling within Berry and between Berry and surrounding towns and rural residences.
- Major tourist route for key destinations including Berry, Nowra and the NSW south coast.
- Freight and bus route, particularly for the NSW south coast and far South Coast.

In the project area, the Princes Highway is a two lane single carriageway between Toolijooa Road and Schofields Lane, with two short overtaking lanes for southbound traffic only. The existing highway does not meet current road design safety and traffic efficiency requirements, as discussed in **Chapter 2**.

The project commences at the junction of the existing highway and Toolijooa Road. Toolijooa Road is a local road which eventually provides a connection to Beach Road and Crooked River Road. This road only carries small volumes of traffic (less than 500 vehicles per day), and is primarily used by traffic accessing properties to the east of the highway.

From Toolijooa Road, the highway passes through the Foxground bends, passing Foxground Road and Broughton village. This section of the highway is winding, and there are steep grades, sharp bends and limited overtaking opportunities. Vehicles at the intersection of the highway with Foxground Road can turn either left or right onto or from the highway. Foxground Road is a local road that provides sole access to the highway for rural and rural-residential properties located along Foxground Road, Free Selectors Road and Hoddles Road. Rural properties along the highway have uncontrolled direct accesses to the highway, and are able to turn either left or right onto or from the highway.

After passing through the Foxground bends, the Princes Highway crosses the Broughton Creek floodplain and crosses Broughton Creek once. The highway then travels through the undulating landscape until reaching Berry. There are several at-grade junctions with local roads, including Austral Park Road and Tindalls Lane. These local roads only serve to provide connections to the highway for properties located alongside these roads. Vehicles can turn either left or right to or from the highway from these intersections or from private accesses.

Within Berry, the Princes Highway carries both highway and local traffic through the town centre (refer to **Figure 7-2**). The highway follows Queen Street within Berry between Tannery Road and Kangaroo Valley Road. These two roads, as well as Prince Alfred Street, provide access to local and regional areas with:

- Prince Alfred Street and Tannery Road providing connections between Berry and destinations located along the coastline, such as Shoalhaven Heads and Seven Mile Beach. Tannery Road has an annual average daily traffic (AADT) of 1680 vehicles, of which five per cent consists of heavy vehicles.
- Kangaroo Valley Road providing a connection to Kangaroo Valley, Moss Vale, the Hume Highway and beyond. Kangaroo Valley Road has an AADT of 1485 vehicles, of which five per cent consists of heavy vehicles.

The Princes Highway (Queen Street) also has numerous intersections with local roads within Berry. These intersections, in particular the Alexandra Street and Queen Street intersection, provide access to residences, businesses and other facilities located within Berry, such as retail, car parking, tourist accommodation, community facilities and recreational areas.

Parallel carparking is provided along Queen Street. This can contribute to congestion as traffic slows down or stops to enable cars to park or parked cars to merge back into the traffic flow. A pedestrian island, located between Prince Alfred Street and Alexandra Street, provides the only refuge for pedestrians crossing Queen Street.

Woodhill Mountain Road provides access to properties and communities directly north of Berry. This includes Broughton and Broughton Vale. It also provides an alternative access to Berry and the Princes Highway from Woodhill and Wattamolla. Woodhill Mountain Road has an AADT of 970 vehicles, of which six per cent consists of heavy vehicles.

North Street provides an alternative route to Queen Street between Kangaroo Valley Road and Woodhill Mountain Road to the north of Berry. However, only a small proportion of through traffic currently uses this route to avoid congestion. Rawlings Lane connects to North Street, and provides property access to properties immediately north of Berry.

Victoria Street, which runs parallel to Queen Street, provides an immediate connection to the Princes Highway, south of the Kangaroo Valley Road intersection with Queen Street. This carries a small volume of traffic, with about 200 vehicles currently turning at the Victoria Street and the Princes Highway intersection during AM and PM peak periods.

Huntingdale Park Road connects to Kangaroo Valley Road, and provides the sole access to the Huntingdale Park Estate development.

South of Berry, the existing highway travels along the floodplain on a fairly straight alignment and remains a two lane single carriageway. It has at-grade junctions with Hitchcocks Lane and Schofields Lane, where vehicles can turn left or right. These local roads only serve to provide connections to the highway for properties located alongside these roads. As such, these roads carry only small volumes of traffic. Properties also have direct and uncontrolled access to and from the highway.

Beyond the immediate vicinity of the highway the ‘Sandtrack’ offers an alternative route for light vehicles between Gerringong and Bomaderry and comprises Fern Street, Crooked River Road, Gerroa Road and Bolong Road (refer to **Figure 7-2**). The ‘Sandtrack’ enables motorists to bypass the project area, avoiding the winding, hilly sections of the Princes Highway and general highway traffic congestion. It also intersects with local roads and provides an important connection to property and businesses within the project area and beyond. It has a five tonne load limit for heavy vehicles.

Figure 7-2 Transport network in project area

Source: LPMA, 2011

Travel speeds and travel times

The Princes Highway within the project area has a variable posted speed limit ranging from:

- 80 kilometres per hour on the section north of the existing Broughton Creek crossing, through the Foxground bends.
- 90 kilometres per hour on the section between the Broughton Creek crossing to the north of Berry.
- 50 kilometres per hour through Berry.
- 100 kilometres per hour south of Berry.

The ‘Sandtrack’ has a posted speed limit of 90 or 100 kilometres per hour for much of its length. Fern Street is used to travel from the ‘Sandtrack’ into Gerringong and has a posted speed limit of 50 kilometres per hour.

The Princes Highway currently has an average travel time of around 14-15 minutes between Toolijooa Road and Schofields Lane. The ‘Sandtrack’ is shorter in length and operates at a higher average speed, with travel taking less than eight minutes on average between Dooley Road and Shoalhaven Heads Road. The slower Princes Highway time is due to the Foxground bends, and varying and lower posted speed limits and delays when travelling through Berry. However, when comparing the highway and the ‘Sandtrack’ between Gerringong and Bomaderry, the routes are comparable in both length and travel time (about 30 minutes).

Within Berry, there is a posted speed limit of 50 kilometres per hour. Woodhill Mountain Road and Kangaroo Valley Road both have a posted speed limit of 50 kilometres per hour in the vicinity of Berry. Outside of Berry, the posted speed limit on Woodhill Mountain Road and Kangaroo Valley Road increases to 80 kilometres per hour and 60 kilometres per hour respectively.

Annual traffic growth

The closest permanent automatic traffic count site to the project area is on the Princes Highway, near Rose Valley Road, which is north of Gerringong. At this location, the AADT was 21,300 vehicles in 2010 (refer to **Table 7-3**). The average annual growth is 3.2 per cent, or 400 vehicles per year. Although this location is outside the project area, it is indicative of the continuous level of traffic growth along the Princes Highway.

Table 7-3 **AADT traffic growth summary (1990–2010)**

Location:	**Site 7.800: Princes Highway, north of Rose Valley Road**		
Year	**AADT**	**Growth rate**	
		Period	**Average annual growth (%)**
1990	12,944	-	-
1994	14,791	1990 – 1994	3.6
1997	15,711	1994 – 1997	2.1
2000	17,753	1997 – 2000	4.3
2002	18,960	2000 – 2002	3.4
2004	19,371	2002 – 2004	1.1
2006	18,731	2004 – 2006	-1.7
2008	19,675	2006 – 2008	2.5
2010	21,300	2008 – 2010	4.1
-	-	1990 – 2010	3.2

(Source: AECOM, based on NSW Roads and Maritime Services Southern Region Traffic Survey Data)

Traffic patterns, including seasonality

Table 7-4 provides daily and peak period traffic volumes, which are based on survey data collected in May/June 2009 and April/May 2011 at key locations on the Princes Highway and the ‘Sandtrack’.

The survey results indicate that:

- There is a loss of around 2450 vehicles per day to Gerringong and villages adjacent or near to the highway between Berry and Gerringong via local roads.
- The split of traffic between the highway and the ‘Sandtrack’ represents a 55 per cent and 45 per cent split respectively.
- There is a higher proportion of traffic arriving and departing Berry to and from the south, compared to traffic originating/departing from the north.
- Heavy vehicles represent eight per cent of the AADT north of Gerringong, increasing to around 12 per cent and 13 per cent of the AADT to the south and north of Berry respectively.
- Heavy vehicles on the ‘Sandtrack’ represent three to four per cent of the AADT due to the five tonne vehicle load limit on that road.
- Only a small proportion of vehicles travelling to, from and within the project area use the regional roads surveyed. For example, the AADT of Kangaroo Valley Road (1,485 vehicles) is the equivalent of around 12 per cent of AADT on the highway near Kangaroo Valley Road.

Table 7-4 Daily and peak period traffic volume summary (2009-2011)

Location	Year	Two-way traffic flows					
		AM peak (veh/h)	PM peak (veh/h)	Holiday peak nthbound peak (veh/h)	Holiday peak sthbound peak (veh/h)	AADT	
						Flow (veh/day)	% heavy veh
Princes Highway, north of Rose Valley Road	2010	1525	1800	2470	2680	21,300	8
Princes Highway, north of Tannery Road	2011	730	875	1185	1275	10,755	13
Tannery Road, east of Pulman Street	2011	130	165	125	95	1680	5
Woodhill Mt. Road, north of North Street	2011	80	100	90	110	970	6
Prince Alfred Street, south of Queen Street	2011	-	-	155	220	-	-
Kangaroo Valley Road, north of North Street	2011	115	140	155	140	1485	5
Victoria Street, east of Princes Highway	2012	215	190	170	245	2170	4
Princes Highway, south of Victoria Street	2011	930	1090	1250	1475	13,400	12
'Sandtrack', south of Belinda Street	2009	620	760	1010	1100	8700	3
'Sandtrack', south of Beach Road	2009	450	590	770	840	6650	4

(Source: AECOM, based on NSW Roads and Maritime Services Southern Region Traffic Survey Data)
Veh/h = Vehicles per hour

The seasonal variations, weekly and daily peak periods of traffic volumes within the project area reflect the rural nature of the area and the function of the highway as a major tourist route.

The traffic count site near Rose Valley Road shows that traffic flows are highest during major holiday periods, including the school holidays at Christmas, Easter, and Labour Day in October. At this location, daily traffic volumes during Christmas holidays peaked at over 26,000 vehicles or 20 per cent more vehicles compared to the AADT.

In an average week, the Princes Highway experiences a significant increase in southbound traffic on Friday afternoons and Saturday mornings, and northbound traffic on Sunday afternoons due to recreational weekend travel to and from the south coast from Sydney and Wollongong. This would increase the likelihood of congestion and delays during weekend peak hours compared to the AM and PM peaks through the week.

On an average day, the Princes Highway and the ‘Sandtrack’ experience a steady traffic increase throughout the day, peaking at around 3-4pm before decreasing in the early evening. This early peak suggests a significant level of after school pickup and associated social and commercial activity in the area during and after school pickups.

Within Berry, traffic in the town centre is at its highest during holiday and other recreational peak periods. To understand local traffic behaviours and to determine the percentage of vehicles that do not stop in Berry, traffic surveys were undertaken in 2007 and 2011. In 2011, the surveys were undertaken during the Easter and ANZAC long weekends to determine traffic behaviour during the holiday peak period, and included origin-destination surveys.

These surveys found that non-stopping through traffic contributes around 80 per cent of total traffic travelling through Berry on the Princes Highway on a typical weekday. During the holiday peak periods, traffic volumes are higher and travel patterns vary. As a result, through traffic fluctuates considerably between 50 and 75 per cent of total traffic.

The 2011 survey highlighted the heavy congestion and delays experienced on the road network within Berry during the busiest peak periods (refer to **Table 7-5**). For example average travelling time on the Princes Highway (northbound) between the Victoria Street intersection and the Tannery Road intersection was around 15 minutes during the northbound holiday peak period. This increased to 20-22 minutes for the 85th percentile. The 85th percentile represents the time 85 per cent of motorists took to travel through Berry and is used to distinguish between stopping and non-stopping traffic.

Table 7-5 Princes Highway travel times through Berry (holiday peak periods)

Origin	Destination	Direction	Minimum (mm:ss)	Average (mm:ss)	85th percentile (mm:ss)
Northbound holiday peak period					
Princes Highway, north of Tannery Road	Princes Highway, south of Victoria Street	Southbound	02:24	08:31	06:00-06:30
Princes Highway, south of Victoria Street	Princes Highway, north of Tannery Road	Northbound	03:02	14:44	20:00-22:00
Southbound holiday peak period					
Princes Highway, north of Tannery Road	Princes Highway, south of Victoria Street	Southbound	02:48	06:08	05:30-06:00
Princes Highway, south of Victoria Street	Princes Highway, north of Tannery Road	Northbound	02:40	05:44	04:00-04:30

mm:ss – minute minute:second second

Current network performance

Level of service (LoS) is a qualitative measure describing operational conditions within a traffic stream. The desirable maximum capacity of each road section is determined from the 'Guide to Traffic Management, Part 3: Traffic Studies and Analysis' (AUSTROADS, 2009). It is generally described in terms of service measures such as the following:

- Speed and travel time.
- Freedom to manoeuvre.
- Traffic interruptions.
- Comfort and convenience.
- Road safety.

A description of the LoS scale for highway flows and intersection performance is provided in **Table 7-6** and **Table 7-7** respectively.

Table 7-6 LoS for highway flows

LoS	Description
A	A condition of free flow in which individual drivers are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to manoeuvre within the traffic stream is extremely high, and the general level of comfort and convenience provided is excellent.
B	In the zone of stable flow where drivers still have reasonable freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is a little less than with LoS A.
C	Also in the zone of stable flow, but most drivers are restricted to some extent in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience declines noticeably at this level.
D	Close to the limit of stable flow and approaching unstable flow. All drivers are severely restricted in their freedom to select their desired speed and to manoeuvre within the traffic stream. The general level of comfort and convenience is poor, and small increases in traffic flow will generally cause operational problems.
E	Traffic volumes are at or close to capacity, and there is virtually no freedom to select desired speeds or to manoeuvre within the traffic stream. Flow is unstable and minor disturbances within the traffic stream will cause breakdown.
F	In the zone of forced flow, where the amount of traffic approaching the point under consideration exceeds that which can pass it. Flow breakdown occurs, and queuing and delays result.

Table 7-7 LoS criteria for intersections

LoS	Average delay/vehicle (seconds/vehicle)	Traffic signals | roundabout	Give way | stop signs
A	Less than 14	Good operation	Good operation
B	15 to 28	Good with acceptable delays and spare capacity	Acceptable delays and spare capacity
C	29 to 42	Satisfactory	Satisfactory, but accident study required
D	43 to 56	Operating near capacity	Near capacity and accident study required
E	57 to 70	At capacity; at signals incidents would cause excessive delays	At capacity; requires other control mode
F	>70	Roundabouts require other control mode	At capacity; requires other control mode

Source: 'Guide to Traffic Generating Developments' (RTA 2002)

The Princes Highway both north and south of Berry currently operates at LoS D in both the morning and afternoon peak periods at the locations specified in **Table 7-8**, while the 'Sandtrack' currently operates at LoS C (refer to **Table 7-8**). During holiday peak periods, the operational performance of the Princes Highway deteriorates to an unacceptable LoS E at most locations and the 'Sandtrack' operates at LoS D.

By 2037, the Princes Highway would operate at an unacceptable LoS E or LoS F for all peak periods in the absence of the project, should traffic continue to grow at current rates (refer to **Table 7-9**). This would result in the breakdown of traffic flow and major delays. The 'Sandtrack' would be expected to deteriorate to LoS D during the typical AM and PM peak, and LoS E during the highest holiday (southbound) peak period.

Key intersections in and around Berry currently have sufficient capacity to accommodate the high levels of demand associated with holiday peak period traffic (refer to **Table 7-10**). The intersections of Queen Street and Kangaroo Valley Road, Queen Street and Albert Street, and the Princes Highway and Tannery Road have three approach roads, with only small levels of traffic demand from their minor approaches. With little conflicting traffic demand, these intersections operate with minimal delay at LoS A.

As traffic volumes increase on Queen Street (Princes Highway), conflicting traffic demands of through and local traffic within Berry would result in longer delays and decreased LoS by 2037 (refer to **Table 7-11**). There would also be fewer gaps in the traffic flow, creating significant delays to vehicles attempting to turn onto or cross Queen Street. This would cause the performance of some major intersections of Queen Street, such as Kangaroo Valley Road, Alexandra Street, Prince Alfred Street and Tannery Road to deteriorate during peak periods, with significant average delays by 2037.

Longer delays would also have implications on the performance of the local road network in Berry where queuing traffic blocks adjacent intersections. If the road network remains unchanged and highway traffic is not removed from Berry, it is expected that local roads and intersections would be unable to accommodate the forecast increase in traffic volumes.

Table 7-8 2011 Highway (midblock) LoS summary (current situation)

Location	AM peak hour (veh/h)		PM peak hour (veh/h)		Holiday peak northbound (veh/h)		Holiday peak southbound (veh/h)	
	2-way volume	LoS	2-way volume	LoS	2-way volume	LoS	2-way volume	LoS
Princes Highway: Toolijooa Road – Tannery Road	730	D	875	D	1187	D	1275	E
Princes Highway: Victoria Street – South of Schofields Lane	927	D	1090	D	1248	E	1477	E
'Sandtrack': Dooley Road – Shoalhaven Heads Road	681	C	814	C	977	D	1144	D

Table 7-9 2037 Highway (midblock) LoS summary ('Do nothing' scenario)

Location	AM peak hour (veh/h)		PM peak hour (veh/h)		Holiday peak northbound (veh/h)		Holiday peak southbound (veh/h)	
	2-way volume	LoS	2-way volume	LoS	2-way volume	LoS	2-way volume	LoS
Princes Highway: Toolijooa Road – Tannery Road	1381	E	1658	E	2172	F	2372	F
Princes Highway: Victoria Street – South of Schofields Lane	1749	E	2062	E	2286	F	2714	F
'Sandtrack': Dooley Road – Shoalhaven Heads Road	1108	D	1324	D	1539	D	1789	E

Table 7-10 2011 intersection LoS summary (current situation)

Intersection / approach road	Holiday peak northbound			Holiday peak southbound		
	Approach volume (veh/h)	Average delay (second)	LoS	Approach volume (veh/h)	Average delay (second)	LoS
Princes Highway / Victoria Street						
Princes Highway northbound	893	0.0	A	542	0.0	A
Victoria Street westbound	51	0.0	A	158	0.5	A
Princes Highway southbound	280	0.0	A	776	0.0	A
Total	1224	0.0	A	1476	0.1	A
Queen Street (Princes Highway)/Kangaroo Valley Road						
Queen Street eastbound	751	0.0	A	457	0.0	A
Kangaroo Valley Road	92	3.7	A	97	3.0	A
Queen Street westbound	353	0.1	A	846	0.0	A
Total	1196	0.3	A	1400	0.2	A
Queen Street (Princes Highway)/Alexandra Street						
Queen Street eastbound	819	0.0	A	543	0.0	A
Alexandra Street southbound	79	12.5	A	118	22.2	B
Queen Street westbound	318	0.1	A	812	0.0	A
Alexandra Street northbound	92	8.6	A	65	16.8	B
Total	1308	1.4	A	1538	2.4	A
Queen Street (Princes Highway)/Prince Alfred Street						
Queen Street eastbound	816	0.0	A	517	0.1	A
Queen Street westbound	329	1.6	A	797	2.3	A
Prince Alfred Street northbound	151	9.2	A	139	22.7	B
Total	1296	1.5	A	1453	3.5	A
Queen Street (Princes Highway)/Albert Street						
Queen Street eastbound	859	4.1	A	528	4.1	A
Albert Street	58	2.6	A	62	1.4	A
Queen Street westbound	367	2.7	A	865	2.4	A
Total	1284	3.6	A	1455	3.0	A
Princes Highway/Tannery Road						
Princes Highway eastbound	914	1.5	A	550	1.9	A
Princes Highway westbound	292	1.1	A	790	1.1	A
Tannery Road	66	1.2	A	79	2.4	A
Total	1272	1.4	A	1419	1.5	A

Table 7-11 2037 intersection LoS summary ('Do nothing' scenario)

Intersection / approach road	Holiday peak northbound			Holiday peak hour southbound		
	Approach volume (veh/h)	Average delay (seconds)	LoS	Approach volume (veh/h)	Average delay (seconds)	LoS
Princes Highway / Victoria Street						
Princes Highway northbound	1681	0.0	A	870	94.7	A
Victoria Street westbound	83	0.2	A	173	3.9	A
Princes Highway southbound	486	0.0	A	918	0.0	A
Total	2250	0.0	A	1961	42.4	D
Queen Street (Princes Highway) / Kangaroo Valley Road						
Queen Street eastbound	1469	0.2	A	733	104.4	F
Kangaroo Valley Road	270	276	F	106	773.9	F
Queen Street westbound	663	19.5	B	1056	15.4	B
Total	2402	36.5	C	1895	92.3	F
Queen Street (Princes Highway) / Alexandra Street						
Queen Street eastbound	1637	0.6	A	789	86.2	F
Alexandra Street southbound	130	276	F	106	426.6	F
Queen Street westbound	634	1.0	A	1011	3.3	A
Alexandra Street northbound	136	329	F	98	438.9	F
Total	2537	32.4	C	2004	79.6	F
Queen Street (Princes Highway) / Prince Alfred Street						
Queen Street eastbound	1589	2.0	A	766	90.2	F
Queen Street westbound	659	3.9	A	1002	5.3	A
Prince Alfred Street northbound	222	197	F	156	296.9	F
Total	2470	20.0	B	1924	62.7	E
Queen Street (Princes Highway) / Albert Street						
Queen Street eastbound	1595	4.6	A	766	72.6	F
Albert Street	83	20.5	B	42	137.7	F
Queen Street westbound	855	16.8	B	1100	41.6	C
Total	2533	8.9	A	1908	56.2	E
Princes Highway / Tannery Road						
Princes Highway northbound	1656	4.0	A	776	72.7	F
Princes Highway southbound	583	1.2	A	996	25.6	B
Tannery Road	166	5.4	A	81	696.7	F
Total	2405	3.4	A	1853	74.7	F

Road safety

The current fatality rate for the project area is around 0.8 per 100 million vehicle kilometres travelled (MVKT). The NSW average fatality rate is 0.6 per 100 MVKT (for the 12-month period ending in June 2012). The project area therefore has over 30 per cent more fatalities per kilometre travelled than the NSW average. An analysis of crash statistics collected by RMS between 1 July 2003 and 30 September 2010 found that this section of the highway performs relatively poorly, with 118 recorded crashes during this period, of which 61 resulted in personal injury and three involved fatalities.

In addition, the ‘Sandtrack’ has a high fatality rate of 0.7 per 100 MVKT, again higher than the NSW average. Five fatal and 81 injury crashes occurred on the ‘Sandtrack’ between 1 July 2003 and 30 September 2010.

The frequency of crashes on the highway and the ‘Sandtrack’ would be expected to increase should the network remain unchanged.

Modes of travel

Private vehicles are the predominant mode of transport in the Shoalhaven and Kiama local government areas (LGAs), representing around 85 per cent of total trips on a weekday. Berry is about two and a half hours drive from Sydney, and it typically takes an additional 15 minutes to drive further south to Bomaderry. Private vehicles are the main transport mode because public transport services are limited both within and to the project area.

In terms of public transport, bus and rail account for fewer than five per cent of total trips on a weekday in the Shoalhaven and Kiama LGAs. Berry and the surrounding area are serviced by:

- The South Coast railway line, with Berry station located at Railway Street.
- Shoal Bus, a private bus operator providing two local services, and two school bus services.
- Premier Motor Service, a private bus operator providing regional/interstate services and school bus services.

The South Coast Railway Line provides connections to Sydney, Wollongong, Dapto, Kiama, Gerringong, Berry and North Nowra/Bomaderry. There are no direct services to Sydney and passengers are required to change at Wollongong, Dapto or Kiama. Daily passenger demand at Berry is low, with only 140 passengers entering or exiting the station during a typical 24 hour period.

Local and regional bus and coach services utilise the Princes Highway and local road network within Berry (refer to **Table 7-12**). However, the number of routes and frequency of services available are limited. This has resulted in fewer bus passengers when compared to other forms of travel, with bus passengers representing two to four per cent of the average weekday travel demand from the Shoalhaven and Kiama LGAs.

Patronage figures for school services between Gerringong, Berry and Bomaderry suggest around 20 students typically use these services on a daily basis during the school term.

Table 7-12 Description of bus routes within the project area

Route	Frequency	Comments
Shoal Bus		
A regular service travels from Werri Beach to Berry via the 'Sandtrack' and Beach Road; and then on to Bomaderry and Nowra via the Princes Highway (Route 705).	A minimum service of twice per day, with an additional two 'Shoal Shopper' services on Tuesday and Friday.	Express service travelling between Gerringong and Nowra typically takes 30-45 minutes, while all stop services can take over an hour.
A regular service operates between Berry (Queen Street and Station Road) and Shoalhaven Heads via Prince Alfred Street and Coolangatta Road (Route SB).	Two services operate on a typical weekday during morning and afternoon school pickup hours, with one on Saturdays.	On a typical weekday, the travel time for this route is around 30 minutes in the morning and 15 minutes in the afternoon.
School-specific services: A school service starts in Gerringong, travels down the 'Sandtrack', before it travels to Berry via Beach Road; and then to Bomaderry via the Princes Highway. A school service starts in Foxground and travels along the Princes Highway through Berry to Nowra.	Morning pick-up and afternoon drop-off periods.	The Foxground – Nowra service has informal rural pick-up and drop-off locations along the Princes Highway where children reside, as well as at numerous intersections between the Princes Highway and local roads in the project area.
Premier Motor Service		
Daily services operate in each direction, linking Sydney and Melbourne via Kiama, Gerringong and Nowra.	Two daily Princes Highway bus services in each direction.	-
A school service that operates between Bomaderry and Toolijooa Road along the Princes Highway.	Morning pick-up and afternoon drop-off periods.	-

Road shoulders and verges provide the only means for pedestrians or cyclists to travel along the Princes Highway. This and the speed of traffic combined with significant travel distances between neighbouring towns (ie Gerringong, Bomaderry and Berry), result in very low pedestrian and cyclist flows.

Footpaths are provided in Berry between Woodhill Mountain Road and Kangaroo Valley Road to service local shops and businesses on Queen Street. Residential streets in the town have one-sided, partial or no footpaths.

There are currently no cycle-specific facilities along the Princes Highway in the project area. In the surrounding region, an off-road cycle route links Gerringong and Gerroa along Fern Street and a six kilometre coastal walking track links Kiama and Gerringong.

There are no formal cycle specific facilities in Berry but Shoalhaven Council promotes various cycle routes to and from Berry utilising the Princes Highway and other local and regional roads (for example Berry to Seven Mile Beach via the Princes Highway, Tannery Road and Beach Road, and Berry to Kangaroo Valley via Berry Mountain).

A proposed 1400 kilometre coastal cycleway stretching from the Queensland border, through NSW to the Victorian border includes a section within the study area that follows the route of the ‘Sandtrack’. This connects to the Berry to Seven Mile Beach route described above. It is largely funded by RMS and implemented by local government, and has already resulted in over 330 kilometres of the route being constructed or committed, in the form of shared pedestrian/cycle paths or on-road cycle lanes along local streets. There are opportunities for Shoalhaven and Kiama Councils to apply for grants to improve the route for cyclists.

Garbage truck services operate along North Street and Rawlings Lane, Berry on Thursdays. These services are operated by Shoalhaven City Council.

Police and fire brigade services also operate within Berry. The police station is located at 56 Victoria Street, Berry and the fire station is located at 26 Prince Alfred Street, Berry.

7.1.3 Assessment of potential impacts

Construction impacts

Construction activities would disrupt highway, regional and local flows, leading to travel time delays and decreased network performance as discussed in this section.

Construction routes

The project construction would create an increase in construction vehicles travelling to, from, and within the project area on the existing Princes Highway and local roads. This would include additional traffic demand generated by:

- Construction workers travelling to and from worksites.
- Delivery of heavy vehicles, machinery and other equipment required for highway construction.
- Delivery of construction materials including cement, aggregates and pre-fabricated structures.
- Movement of spoil haulage generated by earthworks, including the transfer of spoil to stockpile sites and/or removal from the project area.

Construction traffic would use the cleared project footprint where possible, to transport materials within the project area. This would occur either adjacent to the highway or via a haul route as appropriate.

It is anticipated that a large proportion of construction-related traffic would travel to and from the project area from Kiama, Port Kembla and Wollongong. North of the project, the Gerringong upgrade of the Princes Highway is proposed to be completed, providing a divided carriageway with two lanes in each direction (Gerringong upgrade) prior to construction of the current project. The main construction route would include the existing highway north of Gerringong and the upgraded section of highway between Gerringong and the project. This would provide sufficient capacity for construction-related vehicles to travel to and from work sites safely and efficiently.

Wherever practicable, the new sections of highway that are to be constructed away from the existing highway (referred to as offline construction) would be completed first, with the aim of removing construction-related vehicles from the existing highway. This would minimise traffic impacts along the construction route. Construction traffic entry and exit points would be minimised and controlled and the use of the existing highway would be restricted at peak hours, especially during holiday periods. This would also maintain traffic flow along the construction route.

During construction of the bypass at Berry, construction vehicles would be present in the northern end of Berry to source and transport material to/from the project footprint to the proposed stockpile site and compound/office adjacent to Woodhill Mountain Road and also to the compound/office south of North Street, accessed via Kangaroo Valley Road. All other compound stockpile sites and construction compounds/offices would be accessed directly from the existing highway or would involve additional travel for short distances on local roads after turning off the highway (eg Toolijooa Road).

Construction traffic

The ultimate volume of traffic generated by the project would be dependent on the construction methods adopted by the selected contractor, location of material suppliers, final material and spoil volumes, location and size of stockpile sites and use of haulage roads. These construction methods and subsequent detailed forecasts of traffic volumes and trip patterns would be developed from the final detailed design. However, based on assumptions on construction material estimates and staffing requirements, it has been estimated that around:

- 45,000 heavy vehicles would be generated during construction (or 90,000 vehicle movements) across the three year construction period. This would equate to an average of around 53 heavy vehicles per day, or 106 heavy vehicle movements per day.
- 65 light vehicles per day (or 130 movements per day) would be generated by construction workers. This is based on an assumed average of two construction personnel per vehicle.

Earthworks haulage and the delivery of dry bulk materials are expected to generate the vast majority of heavy vehicle movements (refer to **Table 7-13**).

Table 7-13 Construction traffic estimates

Estimated construction traffic generation – heavy vehicles:					
Source	Estimated volume of materials for haulage (average, per km)	Estimated volume of materials for haulage (total)	Vehicle capacity (average)	Estimated vehicle generation	
				Total	Daily (average)
Earthworks	-	1,000,000 m^3	30 m^3	33,333	39
Dry bulk materials	28,450 m^3	330,000 m^3	30 m^3	11,000	13
Reinforcing steel	460 tonnes	5320 tonnes	10 tonnes	532	1
Pre-fabricated units	18 units	205 units	1 unit	205	<1
Total – heavy vehicles	-	-	-	45,000	53

Impacts on regional roads, local roads and property access

Construction traffic would also generate noise, air quality and amenity impacts, particularly when heavy vehicles travel through Berry. However, it is not expected that the increase in traffic would reduce road safety, provided that adequate traffic management measures are employed.

It is RMS' goal to maintain an 80 kilometres per hour construction speed zone (where normal posted speeds equal or exceed this limit), which would minimise traffic delays. However, delays for traffic using the Princes Highway would be expected during construction periods for sections of the project where the existing highway would be upgraded (referred to as online construction). Delays would also be expected when tying new work in with the existing highway. For example disruptions and delays to local and highway traffic would be experienced during construction due to the narrowing of lanes and temporary speed reductions. There would also be delays to local traffic when other local or private roads are being bridged or tied in with the project. Large sections of the project completed offline would minimise the impacts to traffic efficiency on the current road network. This would include sections at Toolijooa Ridge, Broughton Creek and the Berry bypass.

Local roads outside of Berry that would potentially experience delays during construction include roads directly linked to, or serviced by, the new grade-separated interchanges at Toolijooa Road, Austral Park Road, and Tindalls Lane. Residents in the Foxground and Broughton Village areas who would use the new interchanges at Toolijooa Road and Austral Park Road would experience some closures and detours while construction is underway. Residents accessing properties along sections of the proposed upgraded highway may also experience delays and traffic management measures would maintain access while construction work is underway.

Within Berry, temporary delays would occur where:

- Proposed interchanges tie into the Berry bypass, including the upgrade and modification of existing intersections (for example the intersections of Kangaroo Valley Road with Queen Street and Huntingdale Park Road).
- Local road works are proposed (for example, the Woodhill Mountain Road roundabout).
- Temporary and/or permanent severance of local road connections are proposed, specifically Victoria Street, North Street, Rawlings Lane and Kangaroo Valley Road.

It is likely that roads directly linked to, or serviced by the new grade-separated interchanges would experience some closures and detours. In particular, the construction of the new Kangaroo Valley Road overpass at the southern interchange to Berry would require a temporary road closure. Kangaroo Valley Road is the key local road connection used by newer residential areas of Berry to access the highway and the retail and recreational areas of Berry. During this time, it is possible that traffic would be diverted along North Street and as a result, the Kangaroo Valley Road bridge would need to be operational before construction could commence on the bypass section that severs North Street, unless alternative arrangements for access are arranged.

North Street and Rawlings Lane properties would require access modifications, and bus routes and garbage routes would be impacted as a result of the permanent severance of North Street. These are discussed further within the operational impacts section.

It is estimated that about three per cent of total through traffic travelling between Gerringong and Bomaderry would shift from the highway to the 'Sandtrack', temporarily increasing traffic volumes on the 'Sandtrack', particularly during holiday peak periods. The impact of this increase in traffic on the performance of the 'Sandtrack' is discussed further within the LoS assessment below.

Toolijooa Road is a local road that currently carries very low traffic volumes (less than 500 vehicles per day), with the majority of vehicles using it to access properties along its length between the Princes Highway and Beach Road. It could potentially offer an alternative route during construction for vehicles attempting to avoid traffic delays resulting from construction activity, as the intersection between Toolijooa Road and the Princes Highway is located at the boundary of the project area to the east. However, it is anticipated that Toolijooa Road would continue to be mainly used by local residents during construction, given it is:

- Signposted as a local road with a posted speed limit of 60 kilometres per hour.
- Of a lower standard than the Princes Highway and the 'Sandtrack', with lower quality road surfaces including an unsealed section, narrow lanes, and a poor alignment.

The use of local roads by heavy vehicles associated with construction would be limited to where these roads provide access to construction ancillary sites, or where local road modifications are proposed. Two construction ancillary sites are located off the Princes Highway which would require travel along local roads, namely the site located off Woodhill Mountain Road and the site located adjacent to North Street (and accessed via Kangaroo Valley Road).

The existing AADT on Woodhill Mountain Road and Kangaroo Valley Road is 970 and 1485 vehicles respectively. Based on the most-likely construction scenario and assuming a maximum of 50 heavy vehicles per day, the impacts on both local roads is likely to be between a three per cent and five per cent increase on existing traffic volumes. Although the presence of heavy vehicles close to the town would be a temporary inconvenience to the community during construction of the bypass, the additional trucks would have a negligible impact on the operational performance of both roads with minimal delay and congestion. This is due to the low volume of daily and peak period local traffic flows that currently travel on Woodhill Mountain Road and Kangaroo Valley Road, the close proximity of the stockpile/ compound sites and direct access to the Princes Highway to transport residual material to other sites/locations external to the town.

Public transport and emergency services

There would be potential for disruptions to existing public transport bus services due to construction of the project. Existing bus services pick up and set down at informal stops along the highway at driveways and intersections. Permanent or temporary closures of local access points as well as construction activities along the outer edge of the highway, would limit the areas along the highway where buses would be able to stop safely.

There would be potential delays to response times for emergency services. Delays due to construction activities, queuing traffic and reduced speed limits may disrupt emergency services. Procedures to minimise the impacts to emergency services during construction would be incorporated into the construction environmental management plan (CEMP) (refer to **Section 7.1.4**).

Impacts on network performance (LoS)

To assess the impacts of construction work on the LoS of the highway and key intersections within Berry, the following representative and worst case scenarios have been assessed, as follows (refer **Appendix D**):

- Representative or the 'most likely' scenario, indicative of construction traffic increasing volumes on the Princes Highway on a typical day, with a proportion of traffic transferring to the 'Sandtrack' to avoid construction works.
- A worst case scenario for the opening year (2017), representing the assessment of the road network during a holiday peak with the expected transfer of 'Sandtrack' traffic predicted following the completion of the Princes Highway upgrade program.

The worst case scenario would be ameliorated by the implementation of appropriate mitigation measures, as outlined at **section 7.1.4**. During the representative scenario, the construction traffic is estimated to consist of:

- 65 light vehicles used by construction workers during AM and PM peak hours.
- 10 heavy vehicles during AM and PM peak hours, based on the assumption that heavy vehicles would follow a more even distribution throughout a typical day compared to construction workers.

When compared to the total traffic on the Princes Highway, construction traffic is expected to contribute around seven per cent of total traffic during these peak periods. As an example, during a typical 2017 AM peak hour on the Princes Highway east of Tannery Road, total traffic is expected to reach around 1031 vehicles, including an estimated 75 construction vehicles.

Highway and 'Sandtrack' performance

Based on 2017 traffic volumes, the highway is expected to operate at a LoS E without the introduction of construction traffic north and south of Berry. This would not change with the addition of construction traffic (refer to **Table 7-14**). However, travel speeds would marginally decrease as a result of construction traffic. Average travel speeds on the Princes Highway would be around 50-60 kilometres per hour, with passing constrained by traffic management measures through construction zones. Current levels of road safety are not expected to decrease with the introduction of appropriate traffic management measures.

The 'Sandtrack' is expected to continue at LoS C during the typical AM and PM peak hours during the representative scenario up to and including the final year of construction, despite the predicted increase in light vehicles using this route to avoid construction delays. This relatively small increase in traffic is not expected to decrease the safety of this route. RMS would not utilise the 'Sandtrack' as a diversion route and would not seek the removal of the existing five tonne limit on the 'Sandtrack'. However, a three per cent transfer of traffic to the 'Sandtrack' has been factored into the assessment to account for motorist behaviour. The relatively small increase in traffic is not expected to decrease the safety of the 'Sandtrack'.

Table 7-14 2017 midblock LoS summary (representative construction scenario)

Location	AM peak hour (veh/h)		PM peak hour (veh/h)	
	2-way volume	LoS	2-way volume	LoS
Princes Highway: Toolijooa Road – Tannery Road	972	E	1150	E
Princes Highway: Victoria Street – South of Schofields Lane	1,160	E	1348	E
'Sandtrack': Dooley Road – Shoalhaven Heads Road	728	C	870	C

For the worst case scenario, two key assumptions have been made:

- Completed portions of the project have been opened to traffic, resulting in the transfer of traffic from the 'Sandtrack' to the highway. The transfer represents the predicted split of traffic once the Princes Highway upgrade program is complete.
- No construction work would be undertaken during holiday peak periods and as such, no construction vehicles would be travelling during this period. This reflects the RMS commitment to manage the project to avoid construction work during these times so that disruption to highway flows during holiday peak periods would be minimised.

Despite the removal of construction vehicles from the road network, the modelled ‘worst case’ scenario reflects the likely period of the poorest performance of the road network. This is a result of the combination of the holiday peak traffic volumes, a three per cent transfer of traffic from the ‘Sandtrack’ and the impact of traffic management measures through construction zones (such as speed restrictions and passing constraints).

The results of the worst case scenario analysis indicate that the highway would operate at LoS E during both the holiday peak northbound and southbound scenarios (refer to **Table 7-15**). Average travel speeds would drop to 50 kilometres per hour or less. This is attributed to the increase in traffic, speed restrictions and the prevention of overtaking in construction zones. Despite this reduction in performance, the LoS E indicates that the highway would have the capacity to accommodate the worst-case traffic volumes during construction.

On the ‘Sandtrack’, the LoS would remain relatively unchanged despite the reduction in traffic, with a LoS C during holiday northbound peak and LoS D during the busier holiday southbound peak.

Table 7-15 2017 midblock LoS summary (worst-case construction scenario)

Location	Holiday peak northbound (veh/h)		Holiday peak southbound (veh/h)	
	2-way volume	LoS	2-way volume	LoS
Princes Highway: Toolijooa Road – Tannery Road	1666	E	1793	E
Princes Highway: Victoria Street – South of Schofields Lane	1674	E	1967	E
“Sandtrack”: Dooley Road – Shoalhaven Heads Road	792	C	924	D

Berry road network performance

The main factors influencing the performance of the road network and intersections in Berry during construction include the diversion of traffic during road closures and natural traffic growth.

Construction would not include any major works within the centre of Berry. The construction of the new Kangaroo Valley Road interchange would be the most substantial modification to the town’s road network. This would require the temporary closure of Kangaroo Valley Road, with an alternative route made available via North Street.

The majority of works in the vicinity of Berry would be constructed offline with minimal traffic impacts. However it is likely there would be some adverse effects during the tie in of offline sections to online sections. These occurrences would only last for short periods.

To assess the impacts of construction on the local road network, the same worst case and representative scenarios were modelled. However, it was assumed for both scenarios that the road network within Berry had not been upgraded and that the Berry bypass was not operational (that is, traffic continued to travel through Berry).

During the representative scenario, the local network would be expected to accommodate the forecast traffic with minimal delay (refer to **Table 7-16**). Only the intersection approaches from Alexandra Street and Prince Alfred Street would be expected to drop to LoS B during the typical 2017 AM and PM peaks, with a maximum average delay of around 24 seconds.

During the worst case scenario, the Berry road network would continue to operate at acceptable performance levels during 2017 holiday peak periods as the majority of intersection approach roads would continue to operate at LoS A (refer to **Table 7-17**). However, the increase in traffic demand on Queen Street (due to overall higher traffic volumes experienced during this period) would result in further delays for some of the minor intersection approach roads, notably at Alexandra Street and Prince Alfred Street.

With the majority of traffic demand on the Queen Street approach roads (priority through movements), vehicles using the minor approach roads would find gaps in traffic less frequent and subsequently incur additional delays. The holiday peak southbound period modelling scenario indicates that vehicles travelling southbound on Alexandra Street would experience an average delay of about 90 seconds, resulting in LoS F. In addition, vehicles travelling on the Prince Alfred Street northbound approach would experience an average delay of 65 seconds. All other intersection approach roads in Berry would operate at LoS C or better.

In summary, due to the offline construction of the Berry bypass, the local road network and Berry intersections would still perform adequately during the worst-case construction scenario without the provision of additional temporary traffic management measures.

Table 7-16 2017 intersection LoS summary (representative construction scenario)

Intersection / approach road	AM Peak hour Approach volume (veh/h)	AM Peak hour Average delay (seconds)	AM Peak hour LoS	PM Peak hour Approach volume (veh/h)	PM Peak hour Average delay (seconds)	PM Peak hour LoS
Princes Highway / Victoria Street						
Total	1207	0.0	A	1329	0.0	A
Queen Street (Princes Highway)/Kangaroo Valley Road						
Total	1465	0.8	A	1672	1.0	A
Queen Street (Princes Highway)/Alexandra Street						
Queen Street eastbound	714	0.2	A	750	0.0	A
Alexandra Street southbound	48	19.1	B	98	23.6	B
Queen Street westbound	620	0.2	A	684	0.1	A
Alexandra Street northbound	33	10.6	A	52	13.9	A
Total	1415	1.1	A	1584	2.0	A
Queen Street (Princes Highway)/Prince Alfred Street						
Queen Street eastbound	612	0.2	A	682	0.2	A
Queen Street westbound	650	2.4	A	622	2.1	A
Prince Alfred Street northbound	137	13.4	A	210	17.6	B
Total	1399	2.5	A	1514	3.4	A
Queen Street (Princes Highway)/Albert Street						
Total	1294	3.4	A	1315	3.2	A
Princes Highway/Tannery Road						
Total	1234	2.0	A	1325	1.6	A

Performance of the intersection shows total movements only where all turning movements perform at LoS A in the worst case and representative scenarios. Refer to the Traffic and Transport Technical Paper at* ***Appendix D* *for more detail.*

Table 7-17 2017 intersection LoS summary (worst-case construction scenario)

Intersection / approach road	Holiday peak northbound Approach volume (veh/h)	Holiday peak northbound Average delay (seconds)	Holiday peak northbound LoS	Holiday peak southbound Approach volume (veh/h)	Holiday peak southbound Average delay (seconds)	Holiday peak southbound LoS
Princes Highway / Victoria Street						
Total	1626	0.0	A	1898	0.3	A
Queen Street (Princes Highway)/Kangaroo Valley Road*						
Total	1806	6.0	A	2015	1.3	A
Queen Street (Princes Highway)/Alexandra Street						
Queen Street eastbound	1178	0.0	A	796	0.3	A
Alexandra Street southbound	76	40.2	C	142	90.3	F
Queen Street westbound	445	0.0	A	1040	0.3	A
Alexandra Street northbound	119	21.7	B	93	41.5	C
Total	1818	3.1	A	2071	8.3	A
Queen Street (Princes Highway)/Prince Alfred Street						
Queen Street eastbound	1163	0.3	A	772	3.6	A
Queen Street westbound	447	2.2	A	1054	3.0	A
Prince Alfred Street northbound	198	23.2	B	214	65.2	E
Total	1808	3.3	A	2040	9.8	A
Queen Street (Princes Highway)/Albert Street*						
Total	1725	4.2	A	1944	3.8	A
Princes Highway/Tannery Road*						
Total	1696	1.6	A	1933	2.2	A

**Performance of the intersection is provided for total movements only where all turning movements perform at LoS A. Refer to the Traffic and Transport Technical Paper at Appendix D for more detail.*

Operational impacts

In comparison to the existing highway, the project would deliver a shortened route, reducing the length of the highway by around 1.5 kilometres between Toolijooa Road and Schofields Lane. The project would also deliver higher safe travel speeds, with the average travel speed increasing from around 52 kilometres per hour (in 2006) to around 98 kilometres per hour (in 2026). It would bypass the Foxground bends and remove conflicts between local and through traffic movements within Berry.

The project would result in an estimated seven minute reduction in travel time for vehicles travelling on the Princes Highway between Toolijooa Road and Schofields Lane.

In the project area the existing Princes Highway is longer, and has an average travel time close to double that of the equivalent ’Sandtrack’ route to the south. Following opening, the project would create a shorter travel time on the Princes Highway than the ’Sandtrack’ in the project area. It is estimated that average travel times along the ’Sandtrack’ would remain roughly constant at around 7.5 minutes. The significant travel time savings on the Princes Highway created by the project are anticipated to result in a large volume of traffic transferring from the ’Sandtrack’ in favour of the upgraded highway following construction. Similar upgrades to the north and south of the project area are likely to improve travel times further on the Princes Highway within the traffic impact footprint, adding to the proportion of overall traffic using the highway rather than the alternative ’Sandtrack’ route.

As described in **Section 7.1.1**, the performance of the project and the ‘Sandtrack’ has been assessed against the ‘do nothing’ scenario using the ‘the project’ and ‘the Princes Highway upgrade program’ scenarios at the year of opening (2017) and year of design (2037). The result of the modelling indicates that the upgraded highway would operate at LoS A or LoS B throughout the project area during typical morning and afternoon peak periods for both the ‘the project’ and ‘the Princes Highway upgrade program’ scenarios (refer to **Table 7-18** and **Table 7-19**).

During the busiest northbound and southbound holiday peak periods, the highway would operate at LoS C or better. The project would provide two lanes in each direction and would increase the safe operating speed of the Princes Highway in the project area. This would be an improvement to the current LoS, with the highway predicted to operate at a LoS F during these peak periods by 2037, if the project was not constructed. In addition, the median strip and safety barrier would enable the directional flows on the highway to operate independently, so a heavy flow of traffic resulting in a decrease in the LoS in one direction would not reduce the LoS in the other (unlike existing conditions).

The ‘Sandtrack’ is expected to operate at LoS C during all peak periods in 2037 as traffic is anticipated to reduce from current levels due to the significant proportion of vehicles expected to transfer to the Princes Highway following its upgrade. This reduction in traffic would improve the ‘Sandtrack’ safety and efficiency, which would enhance the driver experience of this scenic coastal route.

In summary, the Princes Highway in the project area would perform at an acceptable LoS during peak hours in 2037 in both scenarios.

However, while the LoS is expected to improve within the project area, the increase in traffic on the Princes Highway following the upgrade could put pressure on unimproved sections of the highway to the south. For example, the section between Schofields Lane and Cambewarra Road (being the Berry to Bomaderry upgrade) would still be awaiting upgrade and would likely experience additional traffic growth as a result of motorists switching from the ‘Sandtrack’.

Table 7-18 2037 midblock LoS summary ('The project' scenario)

Location	Direction	AM peak hour (veh/h)		PM peak hour (veh/h)		Holiday peak northbound (veh/h)		Holiday peak southbound (veh/h)	
		2-way volume	LoS	2-way volume	LoS	2-way volume	LoS	2-way volume	LoS
Princes Highway: Toolijooa Road – Berry east interchange	Northbound	1050	A	1420	B	2295	C	1298	B
	Southbound	1114	B	1228	B	795	A	2036	C
Princes Highway: Berry bypass	Northbound	990	A	1233	B	1894	C	1031	B
	Southbound	989	A	1086	A	575	A	1691	C
Princes Highway: Kangaroo Valley Road interchange – South of Schofields Lane	Northbound	1123	B	1399	B	2179	C	1299	B
	Southbound	1110	B	1260	B	742	A	2103	C
''Sandtrack'': Dooley Road – Shoalhaven Heads Road	Two-way	532	C	627	C	660	C	774	C

Veh/h = vehicles per hour

Table 7-19 2037 midblock LoS summary ('The Princes Highway upgrade program' scenario)

Location	Direction	AM peak hour (veh/h)		PM peak hour (veh/h)		Holiday peak northbound (veh/h)		Holiday peak southbound (veh/h)	
		2-way volume	LoS	2-way volume	LoS	2-way volume	LoS	2-way volume	LoS
Princes Highway: Toolijooa Road – Berry east interchange	Northbound	1096	B	1481	B	2419	C	1366	B
	Southbound	1162	B	1280	B	838	A	2146	C
Princes Highway: Berry bypass	Northbound	1043	A	1299	B	2007	C	1092	B
	Southbound	1041	B	1142	B	611	A	1791	C
Princes Highway: Kangaroo Valley Road interchange – South of Schofields Lane	Northbound	1211	B	1509	B	2297	C	1369	B
	Southbound	1198	B	1359	B	782	A	2215	C
"Sandtrack": Dooley Road – Shoalhaven Heads Road	Two-way	353	C	416	C	428	C	501	C

Veh/h = vehicles per hour

Intersection LoS

The project proposes grade separated interchanges at the northern and southern ends of Berry. At the northern end, an interchange would be provided for vehicles to join the highway in the northbound direction and exit the highway in the southbound direction. These ramps would connect to the existing Princes Highway.

At the southern end of town, a full grade separated interchange would be provided at Kangaroo Valley Road, providing on-ramps and off-ramps to and from the highway both northbound and southbound. The construction of this interchange would include two new roundabouts on Kangaroo Valley Road to the southeast and northwest of the bypass, at the approximate locations of the existing priority intersections of Kangaroo Valley Road and Huntingdale Park Road, and Queen Street (Princes Highway) and Kangaroo Valley Road respectively. In addition, a new road connection and roundabout would be constructed to the northeast of Kangaroo Valley Road, linking the northbound off-ramps and on-ramps and Rawlings Lane to Kangaroo Valley Road.

The results of the ‘Princes Highway upgrade program’ scenario for the 2037 holiday peak period for both the northbound and southbound movements at key intersections in Berry is provided in **Table 7-20**. At the southern interchange for Berry the three new roundabouts would operate at LoS A, with minimal delays.

It is estimated that during the busiest northbound holiday peak period, traffic exiting the highway via the northbound off-ramp would reach 585 vehicles per hour, with the majority of this traffic travelling on to the Kangaroo Valley Road and Huntingdale Park Road intersection. Overall traffic modelling indicates that the proposed arrangement of intersections at the southern interchange would operate efficiently, with very little delay to traffic on all approaches during both modelled peak periods.

The project would not result in changes to the layout or operation of local intersections in the centre or to the east of Berry, with the exception of the Queen Street and Woodhill Mountain Road intersection which would be reconfigured as a roundabout. While the project would remove major through movements within Berry, traffic demand generated by the town and its local surroundings would continue to grow. This would result in a considerable increase in the proportion of demand generated by the minor approach roads at the intersections listed in **Table 7-20**.

Despite the growth in locally generated traffic there would be an overall reduction in traffic on Queen Street, leading to an improvement in LoS and reduced delays. All intersections and approaches to Queen Street would operate at LoS A (with the exception of Alexandra Street southbound, which would operate at LoS B) and experience minimal congestion or delay. This is attributed to the project (specifically the bypass of Berry), which would remove large volumes of through-traffic from the centre of town.

The project would sever the current North Street road link between Rawlings Lane and Edward Street. North Street is an alternative route to the Princes Highway between Kangaroo Valley Road and Woodhill Mountain Road to the north of Berry. Although only a small proportion of through traffic currently uses this route, the construction of the Berry bypass would require vehicles to use either the bypass or Queen Street as an alternative to North Street.

In addition, the proposed project design currently includes a closure of Victoria Street at its western end, where it currently connects to the existing Princes Highway. This would result in a change in the volume and distribution of traffic on local roads; particularly along and between Victoria Street and Queen Street. The traffic impacts of potential options for the treatment of the western end of Victoria Street are discussed in detail in the *Traffic and Transport Technical Paper* (AECOM, 2012) which is provided at Appendix D of this environmental assessment.

Table 7-20 2037 intersection LoS summary ('the Princes Highway upgrade program' scenario)

Intersection / approach road	Holiday peak northbound			Holiday peak southbound		
	Approach volume (veh/h)	Average delay (seconds)	LoS	Approach volume (veh/h)	Average delay (seconds)	LoS
Kangaroo Valley Road / Huntingdale Park Road						
Huntingdale Park Road	252	0.5	A	244	0.5	A
Kangaroo Valley Rd southbound	141	0.9	A	164	0.9	A
New road connection westbound	603	0.9	A	547	1.1	A
Kangaroo Valley Road northbound	379	0.7	A	259	0.7	A
Total	1375	0.8	A	1214	0.9	A
Northbound highway ramps / Rawlings Lane						
Rawlings Lane	33	0.2	A	18	0.4	A
Northbound off-ramp	585	1.3	A	541	1.8	A
New road connection eastbound	172	0.3	A	141	0.3	A
Total	790	1.0	A	700	1.5	A
Kangaroo Valley Road / Queen Street						
Kangaroo Valley Road	790	0.9	A	664	0.7	A
Southbound off-ramp	166	6.1	A	135	2.4	A
Queen Street	501	0.9	A	701	1.0	A
Total	1457	1.5	A	1500	1.0	A
Queen Street / Alexandra Street						
Total	1402	2.2	A	1309	4.6	A
Queen Street / Prince Alfred Street						
Total	1126	1.4	A	1158	1.1	A
Queen Street / Albert Street						
Total	992	0.3	A	1058	0.1	A
Old Princes Highway / Tannery Road						
Total	924	0.2	A	1014	0.5	A

** Performance of the intersection is provided for total movements only where all turning movements perform at LoS A. Refer to the Traffic and Transport Technical Paper at Appendix D for more detail.*

Performance of the southern interchange for Berry

Shoalhaven City Council requested that an additional northbound off-ramp be provided as part of the project to cater for future traffic growth. Or as an alternative, suggest that the project design allow for future construction of an additional northbound off-ramp.

The performance of the southern interchange was considered as part of the 2037 'Princes Highway upgrade program' scenario. This assessment demonstrated that the project was able to accommodate the predicted traffic volumes during the northbound holiday peak with minimal delay and a LoS A.

Additional sensitivity modelling was undertaken to determine the volume of traffic that would cause a reduction in the performance of this interchange to an unacceptable LoS and at what year this would occur. This modelling indicated that road network performance would deteriorate to LoS F by around 2070, based on forecast traffic growth rates. The project design would have sufficient operating capacity to adequately accommodate traffic volumes much higher than those predicted in the 2037 design year. As a result a second northbound off-ramp in Berry is not required to accommodate projected traffic volumes.

The only feasible connection for a second northbound off-ramp would be at Woodhill Mountain Road. However, environmental constraints and unfavourable geological conditions would result in adverse impacts to the current environment during construction and operation. As the project would provide sufficient network capacity to accommodate predicted traffic volumes and mitigate other environmental impacts, a second northbound off-ramp has not been provided as part of this project.

Despite this, the concept design does not preclude the future addition of a second northbound off-ramp for Berry at Woodhill Mountain Road should it be warranted in the future. The construction of this facility would be subject to a separate environmental assessment.

Property access

Local roads and accesses in rural areas would be restricted to left-in and left-out movements due to a central median and safety barrier fencing. Low daily volumes of traffic, which would previously have turned right from, or into a minor road or private property, would be required to travel to the nearest u-turn facility to make a safe right turn to proceed in the desired direction.

This would provide substantial improvements in road safety, including the elimination of traffic performing right turns to and from minor roads across fast-moving two-way traffic. Existing crash data shows that over 20 per cent of crashes in the project area occurred either at intersections or between vehicles travelling in opposite directions.

Access would be restricted to the following key sections of the project (refer to **Figure 4-15, Figure 4-16** and **Figure 4-17**):

- Tindalls Lane to Austral Park Road.
- Berry (north) interchange to Tindalls Lane.
- Schofields Lane to Berry (south) interchange.

The maximum additional travel time resulting from left-in left-out only movements would be around three minutes. This would be for traffic wishing to enter or depart from properties located between or close to the Berry (north) and Tindalls Lane interchanges. Vehicles would be required to travel to these interchanges and complete a u-turn to travel in the desired direction.

Access to properties within Berry would be affected by the project and would be provided with an alternative means of access. Properties to the north of North Street, which currently gain access to the local road network via Rawlings Lane, would be provided with a link via a new road connection to Kangaroo Valley Road (refer to **Figure 4-3**). A u-turn facility would be provided at Rawlings Lane for garbage services or other heavy vehicles to use. All local properties to the west of the bypass travelling to and from Kangaroo Valley Road would do so via Queen Street.

The severance of North Street would also directly impact access for two properties and would impact local services (for example, garbage collection services). Access to the two North Street properties would be provided via a driveway connection to the proposed cul-de-sac located at the eastern end of North Street, or through an extension of George Street.

Garbage trucks servicing properties on North Street would encounter a cul-de-sac on the eastern side of the bypass or a dedicated u-turn facility on the western side of the bypass. To address this, the design of the cul-de-sac and u-turn facility includes turning provisions on the residual sections of North Street. Travel to North Street (west) and Rawlings Lane would be via Kangaroo Valley Road. For North Street (east), travel would be via Queen Street and Edward Street. School bus services which currently pick up and drop off children along North Street would also use the turning facilities and alternative route.

Victoria Street

Victoria Street currently intersects the Princes Highway at the southern extent of Berry adjacent to Mark Radium Park allowing all turning movements between the two roads. Under the project, various treatments could occur at this intersection. All options would change the volume and distribution of traffic on local roads, particularly along and between Victoria Street and Queen Street.

The project team identified and assessed three design options that could be incorporated at this intersection. The three options are:

- **Option 1** – Victoria Street closed and a one-way southbound on ramp.
- **Option 2** – Victoria Street open and a one-way southbound on ramp.
- **Option 3** – Victoria Street open and a two-way southbound on ramp.

Figures displaying these three options have been provided in **Section 3.6.6**. **Section 3.6.6** also presents a summary of the different impacts associated with each option, including the potential impacts on Mark Radium Park. A summary of the traffic impacts associated with each option is provided below.

In order to assess the local road traffic impacts of the three options identified, RMS and Shoalhaven City Council commissioned a number of traffic surveys which were undertaken during April and May 2012. These surveys measured the traffic volumes and patterns on Victoria Street and other key adjacent local roads within Berry.

The AADT on Victoria Street is currently highest at the western end, near the Princes Highway intersection with around 2200 vehicles per day in comparison to around 1200 vehicles per day at the eastern end between Prince Alfred Street and Alexandra Street. Traffic on key north-south roads between these two locations on Victoria Street peaks at 750 vehicles per day on Albany Street, with an average AADT of around 350-450 vehicles on the other roads, such as George Street, Edward Street, Alexandria Street and Prince Alfred Street.

Existing turning volumes at the Princes Highway and Victoria Street intersection were recorded to gain an understanding of the amount of traffic that would be re-distributed to other local roads, which would vary depending on the option selected. The movement from Victoria Street to the Princes Highway southbound was the most heavily trafficked at around 1100 vehicles per day. The opposite movement from the Princes Highway northbound into Victoria Street had a similar level of daily traffic with an AADT of 925 vehicles.

Modelling undertaken to forecast travels levels in 2037 showed that for all three Victoria Street design options, the four local north-south roads between George Street and Alexandra Street would be expected to experience the largest increase in daily traffic volumes, ranging between 107 per cent and 185 per cent over the next 25 years. These figures appear relatively high, however the AADT would be around or less than 2000 vehicles per day in 2037, which equates to:

- Approximately 100 vehicles per hour in each direction during the busiest 100 southbound peak period, or less than two vehicles per minute.
- The existing daily traffic volumes on Victoria Street near Mark Radium Park.

Option 1 would re-distribute the largest amount of traffic from Victoria Street to other local roads, resulting in a 35 per cent increase on George Street, Edward Street, Albany Street and Alexandra Street when compared to the other two options. However, option 1 would also remove 2000 vehicles per day from the western end of Victoria Street and there would be a 45 per cent reduction at the eastern end of Victoria Street.

Table 7-21 provides a summary of both the positive and negative traffic related impacts for the three Victoria Street design options. A detailed assessment of these options is provided in **Section 7.2.7** of the *Traffic and Transport Technical Paper* provided at **Appendix D**.

Table 7-21 Summary of traffic impacts for the Victoria Street design options

Victoria Street options	Positive impacts	Negative impacts
Option 1	• In 2037, daily traffic volumes on Queen Street would be around 50 per cent less than today. • Around 2000 vehicles would be removed from the western end of Victoria Street. • Traffic volumes on the eastern end of Victoria Street would decrease by around 45 per cent in 2037 when compared to the other options. • All local roads would perform at LoS A or LoS B in 2037, with only Queen Street operating at LoS C. • Least impact and land-take of Mark Radium Park and the closure of Victoria Street would allow for safer pedestrian connectivity to the park. • A turning circle at the eastern end of Victoria Street (adjacent to Mark Radium Park) would be provided that could be used as a u-turn for larger vehicles (buses, garbage trucks etc.)	• In 2037, daily traffic volumes on local north-south are predicted to be three times greater when compared to existing levels. • Largest impacts on the local road network due to additional traffic volumes (around 35 per cent more than the other two options) on the north-south roads between Victoria Street and Queen Street. • Additional travel time to/from residential areas along and adjacent to Victoria Street to/from the south.

Victoria Street options	Positive impacts	Negative impacts
Option 2	• In 2037, daily traffic volumes on Queen Street would be around 60 per cent less than today. • Traffic volumes on the local north-south roads between Victoria Street and Queen Street would decrease by around 35 per cent in 2037 when compared to option 1. • Most of the existing traffic movements and patterns on the local road network would be maintained, including direct access from Victoria Street to the Princes Highway southbound. • All local roads would perform at LoS A or LoS B in 2037.	• In 2037, daily traffic volumes on local north-south are predicted to double when compared to existing levels. • Additional travel time to residential areas along and adjacent to Victoria Street from the south. • Potential safety issues due to slow moving traffic turning left from Victoria Street merging with vehicles accelerating on the southbound on ramp.
Option 3	• In 2037, daily traffic volumes on Queen Street would be around 60 per cent less than today. • Traffic volumes on the local north-south roads between Victoria Street and Queen Street would decrease by around 35 per cent in 2037 when compared to option 1. • The majority of existing traffic movements and patterns on the local road network would be maintained, including direct access from Victoria Street to the Princes Highway southbound. • All local roads would perform at LoS A or LoS B in 2037. • A roundabout at the Victoria Street and southbound on ramp intersection would be provided that could be used as a u-turn for larger vehicles (buses, garbage trucks etc.).	• In 2037, daily traffic volumes on local north-south are predicted to double when compared to existing levels. • Only 45 vehicles per day would travel northbound on Queen St (the southbound on ramp) between the Victoria Street and Kangaroo Valley Road intersections. This low volume of traffic shows that the two-way ramp option would provide a negligible benefit when compared to the other two options – particularly option 2. • Additional travel time to residential areas along and adjacent to Victoria Street from the south.

For all options, predicted traffic volumes would not significantly change the residential nature of the local road network in Berry, particularly as the AADT on Queen Street in 2037 is expected to be at least 50 per cent less than existing daily traffic volumes.

For the purpose of the environmental assessment, Option 1 is the current preferred option. Nonetheless, RMS is able to deliver any of the Victoria Street design options through the project.

RMS will continue discussions and encourage feedback and submissions through the environmental assessment display period. Traffic impacts along with other environmental impacts will contribute to the selection of a final solution for Victoria Street.

Traffic crashes

The project would significantly reduce the frequency and severity of crashes in the project area. This would both increase the level of road safety to highway users and reduce the cost attributable to crashes.

A traffic crash analysis was undertaken using RMS' 'Crash Reduction Guide' and data from 1 July 2003 to 30 September 2010. The following crash reductions along the highway between Toolijooa Road and Schofields Lane were predicted as a result of the project (refer to **Table 7-22**):

- 100 per cent reduction in crashes at intersections and between vehicles travelling in opposing directions.
- 74 per cent reduction in off-path crashes on curves.
- 50 per cent reduction in crash frequency between vehicles travelling in the same direction.
- 64 per cent total reduction in crashes in the project area.

Upgrades of existing heavy vehicle rest areas north and south of the project area are currently being planned and are proposed by RMS within the scope of other projects. These upgrades would also be likely to reduce the occurrence of fatigue related crashes.

In addition to the road safety improvements on the Princes Highway, by drawing traffic from the 'Sandtrack', the project would be expected to further reduce the overall frequency of crashes within the project area. It is estimated that without the project, annual vehicle kilometres travelled on the 'Sandtrack' between Gerringong and Bomaderry would increase from around 90 MVKT to 160 MVKT by 2037. This would be expected to increase crash occurrences by a similar proportion. However, with the project, in 2037 vehicle kilometres travelled on the 'Sandtrack' between Gerringong and Bomaderry would be expected to decrease to 53 MVKT, or 57 per cent, resulting in a directly proportional drop in crash occurrences.

Table 7-22 Existing and proposed crash statistics (1 July 2003 – 30 September 2010))

Scenario	Accident type (from DCA code)*							
	Length of road (km)	Intersection - adjacent approaches	Vehicles from opposing direction	Vehicles from the same direction	Off path, on straight	Off path, on curve	Other	Total
Existing conditions	12.6	6	14	24	13	46	10	118
Proposed conditions	11.3	1	0	12	12	12	5	42
% Crash reduction	-	83	100	50	8	74	50	64

** DCA (definitions for coding accidents) – A system of categorising crashes based on the movement of the vehicle/s prior to the collision.*

Emergency access

The introduction of median fencing would mean that emergency access would be restricted, potentially leading to delays in emergency service responses to traffic incidents. The project would include emergency u-turn facilities which provide an opportunity for emergency service vehicles to execute a u-turn manoeuvre on the highway rather than travelling to the next grade-separated interchange. In addition, a lay-by area with an emergency telephone would be incorporated within this facility.

U-turn facilities on the highway for public use are not proposed on the basis that the frequency of grade-separated interchanges minimises the need for a dedicated at-grade public u-turn facility. Two u-turn facilities are provided off the highway; one on a section of the residual highway just north of the Austral Park Road interchange, and the other at Mullers Lane south of Berry.

In the case of a significant traffic incident that blocks all lanes, emergency u-turn facilities would be used to redirect traffic to contra flow under emergency services control. The continuous median safety barrier would be 'dropped' at key locations when a facility is needed.

The 'Sandtrack' would also be maintained as an alternative route during major incidents, as currently identified in the RMS incident management plan for the area.

Public transport, pedestrians and cyclists

There are several bus routes that use some portion of the Princes Highway within the project area (refer to **Section 7.1.2**). As a result, it is expected that:

- Bus travel times would be improved as the project would enable higher safe travel speeds on the Princes Highway, while intersection delays in Berry would reduce as a result of fewer vehicles travelling through the town. A reduction of traffic on the 'Sandtrack' would also benefit travel times for buses using this alternative route.
- Service delays caused by traffic incidents and congestion would reduce as the project would decrease the frequency of traffic crashes. The provision of two lanes per direction on the Princes Highway would substantially ease congestion and improve the LoS during peak times.
- Travel to and from bus stops by car, walking and cycling would be quicker in Berry as there would be less traffic throughout the town.
- Reduced traffic volumes would improve air quality, decrease noise levels, enhance pedestrian safety and improved amenity for bus users waiting at stops within Berry and on the 'Sandtrack'.

School bus services that currently stop at informal locations, such as local roads or property accesses, would be discouraged with two dedicated bus stops provided, at Toolijooa Road and Tindalls Lane. This would remove the risk of accidents caused by buses speeding up and slowing down in high-speed traffic, but would inconvenience users required to travel to and from other existing bus stop locations. However, this must be considered in the context of the safety benefits from consolidating stopping locations along the Princes Highway and reduced travel time.

The severance of North Street would affect school services in Berry. However, the project would provide turning facilities in newly created cul-de-sacs, and buses would use the alternative Queen Street route. The negative impacts would be limited to a small amount of additional travel time for these services.

Impacts to rail services would not be expected and travel time to and from Berry railway station for passengers travelling by car, bus, walking, or cycling would be reduced due to a decrease in traffic and associated delays in Berry.

For cyclists and pedestrians within the project area, there would be reduced delays at intersections in Berry due to a reduction of traffic in the town.

Cyclist safety and amenity within Berry and on the 'Sandtrack' is expected to improve due to lower traffic volumes, which would reduce the potential for crashes. For sections of the project outside Berry, the 2.5 metre shoulder on the highway would allow greater separation between bicycles and pedestrians and high speed traffic.

Within Berry, the addition of two roundabouts on Kangaroo Valley Road to the west of the town was identified as a concern by the community, potentially reducing amenity for pedestrians and cyclists. This would include pedestrians and cyclists re-routed from North Street following its severance by the Berry bypass. However contemporary guidelines relating to road design, indicate that there is no evidence to suggest that roundabouts are less safe for pedestrians and cyclists than other forms of intersection control.

Pedestrian and cyclist arrangements would be provided to ensure that safe access is maintained (refer to **Section 7.1.4** and **Section 7.6**). Residual impacts would remain where the proposed median along the highway would require pedestrians and cyclists that wish to cross the highway to travel to the proposed interchanges.

A number of design responses have also been incorporated into the current design of the project to minimise the negative impacts on pedestrian and cyclists along the project and at key local road modifications. This includes:

- Provisions for cyclists in accordance with the RMS NSW Bicycle Guidelines and Austroads Cycling Aspects of Austroads Guides at all interchanges and intersections constructed as part of the project.
- A wider bridge design at Kangaroo Valley Road bridge (around 21 metres wide) to provide generous shared paths on both sides of Kangaroo Valley Road, minimising the amenity impacts on pedestrians and cyclists at this location.
- Line marked shoulders to be provided at ‘squeeze points’ for pedestrians and cyclists (such as bridges and roundabouts).
- Off-road pedestrian and cyclist path along the south of the bypass to mitigate the closure of North Street, providing connectivity between Kangaroo Valley Road and North Street.

7.1.4 Environmental management measures

Mitigation and management measures would be implemented to avoid, minimise or manage impacts to traffic and transport. These mitigation and management measures are identified in **Table 7-23** and have been incorporated in the draft statement of commitments in **Chapter 10**.

Table 7-23 Management and mitigation measures

Potential impacts	Mitigation and management measures
Construction	
Travel delays due to construction traffic and works	Prepare and implement a detailed traffic management plan (TMP) as part of the CEMP. The TMP is to include appropriate guidelines and procedures required to ensure the continuous, safe and efficient movement of construction and non-construction traffic in and around the project area (including the ‘Sandtrack’) during construction. The TMP would be submitted in stages to reflect the progress of the work and would detail: • Signage requirements. • Lane possession and approval process during periods of online construction. • Traffic control devices such as temporary signals. • A local and regional communications strategy. • Strategies to identify and respond to any changes in road safety (including the ‘Sandtrack’) as a result of highway construction works.

Potential impacts	Mitigation and management measures
	Where feasible, construct offline sections of the project first to provide travel routes for construction vehicles off the Princes Highway where feasible (Toolijooa Road to Austral Park Road and the Berry bridge to Kangaroo Valley Road). Implement a queue length management strategy to minimise delays to traffic on the Princes Highway. Where feasible, program deliveries of materials along the existing road network outside of holiday peak periods. Use the cleared footprint adjacent to the Princes Highway along the section to be duplicated for construction traffic where feasible to minimise use of the existing road network by construction traffic. Design the works to minimise the number of construction site entry and exit points and provide traffic control to avoid traffic conflicts and minimise delays. Make provision for emergency services vehicles to pass through construction zones and update the local emergency services on the staging and progress of works that would affect their movement.
Travel delays due to temporary road closures	Provide timely, accurate, relevant and accessible information about changed traffic arrangements and potential delays to road users and local communities with provision for feedback through a complaints line during construction.
Operation	
Lack of safe access for pedestrians and cyclists at the southern interchange	Monitor the performance of the southern interchange roundabouts within the first four weeks after opening and develop any remedial actions necessary to ensure continued safe access for pedestrians and cyclists.
Reduced traffic efficiency at key access points to and from Berry and at local roads does not meet the project objectives	Monitor traffic on the Princes Highway and key local roads in Berry, particularly during peak periods, six months and 12 months after opening the project to monitor the performance of the network and ensure it is performing as expected. The results would also be used to inform the operational noise monitoring for the project. Investigate and implement any remedial action if required.
Increased traffic on Princes Highway south of Berry	Provide a temporary tie-in where the project finishes, enabling southbound highway traffic to merge safely from two lanes into one. This would remain in operation from the opening of the current project until the completion of the proposed Berry to Bomaderry upgrade.

7.2 Noise and vibration

This chapter provides an assessment of noise and vibration impacts of the project, which was nominated in the DGRs as a key environmental issue for the project. It represents a summary of the *Noise and Vibration Technical Paper* (AECOM, 2012), which was prepared for the project to address the DGRs. The technical paper is provided at **Appendix E** of this environmental assessment. The relevant extract from the DGRs is presented below.

Director-General's requirements	Where addressed
***Noise and Vibration** - including but not limited to:*	
A construction noise and vibration assessment including construction traffic noise, batch plants and blasting impacts. The EA must clearly identify nearest sensitive receptors and assess construction noise/vibration generated by representative construction scenarios focussing on high noise generating works. Where work hours outside of standard construction hours are proposed, clear justification and detailed assessment of these work hours must be provided including alternatives considered and mitigation measures proposed. The assessment must further consider any cumulative impacts during construction, having regard to any other developments (both existing and approved) in the locality.	Section 7.2.3 Appendix E – Technical paper: Noise and vibration impact assessment.
An operational road traffic noise assessment including consideration of local meteorological conditions (as relevant) and any additional reflective noise impacts from proposed noise mitigation barriers.	Section 7.2.3 Appendix E – Technical paper: Noise and vibration impact assessment.
The assessment must take into account the following guidelines as relevant: Interim Construction Noise Guideline (DECC 2009), Road Noise Policy (OEH, 2011)*, Environmental Noise Management Manual (RTA 2001), Assessing Vibration: A Technical Guideline (DEC 2006); and Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZECC 1990).*	Section 7.2.1 Section 7.2.3 Appendix E – Technical paper: Noise and vibration impact assessment.

7.2.1 Methodology

To assess the potential impacts arising from construction and operation of the project, an assessment has been undertaken with consideration to the following:

- *Interim Construction Noise Guideline* (ICNG) (Department of Environment and Climate Change (DECC), 2009) to assess construction noise impacts.
- NSW *Environmental Criteria for Road Traffic Noise* (ECRTN) (Environment Protection Authority (EPA), 1999), which has been superseded by the ICNG but is used for guidance in assessing the potential for sleep disturbance.
- *Assessing Vibration: A Technical Guideline* (Department of Environment and Conservation (DEC), 2006) to assess impacts arising from construction vibration, excluding blasting activities.
- *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (Australian and New Zealand Environment Conservation Council (ANZECC), 1990) provides criteria designated to minimise annoyance and discomfort at sensitive receivers as a result of blasting works.
- *Road Noise Policy* (RNP) (Office of Environment and Heritage (OEH), 2011), to assess road traffic noise impacts from the project during the operational stages of the project.
- The *NSW Industrial Noise Policy* (INP) (EPA, 2000) in regard to background noise monitoring.

Background noise monitoring was undertaken at ten locations throughout the project area to determine existing background noise levels (to be used to define construction noise criteria) and to measure average noise levels from the existing roads (to calibrate the operational noise model). Background noise monitoring was undertaken in accordance with all relevant guidelines and the procedures contained in the INP, the ICNG and the RNP.

The locations were selected to be representative of potential impacts arising from construction and operational noise impacts, and are located up to 600 metres from the project. The setback distance of 600 metres was selected to satisfy the assessment requirement of the RNP.

Unattended and attended noise measurements were taken at the nominated locations to determine the existing noise levels in order to establish the following:

- L_{A1}, which represents the noise level exceeded for one per cent of the sample period (ie measurement period).
- L_{A10}, which represents the noise level exceeded for ten per cent of the measurement interval. This is commonly referred to as the average-maximum level.
- L_{Amax}, which represents the maximum noise level measured at a given location over the measurement period.
- L_{Aeq} which is essentially the average sound level or the energy averaged noise level over a defined measurement period. For traffic noise, this description is classified as $L_{Aeq15Hr}$ and L_{Aeq9Hr} for the day and night-time noise levels respectively. This is commonly referred to as the ambient noise level.
- L_{A90}, which represents the noise level exceeded for 90 per cent of the measurement interval. This is taken to be the background noise level.
- Rating Background Level (RBL), which represents the average minimum background sound level, which is the tenth percentile of the L_{A90} values.

To assess construction noise impacts, the study area was divided into six distinct Noise Catchment Areas (NCA's), representing the differing background noise levels measured at each of the monitoring locations. These catchment areas are shown in **Figure 7.3**.

To assess the operational impacts of the project, both daytime and night-time noise levels were predicted for 2017, being the year when the project would open, and 2027, representing 10 years after the project opening. Three scenarios were then developed for both years to represent:

- The 'no build' scenario, being noise levels without the project. This would determine the road traffic noise levels that would occur due to natural traffic growth in the absence of the project.
- The 'build' scenario, being noise levels with the project and incorporating all local roads, the main alignment and interchanges. This was used to assess noise levels at sensitive receivers to which the redeveloped road noise criterion applies, being those sensitive receivers that are already exposed to road traffic noise. This criterion is discussed further in **Section 7.2.3**.
- The 'modified build' scenario. This is similar to the 'build' scenario but only includes the main alignment and interchanges. This scenario was used to assess noise levels at sensitive receivers to which the new road criterion applies, being sensitive receivers that would be subject to a new source of road traffic noise. This criterion is discussed further in **Section 7.2.3**.

Comparing predicted noise levels with and without the project at 2017 would identify any potential noise issues at the commencement of the project. Similarly, comparing predicted noise levels with and without the project at 2027, would identify the potential for noise impacts in the longer term once the project is well established and the traffic using the surrounding road network has stabilised.

The 2027 scenario was also modelled with a low noise pavement and a variety of test noise barriers to identify possible approaches to noise mitigation. As noise barriers have the potential to reflect noise to a receiver on the opposite side of the roadway, a +2dB(A) reflection factor was also added to the results for all sensitive receivers that may be impacted in this way. Meteorological conditions were also considered, and are discussed in **Section 7.2.4**.

7.2.2 Existing environment

Residences, businesses and other community facilities (such as churches and open spaces) are located along the project alignment at varying distances from the existing highway and project alignment (refer to **Appendix B** of the *Noise and Vibration Technical Paper* at **Appendix E** of this environmental assessment). Given the change in land uses and the location of sensitive receivers, there are a number of distinct existing noise environments.

The rural areas to the north of Berry are dominated by pastureland and rural settlement patterns. Generally, the existing noise levels experienced by residences in this area would be relatively low. The exception would be at sensitive receivers which are located in close proximity to the existing highway and would be exposed to traffic noise. In particular, residences located next to the existing highway between Toolijooa Road and Tindalls Lane would be exposed to high traffic noise levels due to the braking and acceleration of vehicles on the steep grades and sharp bends that characterise this section of the existing highway.

Within Berry, the existing highway runs directly through town along Queen Street. Businesses and residences located along Queen Street experience a high level of traffic noise. Noise associated with the existing traffic along Queen Street also affects surrounding residences and businesses that do not have a direct frontage to the highway.

South of Berry, Mark Radium Park and the Bupa Aged Care Facility are located along the Princes Highway.

Residences and churches located along North Street currently experience a low noise environment and are largely unaffected by the existing highway. Traffic volumes are relatively low, although local traffic travelling from the north of Berry through to Kangaroo Valley Road uses North Street to avoid congestion along Queen Street. Occasional heavy vehicle or farm machinery movements also occur on North Street and are associated with the agricultural properties located on the northern side of North Street. The low noise environment at this location makes it an attractive walking and cycling route.

Residences located at Huntingdale Park Estate and other residential areas along Kangaroo Valley Road also experience a relatively quiet noise environment. Traffic noise is largely generated by light vehicular traffic. There is also a small buffer separating residences along Huntingdale Park Road and the existing highway. This shields residences from highway traffic noise to some degree.

The results of the background noise monitoring conducted for the project are provided in **Table 7-24** and **Table 7-25**. Background noise levels for the area reflect the daily traffic volume patterns of the highway with background noise levels dropping when traffic volumes drop significantly. This demonstrates that traffic noise is the dominant noise source in the area. The detailed results of the noise monitoring are provided in the *Noise and Vibration Technical Paper* at **Appendix E** of this environmental assessment.

Table 7-24 Background noise levels dB(A)

Noise logging location*		Rating background level dB(A)		
		Day (7 am 6pm) L_{A90}	Evening (6pm-10pm) L_{A90}	Night (10pm-7am) L_{A90}
BG1	46 Princes Highway, Broughton Village	48	40	40[1]
BG2	10 Austral Park Road, Broughton	40	41 (40)[2]	40
BG3	200 Princes Highway, Berry	41	39	38
BG4	111 Princes Highway, Berry	41	39	37
BG5	132 North Street, Berry	35	37 (35)[2]	35
BG6	92 North Street, Berry	36	36	35
BG7	2 The Gables, Berry	37	37	37
BG8	Andersons Lane, Berry	44	41	33
BG9	Andersons Lane, Berry	41	39	35
BG10	Andersons Lane, Berry	38	36	33

Noise logger locations are shown in **Figure 7.3*
Note 1: Night time L_{A90} has been adjusted to the lower evening L_{A90}
Note 2: The numbers in brackets indicate the RBL with the INP adjustments included

Table 7-25 Day and night time road traffic noise levels

Noise logging location		Ambient road noise level L_{Aeq} (dB(A))	
		Day ($L_{Aeq\ (15h)}$)	Night ($L_{Aeq\ (9h)}$)
BG1	46 Princes Highway, Broughton Village	60	56
BG2	10 Austral Park Road, Broughton	50	48
BG3	200 Princes Highway, Berry	53	49
BG4	111 Princes Highway, Berry	53	44
BG5	132 North Street, Berry	58	46
BG6	92 North Street, Berry	56	46
BG7	2 The Gables, Berry	63	52
BG8	Andersons Lane, Berry	56	54
BG9	Andersons Lane, Berry	52	48
BG10	Andersons Lane, Berry	49	44

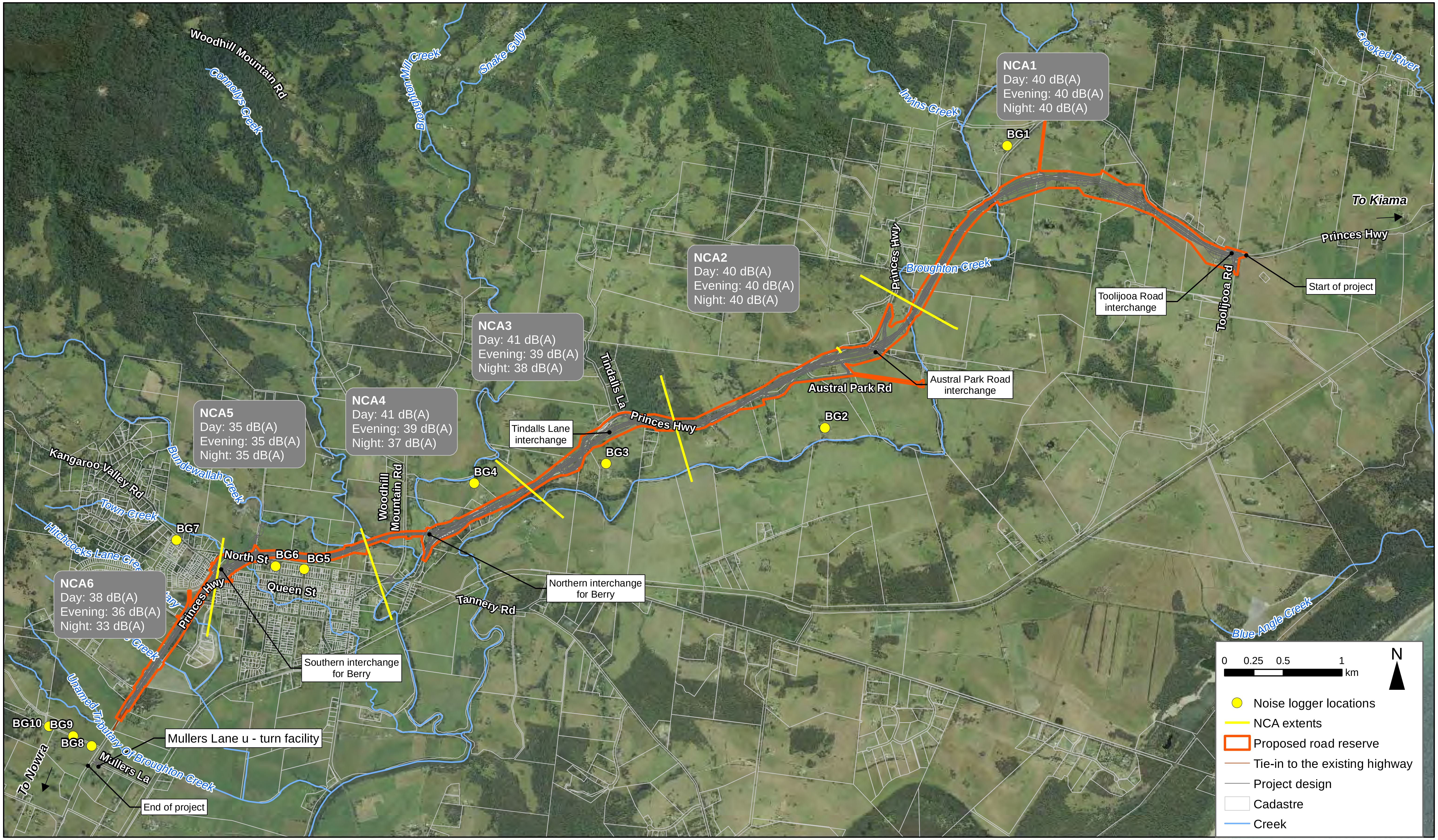

Figure 7-3 Noise catchment areas, background noise levels and noise logger locations

Source: AECOM (2012)

7.2.3 Noise and vibration criteria

Construction noise criteria

The ICNG is used in construction noise assessments. This document supersedes the OEH's previous publication the *Environmental Noise Control Manual* (ENCM) and has been used as the basis for establishing construction noise management levels (NMLs).

NMLs must be set for construction during daytime and out of standard hours periods and must be met where feasible and reasonable. Work that is proposed outside of standard working hours, as defined in the ICNG, generally requires strong justification.

NMLs for residential receivers are derived using the information in **Table 7-26** (excerpt from the ICNG) and are outlined in **Table 7-27** for the noise catchment areas identified for the project.

Table 7-26 Noise management levels for residences for airborne noise

Time of day	Noise management level
	$L_{Aeq(15\ mins)}$
Recommended standard hours Monday – Friday 7am to 6pm Saturday 8am to 1pm No work on Sundays	Noise affected RBL + 10dB
	Highly noise affected 75 dB(A)
Outside recommended standard hours	Noise affected RBL + 5dB

Extracted from ICNG (DECCW, 2009)
**Noise affected – The point above which there may be some community reaction to noise*
***Highly noise affected – The point above which there may be strong community reaction to noise*

Table 7-27 Noise management levels for the project

Noise catchment area	Period	Background noise level	Noise management levels
		$L_{Aeq(15\ mins)}$	$L_{Aeq(15\ mins)}$
NCA1	Day[1]	40	50
	Evening	40	45
	Night[2]	40	45
NCA2	Day	40	50
	Evening	40	45
	Night	40	45
NCA3	Day	41	51
	Evening	39	44
	Night	38	43
NCA4	Day	41	51
	Evening	39	44
	Night	37	42
NCA5	Day	35	45
	Evening	35	40
	Night	35	40
NCA6	Day	38	48
	Evening	36	41
	Night	33	38

1. *RBL:+10dB*
2. *RBL: +5dB*

For construction activities proposed outside the standard hours of construction, different noise management levels apply. Extended construction work hours have been assessed in accordance with the INP shoulder periods. The morning shoulder periods are considered to be 6am to 7am Monday to Friday and 8am to 9am Saturdays.

The RBL is considered to be the mid-point between the night-time and daytime RBL. The NML is the RBL + 5dB(A). The assessment period RBL and NML for the morning shoulder period is provided in **Table 7-28**. Noise levels are between 0 dB(A) and 3 dB(A) less stringent than the night-time NMLs.

Table 7-28 Morning shoulder noise assessment levels

NCA	Period	Mid point in Rating Background Levels (RBL)*	Noise management levels (NML)**
NCA1	Morning Shoulder	40	45
NCA2	Morning Shoulder	40	45
NCA3	Morning Shoulder	40	45
NCA4	Morning Shoulder	39	44
NCA5	Morning Shoulder	35	40
NCA6	Morning Shoulder	36	41

Noise management levels for noise sensitive land uses other than residential receivers such as places of worship or recreational areas are based on internal noise levels. These criteria only apply when the building or area is in use. Noise management levels for the two churches located on North Street and the Berry sportsground and Camp Quality memorial park (Woodhill Mountain Road) are provided in **Table 7-29**.

Table 7-29 Noise management levels at sensitive land uses (other than residential) that are applicable to the project

Land use	Noise management level (when in use)
	$L_{Aeq(15\ mins)}$
Places of Worship	Internal noise level 45 dB(A)
Active recreational areas (characterised by sporting activities and activities which generate their own noise or focus for participants, making them less sensitive to external noise intrusion)	External noise level 65dB(A)
Passive recreational areas (which are spaces used for contemplative activities that generate little noise and where benefits are compromised by external noise intrusion)	External noise level 60dB(A)

Extracted from ICNG (DECCW, 2009)

Where noise is predicted to be above the noise management levels, all reasonable and feasible measures must be applied to reduce noise emissions. Where noise levels are predicted to be above the ‘highly affected’ noise management level (being 75 dB(A))(refer to **Table 7-26**), then restrictions to the hours of construction may apply.

Construction road traffic noise criteria

The RNP does not provide a criterion to assess the noise generated by traffic during construction. Typically, the approach applied to construction traffic noise is to limit the increase in existing road noise levels to 2 dB(A). This has been applied to the construction noise impact assessment for this project.

Sleep disturbance criteria

The ICNG requires the potential impacts on sleep disturbance to be considered where construction works are planned to extend over more than two consecutive nights. The ICNG refers to the ECRTN to provide the appropriate assessment approach. The ECRTN has now superseded by the RNP, for assessment of sleep disturbance. However the RNP refers to the ECRTN as being the most appropriate assessment. As such the ECRTN will be referenced for sleep disturbance.

The ECRTN suggests that for night-time activities, the $L_{A1(60\ second)}$ noise levels should be calculated and compared with the RBL plus 15dB(A) as the sleep disturbance screening criterion. Further assessment is recommended where the screening criterion is exceeded, with consideration given to how often these exceedances occur.

The ECRTN also suggests that:

- The maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions.
- One or two events per night, with maximum internal noise levels of 65 dB(A) to 70 dB(A), are not likely to affect health and wellbeing significantly.

Given that a building with an open window provides up to 10 dB(A) noise attenuation from outside to inside, it is reasonable to assume that external noise levels of 60-65 dB(A) are unlikely to result in awakening reactions.

Construction vibration criteria

Vibration targets vary depending on whether the particular activities of interest are continuous in nature, impulsive or intermittent and whether they occur during the day or night. The effects of vibration in buildings can be divided into two main categories:

- Structural damage of buildings, including superficial cracking in cement render or plaster.
- Human comfort, where the occupants or users of the buildings are inconvenienced or possibly disturbed by vibration (tactile vibration) or ground-borne noise.

Criteria relevant to the response of building occupants to vibration are more stringent than those relevant to building damage. The guidelines or standards used in the assessment are provided in **Table 7-30.**

Table 7-30 Standards/guidelines used for assessing construction vibration

Item	Standard/guideline
Structural damage	German Standard DIN 4150 - Part 3 - Structural Vibration in Buildings - Effects on Structures
Human comfort (tactile vibration) (*)	NSW 'Assessing Vibration: A Technical Guideline' (DEC 2006)
Human comfort (regenerated noise)	NSW 'Interim Construction Noise Guideline' (DECCW 2009)

(*) These documents are based upon the guidelines contained in British Standard 6472:1992, "Evaluation of human exposure to vibration in buildings (1-80 Hz)". This British Standard was superseded in 2008 with BS 6472-1:2008 "Guide to evaluation of human exposure to vibration in buildings – Part 1: Vibration sources other than blasting" and the 1992 version of the Standard was withdrawn. Although a new version of BS 6472 has been published, the EPA still requires vibration to be assessed in accordance with the 1992 version of the Standard at this point in time.

Structural damage

Table 7-31 provides the recommended maximum level of vibration that reduces the likelihood of cosmetic damage caused by vibration. The levels are designed to minimise the risk of cosmetic surface cracks and are set well below the levels that have the potential to cause damage to the main structure. Examples of threshold or cosmetic cracking include minor non-structural effects such as superficial cracking in cement render or plaster.

Table 7-31 Structural damage vibration limits

Group	Type of structure	Vibration velocity in mm/s			
		At foundation At a frequency of		Plane of floor of uppermost storey	
		Less than 10 Hz	10 Hz to 50 Hz	50 Hz to 100 Hz	All frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20	20 to 40	40 to 50	40
2	Dwellings and buildings of similar design and/or use	5	5 to 15	15 to 20	15
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Groups 1 or 2 and have intrinsic value (eg buildings that are under a preservation order)	3	3 to 8	8 to 10	8

Human comfort (tactile vibration)

Acceptable values of human exposure to vibration are primarily dependent on the activity taking place in the occupied space (e.g. workshop, office, or residence) and the character of vibration (eg continuous or intermittent). In addition, specific values are dependent upon social and cultural factors, psychological attitudes, expected interference with privacy, and ultimately the individual's perceptibility.

Table 7-32, **Table 7-33** and **Table 7-34** provide the preferred and maximum values for continuous, impulsive and intermittent vibration, which have been used for the purposes of this assessment.

Where predicted levels are below the preferred values, there is a low probability of adverse comment or disturbance to building occupants. Activities should be designed to meet the preferred values where an area is not already exposed to vibration.

Values up to the maximum level may be used if they can be justified and where all feasible and reasonable measures have been applied. For values beyond the maximum value, consultation with the affected community should be undertaken. Situations exist where vibration above the preferred values can be acceptable, particularly for temporary disturbances and infrequent events of short term duration.

Table 7-32 Preferred and maximum vibration levels for continuous vibration

Location	Daytime		Night time	
	Preferred*	Maximum*	Preferred*	Maximum*
Residences	0.010	0.020	0.007	0.014
Offices, schools, educational institutions and places of worship	0.020	0.040	0.020	0.040

** weighted root mean square (rms) vibration levels for continuous vibration acceleration (m/s^2) in the vertical direction.*

Table 7-33 Preferred and maximum vibration levels for impulsive vibration

Location	Daytime		Night time	
	Preferred*	Maximum*	Preferred*	Maximum*
Residences	0.3	0.6	0.1	0.2
Offices, schools, educational institutions and places of worship	0.640	1.280	0.640	1.280

**weighted root mean square (rms) vibration levels for impulsive vibration acceleration (m/s^2) in the vertical direction*

Table 7-34 Preferred and maximum vibration levels for intermittent vibration

Location	Daytime		Night time	
	Preferred	Maximum	Preferred	Maximum
	$m/s^{1.75}$			
Residences	0.2	0.4	0.13	0.26
Offices, schools, educational institutions and places of worship	0.4	0.8	0.4	0.8

Human comfort (ground-borne noise)

Vibration generated by activities such as compacting or drilling may enter buildings via the ground. This causes the floors, walls and ceilings to vibrate and to radiate noise, which is commonly referred to as ground-borne noise or regenerated noise. Ground-borne noise is typically low frequency and if audible is perceived as a 'rumble'.

In general, ground-borne noise level values are relevant only where they are higher than the airborne noise from the construction activities. Regenerated noise levels would typically be masked by air-borne noise associated with the construction activities.

The ground-borne noise management levels as outlined in the ICNG are provided in **Table 7-35**. The ground-borne noise levels are applicable during the evening and night-time periods only, as the objectives are to protect the amenity and sleep of people when they are at home.

Table 7-35 Recommended ground-borne noise goals for construction activities

Time	Ground-borne noise goals
Evening (6 pm to 10 pm)	40 dB(A) $L_{Aeq,15min}$
Night-time (10 pm to 7 am)	35 dB(A) $L_{Aeq,15min}$

Blasting noise and vibration criteria

Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration (ANZECC, 1990) provides criteria designated to minimise annoyance and discomfort at sensitive receivers as a result of blasting works (refer to **Table 7-36**). The criteria provided in this table are only applicable to annoyance and discomfort from blasting. Building damage criteria has previously been provided in **Table 7-31**. The criteria are for guidance only and may be varied to suit local site conditions.

Australian Standard AS2107.2 '*Explosives – Storage and Use Part 2: Use of Explosives'* recommends that if the prescribed limits in **Table 7-36** cannot be achieved, an agreement may be reached with the land owner permitting higher levels. It also recommends that blasting should generally take place no more than once per day.

Table 7-36 Air blast overpressure criteria and peak particle velocity criteria

Airblast overpressure (dB)	Allowable exceedance
115	5% of total number of blasts over a 12 month period
120	Never
Peak particle velocity (PPV) (mm/s)	**Allowable exceedance**
5	5% of total number of blasts over a 12 month period
10	Never

Operational criteria

Operational noise criteria

The RNP establishes noise assessment criteria for new road projects, redeveloped existing roads and new traffic-generating developments in NSW. It was released in July 2011 and replaced the ECRTN.

The RNP identifies different noise assessment criteria depending on the road category, the type of road project being proposed, and the type of noise sensitive receiver that is potentially affected by the project.

The noise assessment criteria for this project are provided in **Table 7-37** (residential noise sensitive receivers) and **Table 7-38** (other noise sensitive land uses). The criteria applied reflect the highway category of the project and the type of project, being the construction of a new road and the redevelopment of an existing road.

In the case of the new road assessment criteria, this is applied to sensitive receivers that would be subject to a new source of road traffic noise. A receiver is considered to fall into this category if the project would develop:

- A new road where a road of the same category did not previously exist.
- A new road within an existing but previously undeveloped road corridor.
- An alignment or realignment of a road that would produce noise at a receiver from a different direction and that increases noise levels at any exposed facade by 2dB(A) or more.

In the case of the redeveloped road noise criteria, this is applied to sensitive receivers that are already subject to existing road traffic noise.

In addition to the noise assessment criteria provided in **Table 7-37** and **Table 7-38**, the RNP also requires the 'relative increase' in noise levels to be considered for residential receivers. The relative increase is defined as the difference in noise levels when comparing road traffic noise without or with the project, with the assessment criterion set at 12 dB over the existing road traffic noise levels (refer to **Table 7-39**). This criterion has been specifically developed to capture excessive changes in amenity due to a road project, particularly in environments where there is a low existing level of traffic noise.

Table 7-37 Noise assessment criteria for residential receivers

Road category	Type of project/land use	Assessment criteria	
		Day (7 am – 10pm)	Night (10 pm – 7am)
Freeway/arterial/sub-arterial roads	Existing residences affected by noise from new freeway/arterial/sub-arterial road corridors	$L_{Aeq(15\ hour)}$ 55 (external)	$L_{Aeq(9\ hour)}$ 50 (external)
	Existing residences affected by noise from redevelopment of existing freeways/arterial/sub-arterial roads	$L_{Aeq(15\ hour)}$ 60 (external)	$L_{Aeq(9\ hour)}$ 55 (external)
Local roads	Existing residences affected by noise from new local road corridors Existing residences affected by noise from redevelopment of existing local roads Existing residences affected by additional traffic on existing local roads generated by land use developments	$L_{Aeq(1hour)}$ 55 (external)	$L_{Aeq(1hour)}$ 50 (external)

Table 7-38 Noise assessment criteria for other sensitive land uses

Existing sensitive land use	Assessment criteria	
	Day (7 am – 10pm)	Night (10 pm – 7am)
Places of Worship	$L_{Aeq(1\ hour)}$ 40 (internal)	$L_{Aeq(1\ hour)}$ 40 (internal)
Open Space (active)	$L_{Aeq\ (15\ hour)}$ 60 (external) when in use	-
Open Space (passive)	$L_{Aeq\ (15\ hour)}$ 55 (external) when in use	

Table 7-39 Relative increase noise assessment criteria for residential receivers

Road category	Type of project/land use	Assessment criteria Total traffic noise level increase dB(A)	
		Day (7 am – 10pm)	Night (10 pm – 7am)
Freeway/arterial/sub-arterial roads and transit ways	New road corridor/redevelopment of existing road/land use development with the potential to generate additional traffic on an existing road	Existing traffic $L_{Aeq(15\ hour)}$ + 12 dB (external)	Existing traffic $L_{Aeq(9\ hour)}$ + 12 dB (external)

For sensitive receivers to qualify for the consideration of noise mitigation under the ‘new road’ criteria, the predicted noise levels must exceed the applicable noise criteria.

Where feasible and reasonable, noise levels from existing roads should be reduced to meet the noise criteria. The subsequent objective is to protect against excessive decreases in amenity as a result of the project by applying the relative increase criteria. The RNP definitions of reasonable and feasible have been used in this noise assessment. Feasible refers to whether it is feasible for the noise mitigation measure to be engineered or if it is practical to build given project constraints (such as safety and maintenance requirements). Reasonable refers to whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects. This includes considerations to community views and financial costs.

When assessing feasible and reasonable mitigation measures for a redeveloped road, an increase of up to 2 dB(A) represents a minor impact where it is generally not considered feasible and reasonable to provide additional mitigation. An increase of greater than 2 dB(A) would require consideration of all feasible and reasonable mitigation measures.

However if the receiver is found to be acutely affected then appropriate mitigation options must be considered. A receiver is considered acutely affected if the predicted noise levels are equal to or greater than a daytime $L_{Aeq(15hour)}$ of 65 dB(A) or a night-time $L_{Aeq(9hour)}$ of 60 dB(A).

Sleep disturbance

The RNP includes a review of international sleep arousal research and concludes that at our current level of understanding, it is not possible to establish absolute noise level criteria that would correlate to an acceptable level of sleep disturbance.

The application notes for the RNP recommend that sleep disturbance is assessed based on the emergence of the $L_{A1\ (1\ minute)}$ noise level over the corresponding $L_{A90\ (15\ minute)}$ noise level (ie the noise level exceeded for 1 per cent of the measurement period, or the ‘typical maximum’ noise level, against the background noise). The emergence is the amount the maximum noise levels rise above the typical noise levels. If the maximum noise levels (typically from engine braking) are significantly higher than the typical noise, the noise has a high level of emergence. As the emergence increases, the likelihood for sleep disturbance also increases. The emergence level is used as the basis for the sleep disturbance assessment.

The following screening criterion for sleep disturbance is recommended for the assessment of sleep disturbance: $L_{A1\ (1\ minute)} < L_{A90\ (15\ minute)}$ + 15 dB(A).

7.2.4 Assessment of potential impacts

Construction noise and vibration

The proposed construction activities have the potential to generate a range of impacts on sensitive receivers along the project alignment. These have been considered separately and are as follows:

- Impacts from construction noise sources and activities.
- Impacts from construction activities during standard construction hours.
- Impacts from extended or out-of-hours construction activities including sleep disturbance.
- Impacts from temporary construction ancillary facilities, such as stockpiling sites and site compounds.
- Impacts from increased traffic noise due to construction traffic.
- Impacts from construction vibration on buildings and/or human comfort from general construction activities.
- Impacts on buildings and/or human comfort due to blasting activities at Toolijooa Ridge.
- Cumulative noise impacts.

Impacts from construction noise sources and activities

For the purposes of this assessment, six main construction activities have been identified. The equipment expected to be used and the expected working hours for each construction activity are provided below in **Table 7-40**. This does not include batching plant activities, as this activity is not proposed as part of the project. Sources of construction noise and vibration would comprise a range of heavy vehicles, plant and equipment and hand tools. Based on the typical sound power levels for these sources, noise level predictions have been undertaken (refer **Appendix E**).

Table 7-40 Construction equipment for general construction work

Activity	Typical equipment used	Typical and maximum SWL* dB(A)	Expected working hours
Site Establishment /Landscaping	Excavators, chainsaws, mulching plant and chipper, cranes, generators, bobcat, powered hand tools, air compressor.	105 – 110	Standard
Earthworks	Road trucks, compactor, grader, multi-tyred and vibratory rollers, concrete trucks, concrete vibrator, asphalt paving plant, backhoe, sweeper, compressor, generators, rock crusher.	112 – 120	Standard
Bored piling	Bored piling rig.	100 – 110	Standard
Impact piling	Impact (driven) piling rig.	124 – 134	Standard
Bridge works	Piling rigs, cranes.	112 – 120	Standard
Paving	Road trucks, compactor, jackhammers, multi-tyred vibratory rollers, concrete trucks, concrete vibrator, asphalt paving plant, backhoe, concrete saw, profiler, sweeper, compressor, generator.	113 – 118	Standard, Evening, Night-time

**SWL – Sound power level*

A noise source may exhibit a range of particular characteristics that increase annoyance, such as tones, impulses, low frequency noise and intermittent noise. Where this is the case, an adjustment is applied to the source noise level received at the assessment point to account for the additional annoyance caused by the particular characteristics. The adjustments have been applied to the activities in **Table 7-40**.

Impacts from construction activities during standard construction hours

The majority of construction activities would take place from 7am-6pm, Monday to Friday and 8am-1pm Saturday, with no work on Sunday or public holidays.

For each of the six construction activities described in **Table 7-41**, a worst case and representative scenario was assessed to predict impacts on nearby sensitive receivers during standard hours of construction. This does not factor in reductions on noise levels that can be achieved through reasonable and feasible mitigation measures.

The representative scenario reflects a most likely scenario, in which not all the equipment would be in use at the same time (resulting in 112 dB(A)). The worst case scenario represents a larger number of the equipment being in operation at the same time (resulting in 120dB(A)). The results for each scenario and the number of sensitive receivers that would be impacted are provided in **Table 7-41**. The table also provides a total number of highly noise affected sensitive receivers (being those above 75dB(A)).

NCA 5, which represents Berry, contains the majority of the impacted sensitive receivers. This is because of the higher density of sensitive receivers within that noise catchment and the proximity of construction work to sensitive receivers. Activities that are likely to have the most impact on sensitive receivers include paving, bridge works and piling.

For other sensitive land uses:

- Construction activities are not expected to correspond with Sunday services at churches along North Street. As such, impacts are considered to be unlikely.
- Activities at the sportsground at Berry would typically only occur concurrently with construction works during Saturdays mornings, from 9am to 1pm. Impacts could occur, and these would need to be considered during construction scheduling.

The worst case scenario for each activity significantly increases the number of sensitive receivers that would be impacted. However, it is important to note that these scenarios do not necessarily represent the noise impact at sensitive receivers for an extended period of time. Highly noisy activities, such as rock breaking and use of concrete saws, are only likely to occur for a small fraction of the total construction period. The worst case scenario would be ameliorated by the implementation of appropriate mitigation measures, as outlined at **Section 7.2.5**.

Highly noise affected sensitive receivers would require noise mitigation, as detailed in **Section 7.2.5**.

Additional scenarios were assessed for specific works during standard construction hours, such as the Toolijooa cutting and the construction of the southern interchange for Berry. These scenarios were based on predicted activities and duration of the activities as discussed in the *Noise and Vibration Technical Paper* at **Appendix E** of this environmental assessment.

Table 7-41 Predicted levels of construction noise during standard construction hours (daytime)

NCA	NML dB(A)	Typical works: Predicted noise level dB(A)	Typical works: Receivers exceeding NMLs	Typical works: Highly noise affected [1]	Worst case: Predicted noise level dB(A)	Worst case: Receivers exceeding NMLs	Worst case: Highly noise affected
Establishment and landscape works							
NCA1	50	60	3	0	65	4	0
NCA2	50	58	3	0	63	9	0
NCA3	51	51	0	0	56	2	0
NCA4	51	63	12	0	68	15	0
NCA5	45	65	150	0	70	270	0
NCA6	48	57	7	0	62	21	0
		Total	**175**	**0**	**Total**	**321**	**0**
Earthworks							
NCA1	50	67	4	0	75	12	0
NCA2	50	65	10	0	73	18	0
NCA3	51	58	4	0	66	9	0
NCA4	51	70	15	0	78	32	3
NCA5	45	72	315	0	80	456	11
NCA6	48	64	21	0	72	22	0
		Total	**369**	**0**	**Total**	**549**	**14**
Bored Piling							
NCA1	50	55	1	0	65	4	0
NCA2	50	53	0	0	63	9	0
NCA3	51	46	0	0	56	2	0
NCA4	51	58	4	0	68	15	0

NCA	NML dB(A)	Typical works			Worst case		
		Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected [1]	Predicted noise level dB(A)	Receivers exceeding NMLs	Highly noise affected
NCA5	45	60	43	0	70	270	0
NCA6	48	52	1	0	62	21	0
		Total	**49**	**0**	**Total**	**321**	**0**
Impact Piling							
NCA1	50	79	16	1	89	22	3
NCA2	50	77	16	0	87	16	4
NCA3	51	70	10	0	80	14	2
NCA4	51	82	34	4	92	39	13
NCA5	45	84	457	12	94	458	95
NCA6	48	76	22	0	86	22	6
		Total	**555**	**17**	**Total**	**571**	**123**
Bridge Works							
NCA1	50	64	2	0	72	10	0
NCA2	50	63	6	0	71	8	0
NCA3	51	51	0	0	59	3	0
NCA4	51	72	6	0	80	28	2
NCA5	45	71	152	0	79	427	1
NCA6	48	43	0	0	51	8	0
		Total	**166**	**0**	**Total**	**484**	**3**
Paving							
NCA1	50	78	4	0	83	10	0
NCA2	50	73	10	0	81	16	0
NCA3	51	66	4	0	74	7	0
NCA4	51	78	15	0	86	23	0
NCA5	45	80	338	0	88	455	0
NCA6	48	72	21	0	80	21	0
		Total	**392**	**0**	**Total**	**532**	0

NCA – Noise Catchment Area
NML-Noise Management Limit
*Refer to **Table 7-27** for NMLs specific to NCAs*

Impacts from extended or out-of-hours construction activities, including sleep disturbance

It is proposed that construction activities would be undertaken outside standard construction hours. These activities fall into three categories as discussed below:

- Inaudible construction activities, which do not require approval to be carried out.
- Activities to be undertaken during extended construction hours of 6am to 7am and 6pm to 7pm Monday to Friday; plus 1pm to 5pm on Saturdays. Certain additional activities would be undertaken during the extended construction hours for the duration of construction. Approval is sought for these activities as part of the project.
- Out-of-hours activities, which would be undertaken with agreement with the affected receiver or agreed to by the EPA on a case-by-case basis.

Some construction activities would be undertaken outside of the standard and extended construction hours without approval in the following circumstances:

- The works do not exceed the NMLs.
- For delivery of materials required outside standard and extended working hours by the Police or other relevant authorities for safety reasons.
- Where it is required in an emergency to avoid the loss of lives, property and/or to prevent environmental harm.

Extended construction hours

RMS is proposing to undertake extended working hours for the duration of the project in order to reduce the construction period. Extended working hours would consist of an additional time at the start and end of each working weekday (6am to 7am and 6pm to 7pm Monday to Friday; plus 7am to 8am and 1pm to 4pm on Saturday).

Noise modelling has been undertaken to determine the impact of extended hours during the morning shoulder period. The result of this noise modelling is provided in **Table 4-2** to **Table 4-7** of the *Noise and Vibration Technical Paper* provided at **Appendix E**.

The morning shoulder noise modelling showed that there would be a maximum of 91 receivers impacted during this period. However, this scenario represents a worst case scenario and would occur for activities such as impact piling which would be unlikely to occur during the morning shoulder period.

Activities during the morning extended period hours would typically comprise of low noise impacts including deliveries, site access, refuelling, office works, foot-based activities and possibly work in ancillary activities.

When required, certain other activities would also be undertaken during extended construction hours. These activities include compound and site maintenance, bridge works (excluding the bridge at Berry), concrete works, and preparation works associated with blasting activities (such as drilling, haulage and rock crushing). These activities would be limited to the following times and locations:

- Between 6am and 7pm Monday to Friday for the Toolijooa cut, Broughton Creek floodplain and major bridge works (outside Berry township).
- Between 8am and 5pm on Saturdays for the Toolijooa cut, Broughton Creek floodplain and major bridge works (outside Berry township).
- Outside of known likely major traffic peaks (such as the Friday evening prior to a public holiday long weekend).

No construction activity would be undertaken near Berry during the proposed extended hours, given the number of sensitive receivers located close to the construction activities.

The ICNG permits certain types of work that may be undertaken outside normal construction hours. This includes public infrastructure works in which extended construction hours would shorten the length of the project and are supported by the affected community. It also identifies that out of hours work can be granted where a proponent demonstrates and justifies a need to operate outside the recommended standard construction hours.

Extended construction hours at the start and finish of each working day are considered to be in the public interest as they would:

- Shorten the overall construction period by approximately three months or 10 per cent. This would minimise the disruption to the Princes Highway and improve access to the NSW south coast. It would also minimise impacts to local businesses that may be experienced during the construction period.
- Reduce the publics' exposure to a substandard and inefficient road, reducing the potential for crashes.
- Potentially reduce the overall cost of construction.

The impact of the extended hours would not differ from the predicted noise level for daytime works in **Table 7-41**. However, as the works would take place during the night-time and evening periods, the NMLs would be exceeded by as much as 10 dB(A).

To determine if the extended hours would be supported by the affected community, targeted community consultation with property owners was completed in September 2011 and January 2012. A total of 58 properties from Toolijooa Road to the northern Berry interchange were identified as being potentially impacted by construction noise and therefore may be subject to potential impacts associated with works during extended hours. Of these properties nine are owned by RMS. Contact was made with all 58 properties, via phone calls and/or letters, offering information on the intended activities and offering to meet to discuss the potential impacts further.

A total of 34 of the property owners requested an interview with the project team to discuss potential impacts or to seek clarification regarding the proposed extended working hours. A summary of the comments and feedback recorded during these interviews is included in **Chapter 6**. Discussions included information on:

- The standard working hours and what the extended hours would mean for each property.
- The likely work activities that may be undertaken during extended hours based on current information and the potential construction scenarios.
- The likely complaints management procedures that would be put in place during construction.
- The approvals and control regime that would be put in place for construction activities (such as conditions of consent or the conditions of an Environment Protection Licence).
- Consultation that would be ongoing as the project progresses through detailed design and construction.

Feedback received during the consultation demonstrated that with the appropriate construction programming in place and the consideration of periods of respite during the day, there is general support overall for the application of extended working hours, as it provides a way to potentially shorten the construction period and enables the contractor to make up potential lost time due to inclement weather or other unexpected delays. An additional hour at the start and finish of each working day is generally considered to be an appropriate 'trade-off' to minimise construction delays and complete the project as quickly as possible.

Although feedback was generally supportive of extended construction hours, a number of property owners raised concerns relating to potential disruptions to cattle movements, the requirement to separate livestock from loud noise associated with construction or loud noise events (including blasts) that may disturb livestock (including horses). It was noted that these issues, and other concerns relating to possible personal special events on the property, could be discussed in more detail prior to and during construction through the ongoing project communications channels. Of the 34 consultation interviews undertaken, three property owners expressed some concern over extended working hours in the morning and evening, and one was concerned about Saturday afternoons.

Mitigation and management strategies for extended hours are discussed in **Section 7.2.5**.

Out of hours works

Some construction activities would also be undertaken outside of the standard and extended construction hours in the following circumstances:

- As agreed through negotiations between RMS and potentially affected sensitive receivers. Any such agreement would be recorded in writing and a copy kept on-site for the duration of the works.
- As agreed by the EPA for a specific activity for out-of-hours work, determined on a case-by-case basis.

Activities that would fall into this category are described in **Section 4.7** of **Appendix E**, and include paving, bridge works, refueling activities, utlitity adjustments and road tie-in works. These would need to be undertaken outside of normal and extended construction hours to ensure road safety, minimise disruption to regional and local traffic flows and/or for technical and timetabling reasons.

To consider the impacts of the noisiest out-of-hours construction activities, representative and worst case scenarios were assessed for earthworks, bridge works and paving. Concrete cutting associated with the paving works has the greatest potential for advserse impacts during out of hours work periods. Mitigation measures are available that could minimise this impact, as discussed in **Section 7.2.5.** The detailed results of this assessment can be found in **Appendix E**.

Out of hours activities may cause sleep disturbance. The extent of this impact would be dependent on the specific details of the works, such as equipment and what type of works would be undertaken. Potential impacts on sleep disturbance would need to be included in any future planning for out of hours work.

Impacts from temporary construction ancillary facilities, such as stockpiling sites and site compounds

The noise criteria for the ancillary facilities apply to the NCA within which the facility occurs (refer to **Figure 7.3**). **Table 7-42** is a summary of the potentially most affected sensitive receivers surrounding each ancillary facility site (refer to **Appendix B** of the *Noise and Vibration Technical Paper* at **Appendix E** of this environmental assessment) and predicted typical and worst case noise levels for each. In cases where two proposed ancillary facilities are in close proximity to one another, the noise assessment has considered this as one site. Evening and night time periods were also considered, as these sites may be required to support extended or out of hours construction activities. Noise contours for the operations of the ancillary facilities are provided in the *Noise and Vibration Technical Paper* at **Appendix E** of this environmental assessment.

The predicted noise levels indicate that activities within the site compounds are likely to exceed the appropriate NMLs. There would also be the potential for cumulative impacts to arise when road works and activities at ancillary construction sites occur at the same time. This could increase noise levels by as much as three dB(A) above the maximum noise level. This is not generally considered to be a significant increase.

However, given noise has been predicted to be above the NMLs, all reasonable and feasible noise mitigation and management measures would be considered and detailed by the contractor in the Construction Noise and Vibration Management Plan (CNVMP).

Table 7-42 Construction ancillary facilities*

Receiver number	Distance (m)	Noise catchment area	Predicted noise levels dB(A)		Standard hours NML dB(A)	Out of hours NML dB(A)	
			Representative	Worst case		Evening	Night-time
Construction ancillary site A							
1	89	NCA1	58	66	50	46	45
3	45	NCA1	61	69	50	46	45
4	457	NCA1	43	51	50	46	45
5	190	NCA1	51	59	50	46	45
Construction ancillary sites B and C							
9	210	NCA1	51	59	50	46	45
10	185	NCA1	52	60	50	46	45
11	185	NCA1	51	59	50	46	45
Construction ancillary site D							
12	123	NCA1	40	48	50	46	45
14	109	NCA1	58	66	50	46	45
16	394	NCA1	43	51	50	46	45
Construction ancillary sites E and F							
19	328	NCA1	45	53	50	46	45
20	340	NCA1	46	54	50	46	45
23	285	NCA1	46	54	50	46	45
25	575	NCA2	40	48	50	46	45
Construction ancillary sites G and H							
30	380	NCA2	45	53	50	46	45
31	240	NCA2	50	58	50	46	45
32	220	NCA2	51	59	50	46	45
33	50	NCA2	63	71	50	46	45
34	165	NCA2	54	62	50	46	45
35	350	NCA2	46	54	50	46	45
36	0	NCA2	78	86	50	46	45
38	335	NCA2	46	54	50	46	45
Construction ancillary site I							
41	180	NCA2	51	59	50	46	45
46	200	NCA2	51	59	50	46	45
48	40	NCA2	65	73	50	46	45
51	70	NCA3	61	69	51	44	43
52	200	NCA3	51	59	51	44	43
53	77	NCA3	58	66	51	44	43
56	147	NCA4	53	61	51	44	42
57	267	NCA4	50	58	51	44	42

Receiver number	Distance (m)	Noise catchment area	Predicted noise levels dB(A)		Standard hours NML dB(A)	Out of hours NML dB(A)	
			Representative	Worst case		Evening	Night-time
Construction ancillary site J							
66	235	NCA4	49	57	51	44	42
69	142	NCA4	52	60	51	44	42
71	38	NCA4	62	70	51	44	42
73	38	NCA4	63	71	51	44	42
92	170	NCA4	53	61	51	44	42
93	270	NCA4	48	56	51	44	42
Construction ancillary site K							
435	35	NCA5	72	80	45	42	40
452	30	NCA5	66	74	45	42	40
462	26	NCA5	75	83	45	42	40
466	26	NCA5	77	85	45	42	40
467	28	NCA5	76	84	45	42	40
476	31	NCA5	64	72	45	42	40
Construction ancillary site L							
561	57	NCA6	58	66	48	41	38
562	57	NCA6	55	63	48	41	38
564	60	NCA6	56	64	48	41	38

** The construction ancillary sites correspond to the sites illustrated in **Figure 4-19**.*

Impacts from increased traffic noise due to construction traffic

While spoil would be transported as much as practicable along internal haulage routes, construction of the project would increase both light and heavy vehicle movements on the Princes Highway. An increase in construction traffic during the night-time period is not predicted for this project as the extent of haulage activities is not currently known. This would be considered in any request for out-of-hours work.

The increase in noise from additional traffic associated with the construction of this project is likely to be less than 0.5 dB(A). Considering the predicted increase in noise is well below 2 dB(A), the impact from the additional traffic associated with the construction works would not be significant.

However operations, such as idling trucks for long periods alongside sensitive receivers, still has the potential to adversely impact sensitive receivers. Mitigation measures in **Section 7.2.4** would be needed to minimise this potential impact.

Impacts from construction vibration on buildings and/or human comfort from general construction activities

Vibration intensive works may occur during each phase of the project. Vibration generated during construction has the potential to cause structural/cosmetic damage or cause human discomfort by continuous, intermittent and impulsive vibration generated by general construction activity. Ground-borne noise impacts may also be generated by vibration-generating activities, such as compacting or drilling.

The extent of the potential impact is dependent on the type of equipment, the activity being undertaken and the separation distance. Earthworks and bridge works are expected to be the major vibration causing activities, given the use of vibratory rollers, hydraulic hammers and pile drivers. There is a higher likelihood that these activities would cause human annoyance from seven metres to 100 metres away from the construction area (Refer to **Table 7-43**).

Beyond 100 metres, general construction activity from the project is unlikely to cause human response to vibration. For structural impacts, cosmetic damage to buildings would not be likely where the building is distanced from the project by five metres to 25 metres. Safe working distances for vibration intensive plant equipment have been established, and are provided in **Table 7-43**. These were developed using the criteria provided in **Section 7.2.3**.

There are likely to be instances where vibration intensive activities within these setbacks must occur and cannot be avoided. This could be due to the work required, the underlying geological site conditions or the proximity of the building/receiver to the construction site. In these instances, mitigation and management measures would need to be implemented.

Table 7-43 Recommended safe working distances for vibration intensive plant

Plant	Rating/description	Safe working distance	
		Cosmetic damage	Human response
Vibratory roller	< 50 kN (Typically 1-2t)	5 m	15-20 m
	< 100 kN (Typically 2-4t)	6 m	20 m
	< 200 kN (Typically 4-6t)	12 m	40 m
	< 300 kN (Typically 7-13t)	15 m	100 m
	> 300 kN (Typically 13-18t)	20 m	100 m
	> 300 kN (> 18 t)	25 m	100 m
Small hydraulic hammer	(300 kg – 5-12t excavator)	2 m	7 m
Medium hydraulic hammer	(900 kg – 12-18t excavator)	7 m	23 m
Large hydraulic hammer	(1,600 kg – 18-34t excavator)	22 m	73 m
Vibratory pile driver	Sheet piles	2–20 m	20 m
Pile boring	≤ 800 mm	2 m	N/A
Jackhammer	Handheld	1 m nominal	Avoid contact with structure

Impacts on buildings and/or human comfort due to blasting activities at Toolijooa Ridge

Construction of the cutting at Toolijooa Ridge may require the use of explosives, with typically one blast occurring per day. This has the potential to generate vibration and overpressure impacts that may impact on the structural integrity of nearby buildings and cause human discomfort. Four sensitive receivers that have the potential to be affected by blasting activities at Toolijooa Ridge have been identified. These range in distance from around 260 metres to 450 metres away from the cutting.

Overpressure and vibration levels are highly dependent on local site conditions and the charge of the blast. As these conditions are not known at this stage of the project, minimum offset distances have been calculated in **Table 7-44** under ‘typical’ conditions to meet the overpressure and vibration goals provided in **Section 7.2.3** of this environmental assessment. Smaller test blasts would need to be undertaken before project-specific distances can be confirmed.

Table 7-44 Minimum offset distances for overpressure and blast limits

Charge	Minimum offset distances (metres)	
	Overpressure	Vibration (PPV)
1kg	550	30
5 kg	900	67
10 kg	1150	95

Based on the calculated minimum offset distances (refer to **Table 7-44**), the results indicate that although vibration limits would be complied with, overpressure is likely to exceed the appropriate limits at all four sensitive receivers. However, as the project proceeds, it is likely that the noise levels would be mitigated by the cut, and noise levels would gradually decrease. On this basis, the blast size could be increased as the works progress, subject to monitoring confirming that the required levels of mitigation can be achieved.

Blast mitigation strategies would need to be implemented to reduce noise levels and to minimise the likelihood of an exceedance. These are discussed further in **Section 7.2.5** of this environmental assessment.

To improve productivity of the construction, it is also proposed that simultaneous blasts may be undertaken. As blasting would only need to occur for a discrete construction period, simultaneous blasts would deliver the benefits of reducing both the number of blasts and the duration of construction at Toolijooa Ridge. This would require an increase to the maximum allowable levels for overpressure and blast limits given the cumulative impact of the blasts.

In these cases, alternative or secondary criteria and minimum setback distances have been determined, and are provided in **Table 7-45** and **Table 7-46**. As this represents a lowering of recommended criteria, simultaneous blasts would only occur where agreement of the affected receiver is obtained.

Table 7-45 Standard and secondary overpressure and peak particle velocity (PPV) criteria

Criteria	Standard maximum allowable levels	Secondary maximum allowable level
Overpressure	115 dB(Lin)	125 dB(Lin)
PPV	10mm/s	15mm/s

Table 7-46 Secondary minimum setback distances for overpressure and blast limits

Charge	Minimum offset distances (metres)	
	Overpressure	Vibration (PPV)
1kg	240	15
5 kg	410	34
10 kg	520	48

Cumulative noise impacts

The construction of the project is expected to commence in 2014, with the project opening to traffic in 2017. Other major construction work in the area would be associated with:

- The Gerringong upgrade, which is located to the north of the project. Construction work commenced in 2012, with the upgrade expected to open to traffic in 2014.
- The Berry to Bomaderry upgrade proposal, located to the south of the project. This is still in the planning stage. In the event that this project moves forward to assessment and approval stage, it is expected that construction work would commence in 2017.

It is not possible to eliminate the possibility of some overlap of the construction activities of the project with those associated with the Gerringong upgrade. This could increase noise levels by as much as three dB(A) above the maximum noise level. This is not generally considered to be a significant increase, but would be considered in any mitigation strategies (should this eventuate).

Given the current status of the Berry to Bomaderry upgrade proposal which is still in the planning phase, any associated cumulative impacts with specific regard to noise and vibration are not able to be accurately predicted. A cumulative impact assessment can only be made when the Berry to Bomaderry upgrade is at a much more advanced stage where construction stages and scheduling have commenced. If the Berry to Bomaderry upgrade proposal proceeds to the environmental assessment stage, that assessment would assess and consider any cumulative impact from the Foxground and Berry Bypass.

There are no other major projects in the immediate area that would be under construction at the same time as the project.

Operational noise

The project has the potential to generate a range of impacts on sensitive receivers along the project alignment during operation.

Based on the results of noise assessment modelling, noise at a total of 108 sensitive receivers would be above the appropriate noise criteria during the daytime period as a result of the project (refer to **Appendix I** of the *Noise and Vibration Technical Paper* at **Appendix E** of this environmental assessment. Of the 108 sensitive receivers, 7 are considered to be acutely affected (being $L_{Aeq(15\ hour)}$ of 65dB(A) or greater). During the night-time period, noise at 131 sensitive receivers would exceed the appropriate noise criteria as a result of the project, of which 16 are considered to be acutely affected (being $L_{Aeq(9\ hour)}$ of 60dB(A) or greater).

Overall, noise at a total of 164 receivers was found to exceed the applicable operational noise criteria (with some receivers experiencing exceedances during both the daytime and night-time periods) of which 18 receivers are considered to be acutely affected.

The results of the operational noise model can be found in the *Noise and Vibration Technical Paper* at **Appendix E** of this environmental assessment, and are shown on **Figure 7-4** to **Figure 7-6.**

Queen Street

A considerable number of receivers along Queen Street have been found to be acutely affected by noise associated with traffic on the existing highway (Queen Street). The project would redirect a significant amount of existing and future traffic from Queen Street to the new alignment, which would result in appreciable decreases in noise levels at receivers on Queen Street. However, noise levels at these receivers would still exceed relevant noise criteria.

Noise levels emitted from the new alignment (located to the north of Berry) would comply with the appropriate noise criteria at the Queen Street receivers. Considering noise levels emitted from the new alignment would comply with the appropriate noise criteria, these receivers would not be impacted directly by the project. Noise levels at Queen Street receivers would still exceed relevant noise criteria, however this would not be as a result of the project and therefore these receivers would not be considered to be eligible for noise mitigation.

Local roads in Berry

The closure of Victoria Street, Berry would result in changed traffic patterns on local roads within the town. Traffic that currently accesses or exits the highway from Victoria Street would be required to access and exit the project at the southern interchange for Berry utilising Queen Street. As discussed in **Section 7.1,** this would increase traffic volumes on the north-south running local roads in Berry between Queen Street and Victoria Street. These local roads include Prince Alfred Street, Alexandra Street, Albany Street, Edward Street and George Street.

Existing noise levels at receivers along the north-south local roads are currently dominated by noise generated from Queen Street during peak hour traffic flows. As discussed above, traffic flows on Queen Street would decrease as a result of the project and therefore most receivers on the north-south local roads would experience a reduction in noise levels following construction. A small number of receivers located further form Queen Street would experience an increase in noise levels during peak hour flows that is typically considered inaudible (less than two dB(A)).

As with receivers on Queen Street, a number of receivers on the north-south local roads currently experience noise levels above the relevant criteria. The noise at these receivers is currently controlled by traffic movements on Queen Street, rather than the local road on which the receiver is located. With the proposed closure of Victoria Street, noise levels on the north-south local roads would continue to be controlled by movements on Queen Street. As such, the project would not adversely impact noise levels at receivers on north-south local roads within Berry and receivers would not be considered eligible for noise mitigation.

North Street

A large number of receivers along North Street, between the Berry Sportsgrounds and Kangaroo Valley Road would be impacted by the project during operation (refer **Figure 7-6**). It is proposed that a noise barrier would be located along the North Street corridor to reduce the traffic noise impacts on these receivers. The noise barrier would start at the western end of the bridge at Berry and extend along the length of the North Street corridor to the southbound off-ramp of the southern interchange to finish near the intersection of Queen Street and Kangaroo Valley Road (refer to **Figure 7-7**).

A noise barrier over eight metres in height at this location would achieve compliance with the noise criteria at all sensitive receivers at this location. However, an eight metre barrier is not considered appropriate, given the significant visual impacts a barrier at this height would have along North Street. It would also be inconsistent with the community's expressed desire to maintain the existing district views from the town to the north.

Instead, a noise barrier four metres in height has been recommended as part of the project. Following construction of a four metre high noise barrier, 29 receivers would remain above the noise criteria. Six receivers on North Street would be eligible for additional noise mitigation. The remaining receivers would be above the criteria by one to two dB(A) and as a result would not be eligible for additional noise mitigation.

Additional work has been undertaken to assess and minimise visual impacts of the noise barrier along North Street. This would include the incorporation of an embankment or Ha-ha barrier to provide a vanishing slope affect to the noise barrier along North Street. The visual assessment of the noise barrier is discussed in more detail in **Section 7-6** and **Appendix I**.

Northbound off-ramp at the southern interchange for Berry

A noise barrier height of four metres is proposed along the northbound off-ramp for the southern interchange for Berry. It would be located between Huntingdale Park Road and the off-ramp and would finish near the intersection with Kangaroo Valley Road (refer to **Figure 7-7**). In addition to the proposed noise barrier, four properties on Kangaroo Valley Road and North Street would be eligible for additional noise mitigation.

Noise barrier reflection

The proposed noise barriers would be unlikely to impact sensitive receivers located on the opposite side of the project due to the reflection of noise. Any reflection impacts have been included in the noise predictions. As such, any qualification for mitigation at these receivers would have factored in this potential impact.

Other sensitive noise receivers

A small number of receivers located further from Queen Street would experience an increase in noise of typically between one dB(A) and two dB(A) is predicted between the year of opening and 10 years after opening, with a small number of sensitive receivers experiencing an increase of greater than two dB(A).

The proposed low noise pavement for the entire alignment and four metre noise barrier would reduce noise levels at the Berry Uniting Church and at Saint Patrick's Catholic Church, with:

- A noise reduction of seven dB(A) at the facade of the most effected building at the Berry Uniting Church. After taking into account external to internal losses and facade reflections, internal noise levels are predicted to be 40 dB(A) and would be equal to the internal noise criterion of 40 dB(A) ($L_{Aeq(1\ hour)}$).
- A noise reduction of nine dB(A) at the facade of the most effected building at Saint Patrick's Catholic Church. After taking into account external to internal losses and facade reflections, internal noise levels at predicted to be 39 dB(A) and would be below the internal noise criterion of 40 dB(A) ($L_{Aeq(1\ hour)}$).

The predicted noise levels at these locations would be equal to or below the criterion. However, as the noise levels predicted for the churches have been based on a number of assumptions, further analysis would be undertaken at the opening of the project to ensure the noise levels comply with the criterion.

The aged care facility (Bupa Care Services) accessed from Victoria Street, Berry has been assessed in accordance with the RNP against the residential criteria (refer to **Appendix I** of the *Noise and Vibration Technical Paper* at **Appendix E** of this environmental assessment). The maximum $L_{Aeq(9hour)}$ noise level predicted on the site of the Bupa Care Services is 58 dB(A). The predicted noise level exceeds the 'redeveloped road' criteria of 55 dB(A). However, there is no significant increase in noise levels as a result of the project.

A total of 20 isolated properties have been identified that would experience noise levels above the controlling criterion such that they would qualify for the consideration for architectural treatments. These properties are identified generally in **Figure 7-4** to **Figure 7-6.** These properties are identified as Noise Receiver 14a, 17a, 22a, 23, 25, 28, 29, 30, 33a, 73, 110, 299, 355, 374, 384, 386, 438, 439, 445 and 451 in **Appendix B** of the *Noise and Vibration Technical Paper* at **Appendix E** of this environmental assessment. The type of treatment applicable would depend on the level of the noise exceedances, namely:

- Fresh air ventilation, sealing of wall vents and upgraded window and door seals would be generally considered appropriate for properties that experience exceedances up to 10 dB(A) (Architectural treatment type 1).
- Additional upgrade of windows and doors would be considered in addition to the above for properties that experience exceedances over 10 dB(A) (Architectural treatment type 2).

Based on the predicted noise exceedances, all isolated properties, except for Noise Receiver 25, would experience exceedances up to 10 dB(A). Noise Receiver 25 may be eligible for architectural treatment type 2.

Noise levels at the active open space areas, being the Berry Sportsground and the Berry Riding Club, did not exceed the criteria. Noise at the Camp Quality Memorial Park would be above the criteria for passive open space land uses. However, noise reductions are expected at all three locations due to the inclusion of a low-noise pavement and the proposed four metre high noise barrier along North Street. As a result of these mitigation measures, a noise level reduction to 55 dB(A) is predicted. This complies with both noise criteria for active and passive recreational areas.

At Mark Radium Park, the proposed low noise pavement would reduce noise levels by two dB(A) at this location. This remains five dB(A) above the passive recreation criterion of $L_{Aeq(15hour)}$ 55 dB(A). Given the location of Mark Radium Park next to the existing highway and that the park is already receiving treatment in the form of a low noise pavement, the only other form of mitigation suitable is a noise protection barrier. A noise protection barrier in the order of 4 metres would be required to achieve compliance with the criteria. A noise barrier would be a significant structure and impede the use and the serenity of the park, a barrier is considered unfeasible. A small exceedence of the noise criteria at this location would be less significant than a noise barrier, for this reason, the impacts on the park are considered acceptable and not significant.

Figure 7-4 Receivers predicted to exceed criteria in areas from Toolijooa Road interchange to just east of the Austral Park Road interchange

Source: AECOM (2012)

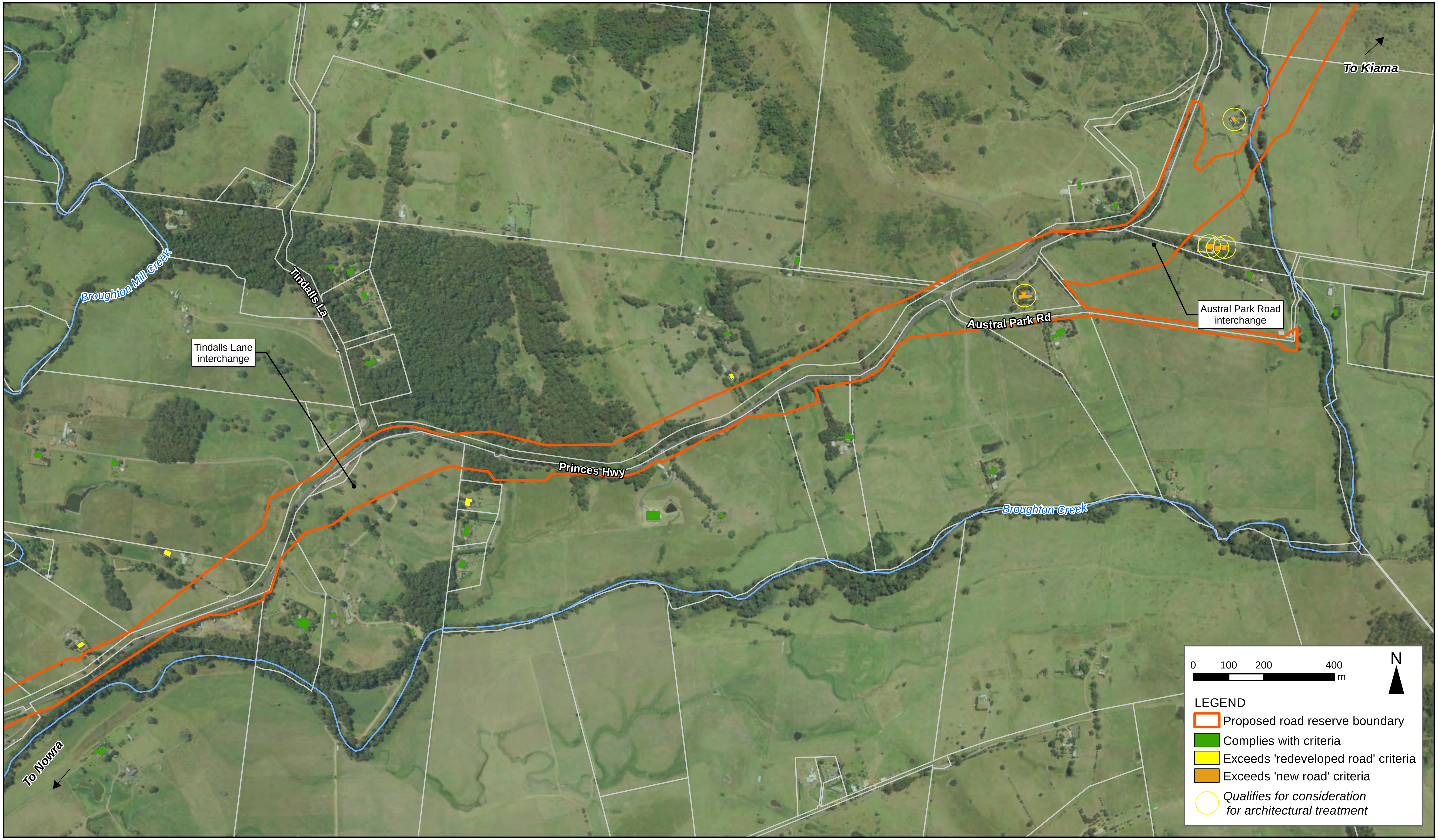

Figure 7-5 Receivers predicted to exceed criteria in areas between Austral Park Road interchange and Tindalls Lane interchange

Source: AECOM (2012)

Figure 7-6 Receivers predicted to exceed criteria in areas between Tindalls Lane interchange and Schofields Lane junction

Source: AECOM (2012)

Figure 7-7 Noise barrier locations at Berry

Source: AECOM (2012), LPMA (2011)

AECOM P:\60021933_G2B\4_Tech_work_area\4.7_GIS\Maps_20120925_CaitlinBennett\Fig 7-7_G019_NoiseProtectionWall_120803.mxd Drafted 25/09/2012

Meteorological effects

Meteorological effects have been assessed in accordance with the INP, as required by the DGRs. There is no requirement to meet the noise criteria under adverse weather conditions and the effectiveness of noise mitigation measures with weather effects has not been considered in this section.

Weather data between January 2000 and January 2001 for the closest weather station at Gerroa, NSW, was sourced from the Bureau of Meteorology. Based on this data, it was noted that:

- Temperature inversions are considered to be a feature of the area, with temperature inversions occurring 47 per cent of the total time between 6pm and 7am during the winter months. Temperature inversions could increase the noise levels at sensitive receivers by up to 5dB(A).
- Sensitive receivers located towards the south of the project would be adversely impacted as a result of wind effects (being residences exposed to wind speeds of up to three metres per second). At these sensitive receivers, noise levels could increase by up to around 5dB(A).

Sleep disturbance

The emergence level (or sleep disturbance guideline) has been considered at two monitoring locations BG9 and BG6 (refer **Figure 7-3**). These locations are considered to be typical of existing receivers north and south of Berry located on the existing alignment.

Monitoring at these two locations indicates that sleep disturbance is likely to be an existing issue for the local area.

For receivers where the project would not move the road closer to them, compared to the existing situation, the emergence is likely to decrease in the future. As traffic volumes increase, the $L_{Aeq(1hr)}$ noise levels would also increase, however as the road is not located closer to receivers, the maximum noise levels would not increase. As the difference between these levels decrease (resulting in a decrease in emergence), the potential for sleep disturbance is likely to become less prominent.

The proposed alignment would also decrease the gradient in some areas, and reduce the undulating nature of the existing alignment. This should reduce the use of truck engine braking and high engine revs, reducing maximum noise levels.

However receivers exposed to a new road would still be likely to receive emergence levels greater than 15 dB(A). Maximum noise levels decay from the source at twice the rate than average noise levels. On this basis, receivers located further from the alignment are theoretically likely to have lower emergence levels and therefore sleep disturbance is likely to be less of an issue.

7.2.5 Environmental management measures

Mitigation and management measures would be implemented to avoid, minimise or manage noise and vibration impacts. These mitigation and management measures are identified in **Table 7-47** and have been incorporated in the draft statement of commitments in **Chapter 10**.

Table 7.47 Mitigation and management measures

Potential impacts	Mitigation and management measures
Construction	
Construction noise	Prepare and implement a CNVMP that identifies reasonable and feasible approaches to reduce noise impacts during construction including for ancillary facilities. Inform the community at least 48 hours before any out of hours work is to be undertaken and provide the following information: • Programmed times and locations of construction work. • Construction noise and vibration impact predictions. • Construction noise and vibration mitigation measures being implemented on site. Provide specific details of all out of hours work to the EPA. Implement a notification and consultation procedure to identify when noise impacts during extended hours and out of hours work are above relevant criteria and enable appropriate management measures to be developed. Implement a hot line and complaints handling procedure for noise and other construction related complaints. Include specific noise mitigation measures in the CNVMP including: • Noise intensive construction works would be carried out during standard construction hours wherever practicable. • Noisy activities that cannot be undertaken during standard construction hours would be scheduled as early as possible during the evening and/or night-time periods. • Appropriate plant would be selected for each task, to minimise the noise impact. • Deliveries would be carried out during standard construction hours where practical and safe to do so. • Non-tonal reversing alarms would be fitted on all construction equipment where possible. • If it is safe, night-time activities would be planned and conducted in such a manner as to eliminate or minimise the need for audible warning alarms. • The offset distance between noisy plant items and nearby residential receivers would be maximised. • Noisy equipment would be oriented away from residential receivers.

Potential impacts	Mitigation and management measures
	• Site access points and roads would be positioned as far as practicable away from residential receivers. • Structures or enclosures would be used to shield residential receivers from noise sources where practicable. • Trucks would travel via internal haul routes and major roads and routes where practicable and would not be allowed to queue near residential dwellings. • Respite periods would be considered during times of noise intensive works where sensitive receivers would be adversely impacted for extended periods. These could include late start and/or early finishes. • Wherever practicable, noise intensive works would be planned in the following order of priority to minimise the potential impacts on sensitive receivers. – Standard working hours. – Extended working hours. – Evening working hours. – Night time working hours. • To reduce the total number of blasts, multiple simultaneous blasts would be undertaken. Simultaneous blasts would not increase the perceived number of blasts in one day, hence would be unlikely to increase the annoyance of potentially impacted receivers. • Bored piling would be used in place of impact piling wherever possible. Additionally, impact piling would only be undertaken during standard work hours.
Construction vibration	Prepare and implement a CNVMP that identifies reasonable and feasible approaches to reduce vibration impacts during construction including for ancillary facilities. Include specific vibration mitigation measures in the CNVMP including: • Vibration intensive works would not occur outside the safe working distances outlined in **Table 7-43** unless necessary. • If vibration intensive works would be required outside the safe working distances outlined in **Table 7-43**, alternative equipment would be used to ensure these distances are not exceeded. • If vibration intensive plant is to be used within the safe working distance for cosmetic damage, works would not proceed until attended vibration measurements are undertaken. • A permanent vibration monitoring system would be installed to warn operators (via flashing light, audible alarm, short message service (SMS) etc) when vibration levels are approaching the cosmetic damage objective to ensure applicable criteria are not exceeded. • Dilapidation surveys of the affected properties would be considered, and if required, undertaken prior to the commencement of construction. • Test blasts would be undertaken initially to determine the correct constants (blast size and offset distance) that would be employed for this project to ensure compliance with appropriate overpressure and vibration criteria for both structural damage and human comfort.

Potential impacts	Mitigation and management measures
Operation	
Noise levels from road traffic exceed criteria at sensitive receivers	Develop and implement all reasonable and feasible mitigation measures required to meet the applicable noise criteria in consultation with the sensitive receivers. Specific noise mitigation recommended for this project includes, where reasonable and feasible: • Low noise road surface. • Noise protection barriers. • Building architectural treatments. Monitor operational traffic noise at sensitive receivers between six months and one year after opening. If the traffic noise levels are above the predicted levels, consult with receivers on the development of further feasible and reasonable mitigation measures to meet the applicable criteria.

7.3 Biodiversity

This chapter provides an assessment of terrestrial and aquatic ecology, which were nominated in the DGRs as a key environmental issue for the project. It represents a summary of the *Terrestrial Flora and Fauna Technical Paper* (Biosis, 2012) and the *Aquatic Ecology and Water Quality Management Technical Paper* (Cardno Ecology Lab, 2012), which were prepared for the project with consideration of the DGRs.

The technical papers are provided at **Appendix F** and **Appendix G**, respectively. The relevant extract from the DGRs is presented below.

Director-General's requirements	Where addressed
***Flora and Fauna** – including but not limited to:*	
An assessment of all project components on flora and fauna and their habitat (both terrestrial and aquatic as relevant) consistent with the Draft Guidelines for Threatened Species Assessment (DEC 2005). The EA must provide details of the survey methodology employed including survey effort and representativeness for species targeted.	Section 7.3.1 and Section 7.3.3 Appendix F — Technical paper: Terrestrial flora and fauna Appendix G — Technical paper: Aquatic ecology and water quality management.
Specific consideration of impacts to threatened species, populations, ecological communities and/or critical habitat listed under both State and Commonwealth legislation that have been recorded on the site and surrounding land.	Section 7.3.2 and Section 7.3.3 Appendix F — Technical paper: Terrestrial flora and fauna Appendix G — Technical paper: Aquatic ecology and water quality management.
Details on the existing site conditions (both terrestrial and aquatic) and quantity and likelihood of disturbance (including quantifying the worst case extent of impact on the basis of vegetation type and total native vegetation disturbed).	Section 7.3.2 and Section 7.3.3 Appendix F — Technical paper: Terrestrial flora and fauna Appendix G — Technical paper: Aquatic ecology and water quality management.
As relevant, consideration of weed infestation and edge effects; habitat fragmentation, impacts to wildlife and riparian corridors; impacts to groundwater-dependent communities, riparian and aquatic habitat (including impacts on SEPP 14 wetlands and fish passage).	Section 7.3.3 Appendix F — Technical paper: Terrestrial flora and fauna Appendix G — Technical paper: Aquatic ecology and water quality management.
Provide details of how flora and fauna impacts would be managed during construction and operation for all project components, including adaptive management and maintenance protocols and monitoring programs.	Section 7.3.4 Appendix F — Technical paper: Terrestrial flora and fauna Appendix G — Technical paper: Aquatic ecology and water quality management.

Director-General’s requirements	Where addressed
Demonstrate actions to be undertaken to avoid, mitigate or offset impacts associated with the project (all components) consistent with the principles of “improve or maintain”. Sufficient details must be provided to demonstrate the availability of viable and achievable options to offset the impacts of the project, where offset measures are proposed to address residual impacts.	Section 7.3.4 Appendix F — Technical paper: Terrestrial flora and fauna Appendix G — Technical paper: Aquatic ecology and water quality management.
Identify potential risks of the project on groundwater resources including: impacts to groundwater-dependent ecological communities.	Section 7.3.3 and Section 7.4 Appendix G — Technical paper: Aquatic ecology and water quality management. Appendix H – Technical paper: Surface water, groundwater and flooding.
Waterways to be modified as a result of the project, including ecological, hydrological and geomorphic impacts (as relevant) and measures to rehabilitate the waterways to pre-construction conditions or better.	Section 7.3.3, Section 7.3.4 and Section 7.4. Appendix G — Technical paper: Aquatic ecology and water quality management. Appendix H – Technical paper: Surface water, groundwater and flooding.

7.3.1 Approach to assessment

The study area, for the purposes of the flora and fauna assessment, is defined as the project area and any additional areas that are likely to be directly or indirectly affected by the project. The study area used for the terrestrial ecology assessment includes the project and a 50 metre buffer either side of the project to account for any indirect impacts. The study area used for the aquatic ecology assessment includes aquatic habitat and biota upstream and downstream of the project.

Methodology

Terrestrial and aquatic flora and fauna in the study area were assessed in accordance with Part 3A Guidelines for Threatened Species Assessment (Department of Environment and Conservation (DEC) and Department of Primary Industries (DPI, 2005).This included:

- Database searches and literature reviews.
- Field surveys to determine the presence or likelihood of threatened species, populations and endangered ecological communities (EEC) to occur.
- Significance assessments to evaluate the potential impacts on threatened species, populations, habitats and EEC likely to be affected by the project.
- Identification of measures to avoid, minimise and mitigate potential impacts, or the provision of an offset strategy where impacts could not be avoided or minimised.

Terrestrial flora and fauna

Existing information about the terrestrial flora and fauna of the study area was obtained from a range of sources, including databases, aerial photographs, maps, previous studies carried out in the vicinity of the study area and consultation. The consultation was undertaken with experts, government agencies, land owners and land managers, local volunteer organisations and natural heritage clubs.

Threatened flora and fauna species, populations and EECs that occur, or are predicted to occur within the study area were identified by undertaking database searches. These included the OEH Atlas of NSW Wildlife, Department of Sustainability, Environment, Water, Population and Communities (DSEWPaC) Protected Matters Database, Birds Australia New Atlas of Australian Birds and OEH Illawarra sub-region database.

Field flora and fauna surveys were then used to ground truth and validate the information obtained during the desktop studies. Field survey sites were selected following a roadside inspection and examination of aerial photographs, topographic maps, existing vegetation maps and threatened species records. Survey sites within the study area included locations with stands of native vegetation and riparian vegetation along creeks and farm dams. Flora and fauna surveys involved random meanders and incidental observations throughout these sites, and opportunistically while travelling between these sites.

Seasonal surveys along the entire upgrade route were conducted in February 2007, November 2008 and May 2009. There were a total of 27 survey sites within the study area. The flora surveys were carried out by two botanists over a total of 22 days during three split survey periods conducted from 12 to 23 February 2007, 4 to 12 November 2008 and 18 to 22 May 2009. Further flora surveys and plant community assessments were carried out by one botanist on 28 June 2011, to identify suitable locations for temporary creek crossings during construction and on 8 November 2011 to assess the proposed diversion of Town Creek. The flora surveys included targeted searches and plot based surveys, such as quadrats. Targeted species include 13 flora species with potential habitat in the study area (random meander surveys) and all flora species and communities (quadrat surveys).

The likelihood of occurrence assessment for threatened flora and fauna and migratory species was based on previous records collated from database searches, data collected during the field survey, the current (known) distribution range of these species, and the presence and condition of suitable habitat in the locality.

Habitat condition assessments were also carried out and involved the collection of data about the plant communities present at each survey site. Specific data that was collected included the dominant species within each stratum, the degree of vegetation cover and the relative condition of the plant community. The condition of the vegetation was assessed based on how it compared to relatively natural, undisturbed vegetation. The vegetation condition was classified as good, moderate, poor or unnatural landscape.

Targeted fauna surveys were conducted using Elliot traps, cage traps, hair tubes, harp traps, ultrasonic call recording, spotlighting and call playback. Diurnal bird surveys, nocturnal frog surveys and reptile surveys were carried out. Incidental fauna observations such as remains (including skins), scats, diggings, burrows and feeding scars were also recorded.

The condition of habitats was evaluated based on the presence of key habitat features, such as vegetation cover, tree hollows and potential foraging, nesting or roosting sites. Habitats were classified as good, moderate or poor.

The species considered in this assessment were defined as those threatened species that are known or considered likely to occur in the locality, based on desktop assessments, field surveys or as requested by OEH.

The locations for ancillary sites (not including temporary creek crossings) were unknown at the time of terrestrial field survey and for that reason have not all been directly surveyed in the field. Instead, a methodology for assessing the ancillary sites was developed. This methodology was based on using agreed criteria as the primary assessment tool to confirm ‘no-go’ areas for ancillary facilities and to identify worst case and representative potential impacts of these facilities on the receiving environment. The agreed criteria are discussed in **Section 4.4.7**.

Aquatic flora and fauna

Threatened species, populations and endangered ecological communities (EECs) that occur or may occur within the study area were identified by reviewing published distributions and current listings on databases maintained by DSEWPaC, Department of Trade and Investment, Regional Infrastructure and Services (DTIRIS) and OEH. Results from a previous search of the NSW Government database 'BioNet' conducted on 7 September 2007 were also used[1]. DSEWPC, DTIRIS and OEH database searches were updated on 22 June 2011.

Aquatic habitats were assessed using three classification schemes, including riparian, channel and environmental (RCE) classification, riparian corridor management classification and fish habitat classification.

The RCE classification was used to understand the environmental state of waterways in the study area. The highest score (52) was assigned to a stream with little or no obvious physical disturbance. The lowest score (13) was assigned to a highly altered stream without any riparian vegetation.

The riparian habitat of each waterway in the study area was classified according to criteria provided in *Riparian Corridor Management Study (RCMS) in the Wollongong Local Government Area* (Department of Infrastructure Planning and Natural Resources (DIPNR) 2004). The classifications are informed by existing habitat conditions and also by the potential value of the habitat if it were rehabilitated. Classification categories are:

- *Category 1* – Environmental Corridor: provides biodiversity linkages by maintaining connectivity for the movement of aquatic species along the riparian corridor and between key destinations.
- *Category 2* – Aquatic Habitat: provides basic habitat and preserves or emulates, as much as possible, a naturally functioning stream.
- *Category 3* – Bank Stability and Water Quality: may have limited habitat value but contributes to the overall basic health of a catchment.

Each waterway in the study area, upstream and downstream of the project, was classified for fish habitat in accordance with the *NSW Policy and Guidelines: Aquatic Habitat Management and Fish Conservation* (Smith and Pollard 1999) and guidelines and policies for fish friendly road crossings (Fairfull and Witheridge 2003). Fish habitat was classified from Class 1 – major fish habitat to Class 4 – unlikely fish habitat.

Fish and macroinvertebrate sampling were used to determine the fauna species present in the study area and to provide an understanding of the health of the ecosystems. Electrofishing was used in appropriate habitats at four sites to sample fish and large mobile macroinvertebrates. Surveys of fish were undertaken once during autumn (April 2009) and revealed the fish present at the time at each site. This survey provides no information on potential variation in fish populations through time; rather it presents an appropriate 'snapshot' of fish communities.

The Australian river assessment system (AusRivAS) protocol (Turak and Waddell 2004) was used to provide an assessment of ecosystem health. The protocol uses an internet-based software package to determine the environmental condition of a waterway. It is based on predictive models of the distribution of aquatic macroinvertebrates at undisturbed reference sites. Observed freshwater macroinvertebrate assemblages (meaning those collected in the field) were compared to macroinvertebrate assemblages expected from reference waterways of the same type, which provides a basis to assess the health of the stream.

The revised SIGNAL2 biotic index (Stream Invertebrate Grade Number Average Level) developed by Chessman (2003) was also used to determine the environmental quality of sites on the basis of the presence or absence of families of macroinvertebrates. This method assigns grade numbers between one and 10 to each macroinvertebrate family or taxa found, based largely on their responses to chemical pollutants. The sum of all grade numbers for that habitat is then divided by the total number of families recorded in each habitat to calculate the SIGNAL2 index.

[1] The 'BioNet' database is no longer operational

The presence of instream macrophyte taxa was also recorded. The survey was done at an appropriate time to reveal a comprehensive range of macrophyte species present.

Water quality was measured at each waterway in the study area using a Yeo-Kal 611 probe. Physio-chemical properties measured included electrical conductivity, salinity, temperature, turbidity, dissolved oxygen, pH and oxidation reduction potential. Alkalinity was measured *in situ* using hand-held titration cells.

Temporary creek crossings were assessed using the above mentioned methodology as part of the aquatic ecology field surveys. Broad areas were identified as requiring temporary creek crossings. Within these areas, four sites were selected based on having the least possible impact on aquatic and terrestrial ecology and water quality.

7.3.2 Existing environment

The study area mainly comprises the existing Princes Highway road reserve as well as agricultural and rural properties. While most of the area outside the road reserve has been cleared for agricultural use, there are scattered patches of native vegetation and isolated remnant trees.

Conservation reserves in the area include the Cambewarra Range Nature Reserve, the Seven Mile Beach National Park, the Barren Grounds Nature Reserve and the Saddleback Mountain Reserve. None of these reserves would be directly impacted by the project.

The northern section of the project lies within the Crooked River catchment, however the project does not intersect any significant or ephemeral waterways in this catchment. As the project cuts through Toolijooa Ridge it crosses into the adjacent Broughton Creek catchment (which is part of the Shoalhaven River catchment). It crosses Broughton Creek on three occasions. Refer to **Section 7.4** for a description of the physical setting of these catchments.

There are several water quality issues facing watercourses within the Shoalhaven area due to past and present land-use practices. These include elevated nutrient levels, heavy metal contamination, suspended sediment resulting from erosion of soils, low dissolved oxygen, bacterial pollution and drainage of acid sulphate soils (ASS) (Environmental Protection Authority (EPA), 1997). Previous studies have found water quality within the study area to be typical of aquatic ecosystems that have been disturbed by agricultural practices (The Ecology Lab 1999, 2007). For further discussion on water quality within the study area, refer to Section 7.4.

Terrestrial flora

A total of 513 vascular flora species were recorded within the study and adjoining areas. About 78 per cent of these species were locally indigenous species and 22 per cent were exotic or environmental weed species. Two threatened flora species were recorded in areas adjoining the study area. Potential habitat for four threatened flora species may exist within the study area. A full list of flora species recorded is provided in **Appendix A** of the *Terrestrial Flora and Fauna Technical Paper* at **Appendix F.**

Most of the study area is covered by cleared land that is considered to have limited to no capacity for regeneration to a native plant community. Cleared land in the study area generally consists of grazed paddocks with little existing native vegetation.

Vegetation communities

As shown in **Figure 7-8**, 25 vegetation communities have been mapped as occurring within a five kilometre radius of the study area. Of these 25 communities, eight are mapped as occurring within the study area, including Illawarra gully wet forest, Currambene-Batemans lowlands forest, riverbank forest, warm temperate layered forest, closed grassland, closed grassland / sedgeland, riparian open forest and constructed wetland.

One of the communities located within the study area, the riverbank forest, is consistent with the EEC *River-flat Eucalypt Forest on Coastal Floodplains of the NSW North Coast, Sydney Basin and South East Corner bioregions* listed under the *Threatened Species Conservation Act 1995* (TSC Act). However, the community within the study area is considered to be highly disturbed and in poor condition as its species composition and structure have been altered and weed species are often dominant in the understorey. A total of 10 hectares of this community is mapped within the study area.

Threatened flora

According to database search results, a total of 17 vascular flora species listed on the TSC Act and/or the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), or their habitat, have been previously recorded within a 10 kilometre radius of the study area. No threatened flora species were recorded in the study area during the field surveys.

Two threatened species, Illawarra Socketwood (*Daphnandra* sp. 'Illawarra') and Hill Zieria (*Zieria granulata*) were recorded in areas adjoining the study area. The closest records of these species were about 600 metres and 200 metres south of the study area, respectively.

Potential habitat may exist within the study area for four threatened flora species. This is based on the proximity of previous records and/or the presence of identified habitat preferences. These species include White-flowered Wax Plant (*Cynanchum elegans*), Illawarra Socketwood (*Daphnandra* sp. 'Illawarra'), Delicate Cress (*Irenepharsus trypherus*) and Hill Zieria (*Zieria granulata*). The OEH has specified five flora species to be assessed for the project including two of the species cited above and an additional three species. The additional three flora species are Illawarra Greenhood (*Pterostylis gibbosa*), Leafless Tongue Orchard (*Cryptostylis hunteriana*) and Bauer's Midge Orchard (*Genoplesium baueri*).

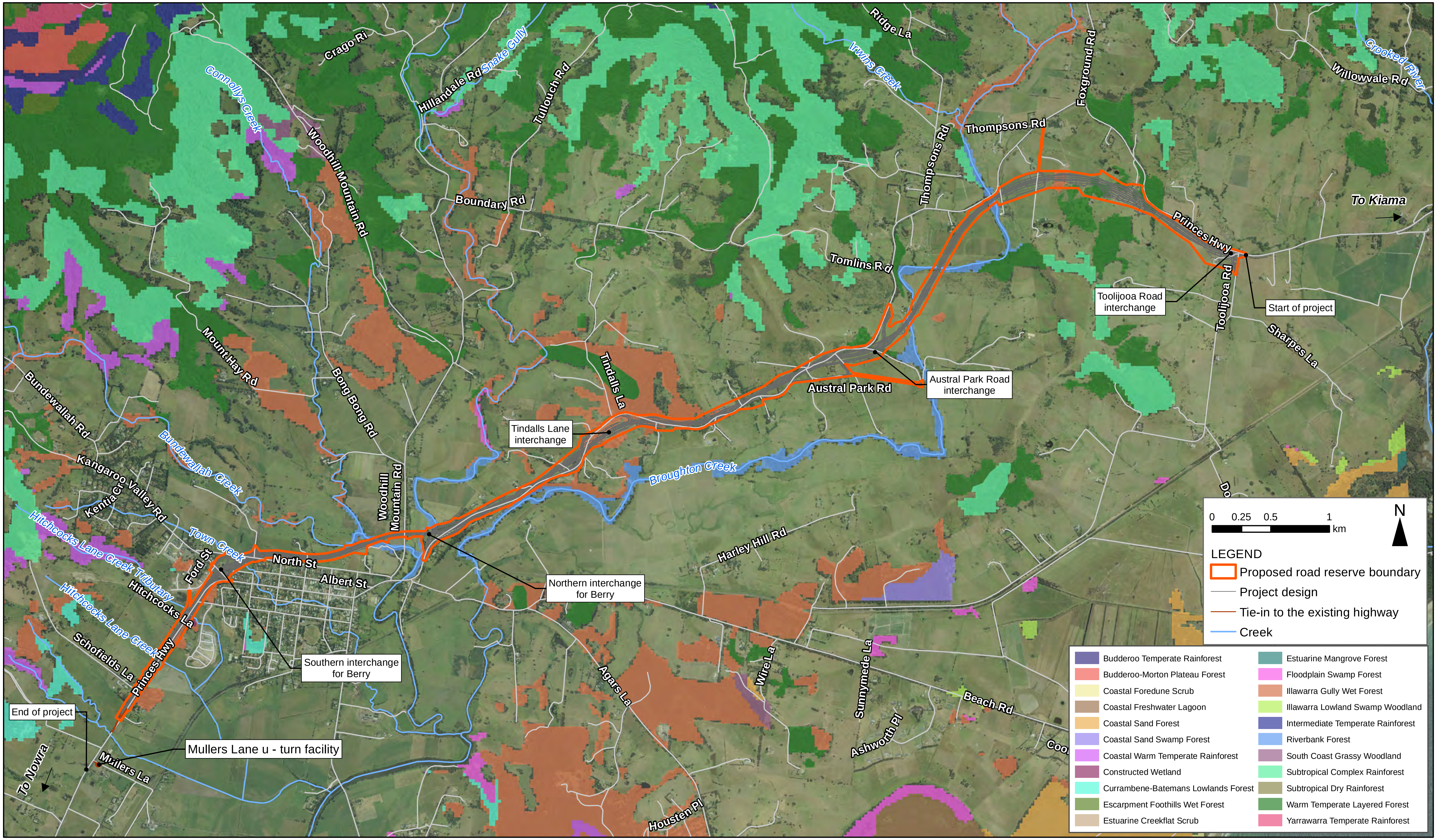

Figure 7-8 Vegetation communities within the study area

Source: AECOM (2012) ,LPMA (2011), OEH (2011)

Note: Closed grassland, closed grassland / sedgeland and riparian open forest is not shown on this figure.

Exotic species

There were seven exotic species recorded in the study area and its surrounds that are listed as noxious weeds in the Shoalhaven local government areas (LGA). Three of these are also listed as noxious in the Kiama LGA. **Table 7-48** provides a list of the eight species and the noxious weed class to which they belong. Noxious weeds are non-native species declared under Section 7 of the *Noxious Weeds Act 1993*.

Table 7-48 Noxious weeds recorded in the study area

Weed species	Common name	Noxious weed class
Ageratina riparia	Mistflower	4
*Lantana camara**	Lantana	4
Ligustrum lucidum	Large-leaved privet	4
Ligustrum sinense	Small-leaved privet	4
*Lycium ferocissimum**	African boxthorn	4
Rubus fruiticosus8	Blackberry complex	4
Senecio madagascariensis	Fireweed	4

**Listed as noxious in Kiama LGA*

The regulatory requirements for the management of these noxious weed classes include:

- Class 4 – The growth and spread of the flora must be controlled according to the measures specified in a management plan published by the local control authority.
- Class 5 – The requirements in the *Noxious Weeds Act 1993* for a notifiable weed must be complied with.

Given that survey effort for noxious weeds was focussed within areas of native vegetation, it is considered highly likely that further noxious weed species would occur within cleared and disturbed portions of the study area.

Throughout Australia, 20 Weeds of National Significance (WONS) have been identified due to their invasiveness, impacts on primary production and the environment, potential for spread and socioeconomic impacts. Two WONS, Lantana (*Lantana camara*) and Blackberry complex (*Rubus fruiticosus*), were recorded in the study area during the current surveys. Other than the requirements of the *Noxious Weeds Act 1993*, there are no additional regulatory obligations to control WONS. The invasion of lantana is also listed as a key threatening process under the TSC Act.

Environmental weeds were present in all areas of native vegetation that were surveyed and they dominated cleared and disturbed areas throughout the study area. The environmental weeds recorded during the field surveys included annual and perennial grasses and herbs. Some examples included Cobbler's Pegs (*Bidens pilosa*), Spear Thistle (*Cirsium vulgare*), Panic Veldtgrass (*Ehrharta erecta*), Kikuyu Grass (*Pennisetum clandestinum*), Paddy's Lucerne (*Sida rhombifolia*) and Curled Dock (*Rumex crispus*). Perennial species such as Sprengeri Fern (*Protasparagus aethiopicus*) and Madeira Winter Cherry (*Solanum pseudocapsicum*) had invaded areas under canopies and dense patches of groundcover. Species such as Creeping Buttercup (*Ranunculus repens*) and *Tradescantia fluminensis* were present in damp areas and riparian zones.

Woody environmental weeds such as Camphor Laurel (*Cinnamomum camphora*) and Wild Tobacco Bush (*Solanum mauritianum*) generally occur on the edges of native vegetation with cleared and disturbed areas as small stands or scattered individuals. Vines including *Araujia hortorum*, Cape Ivy (*Delairea odorata*) and White Passionflower (*Passiflora subpeltata*) are environmental weeds that occur on disturbed edges and under the canopy of patches of native vegetation.

Terrestrial fauna

Fauna recorded within the study area included 125 species of bird (including nine introduced species), 34 species of mammal (including five introduced species), nine species of frog and nine species of reptile.

Threatened fauna

According to database search results, a total of 114 threatened, migratory and/or preliminarily listed fauna species, or their habitats, have been previously recorded within a 10 kilometre radius of the study area or within the Illawarra sub-region of the Southern Rivers Catchment Management Authority (CMA) region. Seventy-three of these fauna species are listed under the TSC Act and 69 fauna species are listed (or nominated for listing) under the EPBC Act (including 20 threatened species and 51 migratory species). Eighty-nine threatened and/or migratory species have been previously recorded within 10 kilometres of the study area.

Nine threatened fauna species and six migratory species were recorded during the field surveys for the project.

Threatened fauna species recorded during the field surveys included:

- Gang-gang Cockatoo (*Callocephalon fimbriatum*).
- Powerful Owl (*Ninox strenua*).
- Yellow-bellied Sheathtail bat (*Saccolaimus flaviventris*).
- Eastern Freetail Bat (*Mormopterus norfolkensis*).
- Grey-headed Flying-fox (*Pteropus poliocephalus*).
- Eastern Bentwing-bat (*Miniopterus schreibersii oceanensis*).
- Eastern False Pipistrelle (*Falsistrellus tasmaniensis*).
- Southern Myotis (*Myotis macropus*).
- Greater Broad-nosed Bat (*Scoteanax rueppellii*).

Migratory species recorded during the field surveys included:

- White-bellied Sea-eagle (*Haliaeetus leucogaster*).
- Fork-tailed Swift (*Apus pacificus*).
- Cattle Egret (*Ardea ibis*).
- Black-faced Monarch (*Monarcha melanopsis*).
- Rufous Fantail (*Rhipidura rufifrons*).
- Australian Reed-warbler (*Acrocephalus stentoreus*).

State Environmental Planning Policy (SEPP) 44 Koala habitat protection

SEPP 44 aims to encourage the proper conservation and management of areas of natural vegetation that provide habitat for Koalas. SEPP 44 identifies both ‘potential’ and ‘core’ Koala habitat. ‘Potential’ Koala habitat is defined in the SEPP as areas of native vegetation where the trees of the type listed in Schedule 2 of the policy constitute at least 15 per cent of the total number of trees in the upper and lower strata of the tree component. “Core’ Koala habitat is defined as an area of land with a resident population of Koalas.

The Koala has been previously recorded north and south of the study area. Although some SEPP 44-listed feed tree species were recorded during the field surveys (eg *Eucalyptus microcorys, E. racemosa, E. robusta and E. tereticornis*), none were dominant within the forest/woodland patches of the study area. Based on the low density of preferred feed trees and the absence of records of these species within the study area, the study area does not constitute "potential" or "core" Koala habitat as defined under the SEPP. However, it is possible that the species moves through the study area on occasion between areas of potential habitat.

Wildlife corridors

Most of the study area is covered by cleared areas and grazed paddocks that contain little native vegetation and have not been mapped or described as a native plant community. As a result, wildlife corridors in the study area are limited. The project does however cross the Seven Mile Beach National Park – Barren Grounds Nature Reserve wildlife corridor. Remnant native vegetation at Toolijooa Ridge, Broughton Creek, Broughton Mill Creek and Bundewallah Creek are discontinuous parts of this corridor and are important to wildlife in the area. Creeks provide dispersal habitat for aquatic fauna and vegetation. Other creeks (such as Town Creek) and some road reserves within the study area also provide limited value as local wildlife corridors for some species. These smaller corridors are important in linking the larger corridors, and also provide the added values of protecting riverbanks, improving water quality and flows, controlling soil erosion and increasing land productivity through shelterbelts, windbreaks and screens (Shoalhaven City Council 2005). **Figure 7-9** displays wildlife corridors located within the study area.

A broader wildlife corridor has been identified by the Southern Rivers CMA. This corridor represents a long term restoration goal which would see a revegetated corridor extending east from the escarpment to the coast. It represents areas of interest for the Southern Rivers CMA and the Berry Landcare group in which efforts towards restoring the native landscape and improving connectivity should be focused. Within the study area, this corridor includes the section of the project between the proposed embankment at Broughton Creek bridge 1 and just east of the Tindalls Lane interchange. It is mostly made up of cleared agricultural land and includes most of the wildlife corridors as shown in **Figure 7-9**.

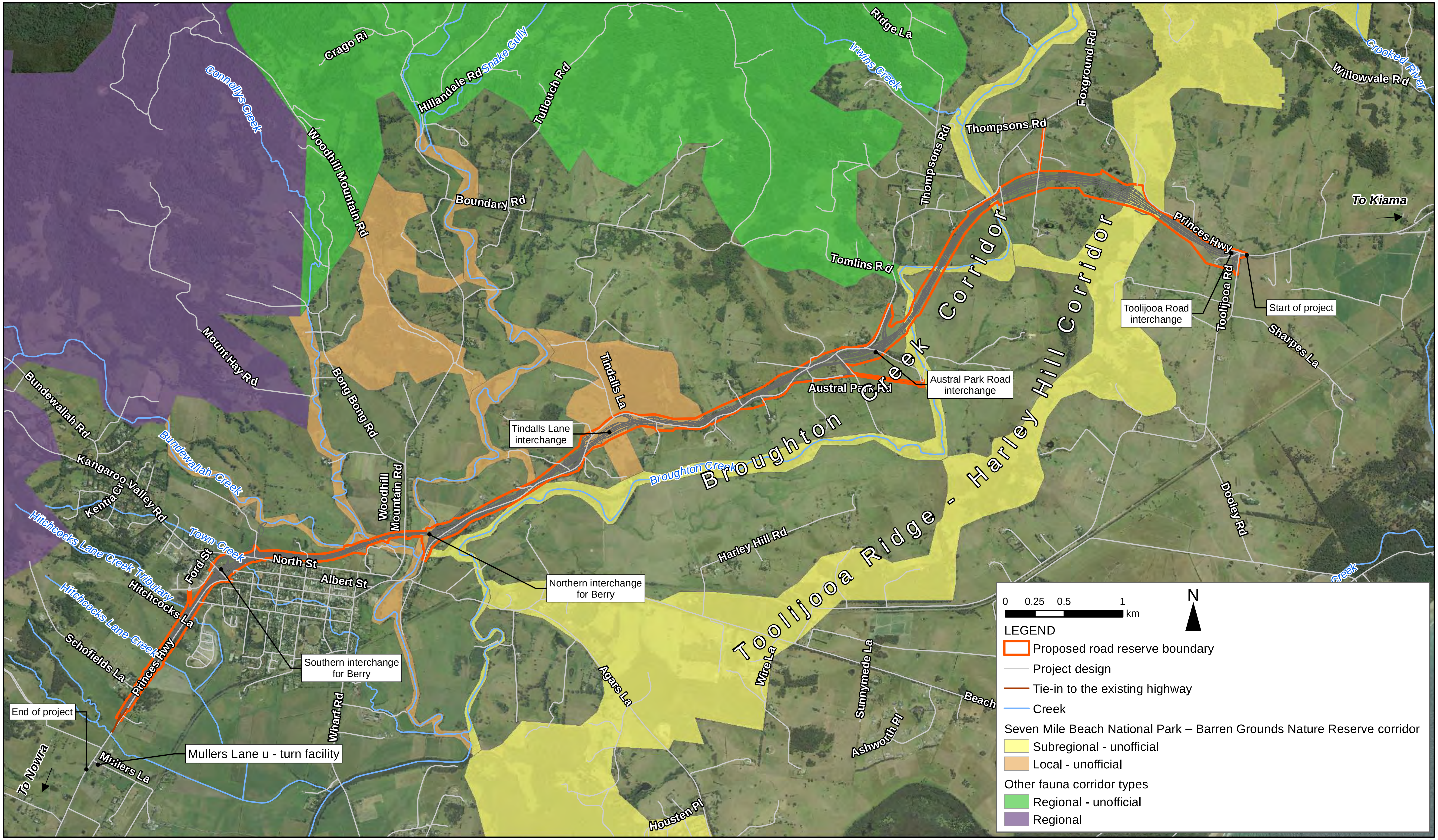

Figure 7-9 Wildlife corridors within the study area

Source: AECOM (2012), LPMA (2011), OEH (2011)

Terrestrial habitats

The following section provides a description of the condition of flora and fauna habitats within the study area.

Toolijooa Ridge and Harley Hill

Native vegetation along Toolijooa Ridge and Harley Hill was generally confined to discontinuous patches of remnant and regrowth vegetation from the uppermost hilltops and steep rocky and inaccessible slopes (Toolijooa Ridge) down to the plateau (Harley Hill). Vegetation communities along Toolijooa Ridge included subtropical complex rainforest which grades into warm temperate layered forest further down slope and along edges. Isolated stands of Illawarra gully wet forest were also present, sometimes represented by scattered remnant trees only. The dominant vegetation community at Harley Hill was the Illawarra gully wet forest. Ongoing disturbances such as grazing and a high degree of weed invasion continue to threaten the integrity of flora and fauna habitats at each of these sites.

The native vegetation along Toolijooa Ridge and Harley Hill was generally considered to be in poor condition along edges where large infestations of the noxious weed Lantana were present and had displaced most native species. Some large hollow-bearing trees were present and provided potential nesting and roosting resources for birds, arboreal mammals and microchiropteran bats.

Broughton Creek

Native vegetation along Broughton Creek was largely restricted to a thin riparian corridor with patches of remnant and regrowth vegetation. Ongoing disturbances such as grazing, erosion and a high degree of weed invasion have had a major impact on habitat condition at each of these sites.

Vegetation alongside Broughton Creek was riverbank forest in poor condition. Each site had a tall native canopy of River Oak (*Casuarina cunninghamiana*) and an understorey completely dominated by a high density of environmental weeds. Natural structural layers of the riverbank forest were no longer intact and in most areas the mid storey and ground layers were completely dominated by environmental weed species. Obvious disturbances at each of these sites included heavy grazing and erosion.

At least six large hollow-bearing River Oaks and six large hollow-bearing Blackbutts (*Eucalyptus pilularis*) were located in the vicinity of Broughton Creek.

Princes Highway at Tindalls Lane

Adjacent to Tindalls Lane and on the north and south sides of the existing Princes Highway was an area of remnant native vegetation that covered about 60 hectares. This was one of the largest areas of native vegetation present in the study area. Historic disturbances such as logging have altered the structure of these communities and environmental weeds were scattered throughout these areas.

The remnant native vegetation in these areas was Illawarra gully wet forest in a moderate to good condition. The native tree, shrub and ground layers were largely intact although woody weeds such as Lantana were present in dense patches. Where dense patches of lantana were absent, the native shrub layer remained intact.

The fauna habitats at this site were varied. Hollow-bearing trees were scarce, but those present (large eucalypts) may provide nesting and roosting habitat for various birds, bats and arboreal mammals. Small scale habitat features such as logs, dense undergrowth and leaf litter were also present, offering further habitat opportunities to a range of species.

Broughton Mill and Bundewallah Creeks

Broughton Mill and Bundewallah Creeks lie immediately north-east of Berry township. Native vegetation along these creeks was largely restricted to a highly disturbed riparian corridor.

Vegetation in this part of the study area was represented by riverbank forest in a highly disturbed, poor condition. There was also a tall native canopy of River Oak and an understorey completely dominated by a high density of environmental weeds. Natural structural layers were not intact and in most areas the mid storey and ground layers were completely dominated by environmental weed species.

Regardless of the degraded nature of much of the area observed along each creek, many sites contained mature casuarinas with small hollows.

Bundewallah Creek (proposed receiving point for Town Creek diversion)

The proposed Town Creek diversion would flow into Bundewallah Creek at the northern end of Rawlings Lane. Native vegetation within this riparian corridor was consistent with riverbank forest. Where the proposed diversion would connect to Bundewallah Creek, the riverbank forest included a sparse canopy of River Oak between 15 and 25 metres in height and woody weeds which formed a dense understorey in patches. Elsewhere the understorey was absent or had scattered woody weeds. Groundcover was dominated by exotic grasses and herbs with occasional patches of native groundcovers.

Bundewallah Creek at the proposed receiving point varied in width from around three metres to 10 metres. The creek was slow-flowing at the time of survey and supported wide pools and rocky riffle areas. Fringing vegetation consisted largely of weedy grasses which would likely provide habitat for common frogs and ducks. Deposited concrete slabs provided basking and shelter habitat for common reptiles. Fauna habitats at this location range from poor to moderate in condition.

Town Creek

Town Creek is a small ephemeral watercourse that passes directly through Berry, and originates to the north west of the town. The dominant vegetation type in the northern reaches of the creek, in the area north of North Street, was closed grassland which generally consists of introduced pasture species. There were also scattered occurrences of native herbs and rushes. The closed grassland represents a modified landscape and has established as a result of the substantial clearing of native vegetation and a long history of agriculture.

Fauna habitat was limited within the closed grassland. However, the land was prone to flooding and small, shallow wetlands were present at the time of survey. Common waterbirds, migratory waterbirds and common frogs may utilise this resource from time to time. Fauna habitat was subject to trampling by cattle which were seen drinking from the wetlands during the survey.

Town Creek south of North Street consisted of closed grassland, closed sedgeland and disturbed riparian open woodland. As with the closed grassland north of North Street, the closed grassland south of North Street was dominated by exotic species and patches of native vegetation. Disturbed riparian open woodland occurred along Town Creek through the Berry township. This vegetation community was characterised by areas of revegetation and regrowth of native vegetation, planted exotic trees, invasive woody weeds and areas of managed open space.

South of Berry, a wetland is located in the area immediately to the west of where Town Creek joins Broughton Mill Creek. This wetland formed following the construction of the access track causeway of the Berry sewage treatment works that encouraged the establishment of aquatic and semi aquatic vegetation. The wetland was characterised by patches of native rushes (Typha, *Typha orientialis)* and sparse cover of other emergent macrophytes. The banks were dominated by pasture grasses with exotic trees and shrubs occurring around the banks.

Fauna habitats along Town Creek south of North Street were disturbed, however they provide foraging and breeding resources for a range of common birds, frogs, reptiles and mammals. Town Creek itself and the wetland provide habitat for threatened and migratory birds. The wetland may offer potential habitat for the threatened Green and Golden Bell Frog. However, at the time of survey, the wetland was shallow and stagnant, limiting its habitat potential. Fauna habitats along Town Creek ranged from poor to moderate in condition.

Broughton Mill Creek (confluence with Town Creek)

Where Town Creek joins Broughton Mill Creek south-east of Berry, the vegetation consisted of riparian open woodland containing stands of exotic shrubs and trees. The groundcover was dominated by introduced pasture species. Fauna habitats were disturbed and subject to trampling by cattle (observed at time of survey). No sedges were present but patches of the reed would provide potential habitat for common frogs and birds.

Hitchcocks Lane

Two separate stands of vegetation occurred on the south side of the existing Princes Highway, one opposite Hitchcocks Lane and the second within a small reserve at the western end of Victoria Street.

Vegetation opposite Hitchcocks Lane was Illawarra gully wet forest and included mature hollow-bearing Bangalay (*Eucalyptus saligna* X *botryoides*) and Blackbutt (*Eucalyptus pilularis*) with a patchy understorey including native shrubs and groundcovers, along with large patches of environmental weed species. The condition of Illawarra gully wet forest at the Hitchcocks Lane site was considered to be moderate.

A small drainage line crosses under the existing Princes Highway and flows into a constructed wetland supporting native rushes such as Typha. The drainage line and wetland provide habitat for common frogs and birds.

Vegetation at the western end of Victoria Street included isolated remnant native trees with a mown grassy understorey. This area was considered to be highly modified and in poor condition. The only vegetation layer that remained undisturbed was the native canopy layer.

Schofields Lane

A native stand of Illawarra gully wet forest occurred south-west of Berry township and directly opposite Schofields Lane. This stand was considered to be in moderate condition, based on the number of mature eucalypt trees present. There were few logs and scattered stags (dead trees) with hollows on the site. There was potential for microbat breeding and roosting habitat.

Aquatic flora and fauna

Macrophytes

Previous surveys of creeks within the Crooked River and Broughton Creek catchments recorded Cumbungi (*Typha sp.*), Spikerush (*Isolepis prolifera*), Starwort (*Aster sp.*), Duckweed (*Lemna sp.*), Water Ribbons (*Triglochin procerum*), Arum Lilies (*Zantedeschia aethopica*), Tall Spikerush (*Eleocharis sphacelata*), River Clubrush (*Schoenoplectus validus*), Unidentified Rush (*Cyperus sp*.), Common Reed (*Phragmites australis*), Knotweed (*Persicaria sp*.), Water Plantain (*Alisma plantago-aquatica*), Watermilfoil (*Myriophyllum sp*.), Watercress (*Nasturtium officinale*) and Blunt Pondweed (*Potamogeton ochreatus*) (The Ecology Lab, 1999; 2007).

Macroinvertebrates

A study of aquatic macroinvertebrates from slow-flowing ‘pool edge’ freshwater habitat in the Crooked River and adjacent Ooaree Creek catchments recorded 41 taxa (The Ecology Lab, 1999). The Crooked River and Ooaree Creek catchments are located to the south east of the project area. This study was located outside the project area and was used for comparative purposes. Consistent with results for water quality, the most common macroinvertebrates collected from pool habitat were midge fly larvae (family Chironomidae), which are tolerant to pollution or degraded habitat. Other relatively abundant taxa included the families; Leptophlebiidae, Hydroptilidae, Physidae, Tricladidae, Baetidae, Tasimiidae and the sub-family Orthocladiinae (The Ecology Lab, 1999).

Fish

A literature and database search was conducted to obtain an inventory of freshwater fish fauna for the study area. There have been few formal fish surveys conducted in the study area, as discussed in **Section 7.3.1** (exceptions include the surveys documented by The Ecology Lab in 1999 and 2007).

Thirty-six fish species were identified as potentially existing or have historically existed within the study area. Of these, 33 are native species and three are exotic species. Three of the native species are listed as threatened. The *Fisheries Management Act 1994* (FM Act) lists the Macquarie Perch (*Macquaria australasica*) as an endangered species, the Black Cod (*Epinephelus daemelii*) as a vulnerable species and the Australian Grayling (*Prototroctes maraena*) as a protected species. The Macquarie Perch and the Australian Grayling are also listed under the EPBC Act as endangered and vulnerable respectively. The Australian Grayling has been recorded by the Australian Museum from Broughton Mill Creek, to the south-east of Berry and from the lower section of Jaspers Creek, just upstream of its confluence with Broughton Creek.

It is likely that not all 36 species identified as potentially or historically existing within the study area would actually occur within the study area. This is because the 36 species were obtained by including surveys from a wider area, including the larger Shoalhaven River system. The Shoalhaven River provides considerable fish habitat and ranges in altitude from sea level to over 500 metres AHD. Like the Shoalhaven River, Broughton Creek supports an estuarine floodplain at lower altitudes. It is likely that fish species that inhabit the lower reaches of the Shoalhaven River would also inhabit the lower reaches of Broughton Creek. However, the freshwater habitats that occur at higher altitudes within the Broughton Creek catchment are generally small and ephemeral. These streams would be unlikely to provide fish habitat and as a result some species found in the upper reaches of the Shoalhaven River may not be present in Broughton Creek.

The Macquarie Perch generally inhabits higher freshwater areas than those commonly found in the study area (NSW DPI 2005). However, Gehrke et al., (2001) claim that Macquarie Perch was historically present (prior to the construction of the Tallowa dam) in sections of the Shoalhaven River as low as 30 metres above sea level. Similar low elevations existed in the study area, although they were smaller and more degraded.

A previous survey of waterways intersecting the study area recorded nine species of freshwater and estuarine fish (The Ecology Lab, 2007). Four species were recorded within freshwater habitat from the Broughton Creek catchment, including Longfinned Eel (*Anguilla reinhardtii*), Flathead Gudgeon *(Philypnodon grandiceps*), Striped Gudgeon (*Gobiomorphus australis*) and Empire Gudgeon (*Hypseleotris compressa*). In addition to Flathead Gudgeon, another five species were recorded at the downstream extent of freshwater in Broughton Creek, which occurs at the Coolangatta Road bridge crossing. These species included Australian Smelt (*Retropinna semoni*), Pacific Blue-eye (*Psuedomugil signifer*), Estuary Perchlet (*Ambassis marianus*), Sea Mullet (*Mugil cephalus*) and the introduced Mosquito Fish (*Gambusia holbrooki*) (The Ecology Lab, 2007).

Field surveys conducted for the project recorded seven native fish species. These species were Bullrout (*Notesthes robusta*), Australian Bass (*Macquaria novemaculeata*), Australian Smelt, Longfinned Eel, Common Jollytail (*Galaxias maculatus*), Flathead Gudgeon and Striped Gudgeon. Australian bass is an important species to recreational fishers and is a common large predator within the study area. Its presence also influences the presence or absence of other fish species. For example, if Australian bass are found in a watercourse, then typically Macquarie perch would only be found upstream of them (McDowall, 1996).

The Shoalhaven/Crookhaven estuary, which is located downstream of the study area, supports a significant fish population. The estuary supports commercial fishing. Fish likely to occur include luderick, whiting (*Sillaginidae*), mullet (*Mugilidae*), flathead (*Platycephalidae*), bream (*Sparidae*) and crab species. A number of threatened and protected species either occur, or suitable habitat for them may occur, in the region of the estuary.

Syngnathiformes

All Syngnathiformes (seahorses, seadragons, pipefish, pipehorses, ghost pipefish and seamoths) that may inhabit the study area are listed as protected species under the FM Act. There are currently 31 syngnathids (seahorse, pipefish, pipehorses and seadragon), four solenostomids (ghost pipefish) and two species of pegasids (seamoths) known to exist in NSW waters. Syngnathiformes are found in a variety of habitats, including seagrass beds, coastal embayments and artificial structures such as jetties or mesh nets.

Some Syngnathiformes inhabit coastal embayments and estuarine habitats, are often associated with seagrass habitat, and can be found in the Crooked River lagoon, downstream of the study area.

Invasive species

The Environmental Reporting Tool identified alligator weed (*Alternanthera philoxeroides*) as potentially occurring in the region. Alligator weed is a WONS. It poses a significant environmental and economic threat and is highly invasive. Alligator weed is a Class 2 noxious weed in the Shoalhaven and Kiama LGAs, and as such the land must be kept free of alligator weed and it must be eradicated when identified.

Migratory marine species

An expanded search which included the distant downstream Shoalhaven/Crookhaven estuary identified 49 aquatic fauna species that are given general protection and listed under Section 248 of the EPBC Act, as migratory marine species, listed marine species, or whales and other cetaceans.

Twelve species are listed as migratory marine species, comprising six mammals, four reptiles and two sharks. There are 26 listed marine species, comprising two mammals, four reptiles and 20 ray-finned fish from the order Syngnathiformes (including pipefish, pipehorses, seahorses, seadragons, and ghost pipefish). Eleven species are listed as whales and other cetaceans.

Aquatic habitats

As discussed in **Section 7.3.1**, the existing quality of aquatic habitats has been assessed using three different measures:

- RCE classification – to provide a measure of habitat disturbance.
- Fish habitat – measured as Class 1 to Class 4 waterways.
- Riparian habitat – measured as category 1 to category 3 waterways.

Broughton Creek

The section of Broughton Creek upstream of Berry was mostly surrounded by cleared agricultural land. There were also large upstream sections with intact native riparian vegetation. Large sections of the creek also alternated between riffle and pool habitats and in-stream fish habitat, such as snags, rocks and deep holes. Closer to Berry, riparian vegetation became sparse and there was greater livestock access to the creek. The channel also became wider and there were longer, deep pool sections with cleared steep banks. Previous surveys have found that Broughton Creek provides major fish habitat (Class 1 waterway). The ephemeral tributaries of upper Broughton Creek have been considered unlikely to provide fish habitat (Class 4 waterways), as they only flow during larger rain events, have poorly defined channels with few standing pools and are often colonised by pasture grasses (The Ecology Lab 2007).

Broughton Creek was moderately disturbed (meaning it had a moderate RCE score) at the location of each of the three proposed highway bridges that would cross the creek. The results of the AusRivAS assessment showed that Broughton Creek was moderately impacted due to pollution and/or damage to the local habitat. However, Broughton Creek was considered to provide major fish habitat and it is a Category 1 waterway meaning that it provides biodiversity linkages along the riparian corridor.

The Coolangatta Road bridge crossing of Broughton Creek marks the downstream extent of freshwater habitat. This crossing is about 1.7 kilometres south of Berry. Further downstream the creek became considerably wider (up to 50 metres) and was estuarine. It meandered through the Broughton floodplain which has been cleared for agricultural use and the riparian vegetation was thin and sparse. There have been historical flood mitigation works in this area and a number of tributaries of Broughton Creek have been straightened and contain tidal gates. The estuarine section of Broughton Creek has been previously classed as major fish habitat (Class 1 waterway) (The Ecology Lab, 2007).

Broughton Mill Creek and Bundewallah Creek

Habitats within the Broughton Mill Creek and Bundewallah Creek catchments were relatively degraded (The Ecology Lab, 2007). Riparian vegetation was sparse or dominated by River Oak and mixed exotic species. The creek banks often had loose and eroded soils. Assessments completed during a prolonged dry period in Bundewallah Creek and Connollys Creek found minimal fish habitat (Class 3 waterway). The sections of Broughton Mill Creek just above and below the point where it joins Bundewallah Creek provided moderate fish habitat (Class 2 waterway). This watercourse had a sequence of pools and riffles, with some large snags and deeper holes.

At the location of the proposed crossing of Broughton Mill Creek, the waterway provided moderate fish habitat and had a moderate RCE score. It is a Category 2 waterway, meaning that it provided some riparian corridor but does not link to other destinations. The results of the AusRivAS assessment showed that Broughton Mill Creek was relatively healthy but showed some signs of pollution and/or local habitat damage.

At the location of the proposed crossing of Bundewallah Creek, the waterway provided moderate fish habitat and had a moderate RCE score. It was also a Category 2 waterway and the results of the AusRivAS assessment showed that Bundewallah Creek was relatively healthy but had some signs of pollution and/or local habitat damage.

Town Creek

At the location of the proposed diversion of Town Creek, the waterway was ephemeral, had a low RCE score and was unlikely to provide fish habitat. The catchment was urbanised with riparian habitat that was highly degraded and the creek is classed as a Category 3 waterway. Reaches of the creek to the north and south of the urbanised reaches had poorly defined channels, with few standing pools and were often colonised by pasture grasses.

SEPP 14 wetlands

The SEPP 14 listed Coomonderry Swamp lies behind Seven Mile Beach National Park on the eastern side of the ridge that separates the Broughton Creek valley and floodplain from the coast. Coomonderry Swamp is a 670 hectare semi-permanent freshwater swamp fed by surface and groundwater from the eastern slopes of Harley hill, Moeyan hill and Coolangatta Mountain (NSW NPWS 1998). The drainage catchments of Coomonderry Swamp, which is about five kilometres southeast of Berry are not within the study area, and would be unaffected by the project.

The Shoalhaven/Crookhaven estuary is located downstream of the Broughton Creek and Shoalhaven River confluence. It supports a number of significant estuarine wetlands, many of which are SEPP 14 listed, including the Comerong Island Nature Reserve.

Groundwater dependent ecosystems

Shallow alluvial groundwater systems have been identified upstream in the Broughton Creek floodplain and in the area immediately north of Berry, where Broughton Mill Creek, Bundewallah Creek and Connollys Creek converge (RTA, 2010). In these areas, groundwater levels are typically between 0.37 metres and 2.5 metres below ground level. Shallow alluvial groundwater systems are often in direct connection with surface water bodies, such as coastal waterways. These systems can be quickly recharged and water levels restored when droughts break (DLWC, 2002). The groundwater system in the study area is likely to support surface flows, hyporheic ecosystems and terrestrial vegetation such as riparian forests. The hyporheic zone is a fluctuating region where water exchanges between the surface and groundwater and is an important habitat for many aquatic invertebrates and a refuge during droughts and floods.

Shallow groundwater can support riparian vegetation either permanently or seasonally. The groundwater needs to be sufficiently high to sustain the vegetation therefore the sections of riparian habitat most dependent on groundwater within the study area most likely occur in areas where the water table is closest to the surface. However, the relationship between groundwater and survival of riparian vegetation in the study area is not known.

Groundwater can also be important for the persistence of aquatic macrophytes during periods when waterways are not flowing. An example would be Cumbungi, whose roots penetrate beneath creek beds.

Groundwater flow can be an important part of maintaining instream flow to support shallow aquatic habitat, such as riffles. At the surface, groundwater flow is often seen as springs or waterlogged soil. Shallow habitats were common within the major waterways of the study area. Each habitat supports a unique variety of aquatic flora and fauna. Groundwater contribution to surface water flows can also be important to the long term survival of unconnected pools. This is especially the case during droughts as pools function as a refuge for aquatic flora and fauna. The importance of groundwater to base flow of waterways within the study area is not known. There are no known significant springs in the study area.

Coomonderry Swamp is a well known groundwater dependent ecosystem (GDE) within the region. Its groundwater inflows come from a catchment outside the study area (to the east of Harley hill, Moeyan hill and Coolangatta Mountain) and therefore would be unaffected by the project.

7.3.3 Assessment of potential impacts

Potential impacts to terrestrial and aquatic flora and fauna within the study area during the construction and operation of the project could potentially include:

- Vegetation clearance and terrestrial habitat loss, including loss of EEC.
- Fragmentation and loss of connectivity.
- Loss of threatened species and their habitats.
- Loss of aquatic habitats.
- Loss of habitat for migratory species.
- Mortality of individuals.
- Invasion of exotic species.
- Reduction of water quality.
- Alterations of natural flow regimes.
- Impacts due to temporary creek crossings and ancillary facilities (construction only).
- Impacts to GDEs.
- Cumulative impacts.

Vegetation clearance and terrestrial habitat loss, including loss of endangered ecological communities

The project would have direct and indirect impacts as a result of vegetation clearance within the study area. Direct impacts would include the removal of vegetation to construct the roadway, temporary creek crossings and to provide areas for ancillary facilities. They would also include the loss of fauna habitat features such as nesting habitat and roosting hollows, as well as feeding and shelter resources.

Table 7-49 shows that 57.1 hectares of native vegetation would potentially be impacted directly or indirectly by the project. This includes an EEC and five different vegetation communities that provide potential habitats for threatened species. Around 0.9 hectares of closed grassland, which is not considered to be a native or derived native plant community, would also be directly or indirectly impacted by the project.

Table 7-49 Area of each plant community potentially impacted by the project

Plant community	Impacted area (hectare)				
	Direct				Indirect (edge effects)
	Roadway	Ancillary facilities	Temporary crossings	Town Creek diversion	
Closed grassland*	-	-	-	0.4	0.5
Closed grassland/ sedgeland	0.1	-	-	2.1	0.3
Constructed wetland	0.2	-	-	0.2	0.3
Currambene-Batemans lowlands forest	-	0.0002	-	-	2.4
Disturbed riparian open woodland	-	-	-	2.6	1.2
Illawarra gully wet forest	13.7	1.7	-	-	10.05
River-flat eucalypt forest**	2.6	-	0.2	0.1	7.1
Warm temperate layered forest	5.0	1.9	-	-	5.3
Total	**21.6**	**3.6**	**0.2**	**5.4**	**27.2**

** Closed grassland is not considered to be native plant or derived native plant community*
***River-flat Eucalypt Forest is an EEC*

Indirect impacts on native vegetation and habitats due to edge effects would be caused by vegetation clearance for the project. Indirect impacts have been assumed to occur within a 50 metre zone from the proposed edge of vegetation clearance. Edge effects would likely include the degradation of adjacent habitat through changes in microclimate, changes in hydrology, changes in floristics, alteration to the pattern and frequency of fire, invasion by exotic flora and fauna species, increase in sedimentation, increase in tree death, increase in rubbish and water pollution and improved access for predators (Bali 2000).

Native riparian vegetation within the study area (being River-flat Eucalypt Forest) would be subject to direct and indirect impacts as a result of the project. This includes the loss of 2.9 hectares of riparian vegetation. This includes the clearance of 0.1 hectares of riparian vegetation for the diversion of Town Creek. Around 7.1 hectares of riparian vegetation would be subject to edge effects. Native riparian vegetation within the study area forms part of the EEC *River-flat Eucalypt Forest on Coastal Floodplains of the North Coast, Sydney Basin and South East Corner Bioregions* listed under the TSC Act. As shown in **Figure 7-8**, areas where this EEC would be directly or indirectly impacted would include:

- The junction of Bundewallah Creek and Connollys Creek and downstream to Broughton Mill Creek.
- Broughton Creek to the east of Berry on the southern side of the Princes Highway.
- Broughton Creek to the south east and east of the intersection of Tomlins Road and Princes Highway, at Broughton.
- Broughton Creek to the east of the intersection of Thompson Road and Princes Highway, at Broughton.
- Bundewallah Creek at the Town Creek diversion.

The diversion of flows from Town Creek would see the degradation of about 2.9 kilometres of existing vegetation and habitat along the existing channel. However, vegetation along the existing Town Creek is highly degraded and dominated by exotic species. With the planting of appropriate riparian vegetation communities along the diversion channel, about 0.4 kilometres of higher quality habitat would be created along the channel.

Removal or degradation of native vegetation within riparian areas would also have the potential to impact on aquatic ecology. Riparian vegetation is important ecologically because it provides a source of organic matter, shade and a source of large woody debris. Riparian vegetation also stabilises the beds and banks of watercourses, protecting them against erosion and acts as a filter for sediments and nutrients entering watercourses.

Riparian vegetation at Broughton Creek, Broughton Mill Creek and Bundewallah Creek, which are all classified as Category 1 (Environmental Corridors) was generally intact but was highly edge affected.

Along smaller waterways, the riparian vegetation that would be removed as a result of the project was already extremely degraded and highly edge effected. Within these communities, large woody vegetation was often absent and they were often dominated by exotic species. Therefore, it is unlikely that the project at these locations would further degrade riparian habitat and cause a significant impact on aquatic ecology, subject to the implementation of the recommended mitigation measures.

An assessment of significance has been carried out for the River-flat Eucalypt Forest EEC following the Guidelines for Threatened Species Assessment under Part 3A of the *Environmental Planning and Assessment Act 1979* (EP&A Act) (refer to **Appendix G** of the *Terrestrial Flora and Fauna Technical Paper* at **Appendix F**). This assessment concluded that the impacts to the EEC are not considered to be significant, on the basis that:

- River-flat Eucalypt Forest in the study area is highly fragmented.
- River-flat Eucalypt Forest that would be subject to direct impacts and potential indirect impacts is currently in poor condition.
- Mitigation measures would be implemented to minimise the direct and potential indirect impacts on river-flat eucalypt forest in the study area (refer to **Section 7.3.4**).

However, there would remain an unavoidable loss of River-flat Eucalypt Forest as a result of the project, which would have residual impacts on terrestrial and aquatic ecology.

Fragmentation and loss of connectivity

The project would have some impact on local and regional wildlife corridors, particularly where the project crosses Toolijooa Ridge and Broughton Creek, despite the existing degree of clearing and fragmentation.

The existing Princes Highway crosses Toolijooa Ridge, however the project would widen the existing highway and deviate to the west. This would result in a wider barrier to fauna movement along the ridge. While the existing highway crosses Broughton Creek once, the project would cross Broughton Creek on three occasions. Construction of the project would also require three temporary crossings of Broughton Creek and temporary crossings of Broughton Mill Creek and Bundewallah Creek. Vegetation removal for the creek crossings would fragment riparian connectivity along Broughton Creek, Broughton Mill Creek and Bundewallah Creek. Movements of non-threatened terrestrial and arboreal mammals and birds may also be limited by the project.

The diversion of Town Creek would require the removal of riparian vegetation along Bundewallah Creek. It would also cause the degradation of vegetation along the existing Town Creek channel where the overall flow speed and volume would be reduced. This would potentially remove any wildlife connectivity along the existing Town Creek. However, an alternative wildlife corridor would be provided along the Town Creek diversion channel and Bundewallah Creek with the planting and rehabilitation of appropriate riparian vegetation.

Fragmentation of wildlife corridors would create barrier effects which would occur where particular species are either unable or unwilling to move between suitable areas of fragmented habitat. Even a small reduction in movements can reduce genetic continuity within a population and reduce the population size. Species most vulnerable to barrier effects include rare species, smaller ground-dwelling species and species with low mobility.

Most threatened species that have been recorded in the study area and/or locality are highly mobile, and would not be averse to crossing cleared areas. These include owls, parrots, cockatoos, raptors and bats. However, the project would create new barriers and exacerbate existing barriers to other threatened species with the potential to occur in the study area. These species would include the Black Bittern, Bush Stone-curlew, Eastern Pygmy-possum, Spotted-tailed Quoll, Yellow-bellied Glider, Koala and Long-nosed Potoroo.

The worst case scenario would see the project being undertaken without the implementation of mitigation measures to minimise impacts to flora and fauna or the mitigation measures implemented fail to achieve the desired outcome, for example fauna may not use the provided mitigation which leads to extinction of local populations. This scenario would likely result in significant impacts to the above mentioned fauna species due to fragmented corridors and connectivity. However, with the implementation of mitigation measures detailed in **Section 7.3.4**, it is considered unlikely that the project would significantly impact flora and fauna corridors and connectivity and likely that the worst case would be ameliorated by the implementation of the appropriate mitigation measures, as outlined at **section 7.3.4**.

Potential impacts on the Southern Rivers CMA corridor have been assessed throughout **Section 7.3.3**. The assessment concentrates on connectivity impacts associated with the most vulnerable areas within this corridor. These are located along creeks and ridgelines which have existing remnant vegetation.

There is potential that the project would impact on fish passage in the study area as a result of bridge structures, culverts and the diversion of Town Creek. Barriers to fish passage have been discussed in alterations to natural flow regimes in this section of the environmental assessment.

Loss of threatened species and their habitats

Terrestrial flora

No threatened flora species, as listed under the TSC Act or EPBC Act, were recorded in the study area. The project would not be expected to impact threatened species listed under the TSC Act or EPBC Act that may potentially occur in the study area.

Assessments of significance following the Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act were carried out for seven flora species listed as threatened under the TSC Act as a precautionary measure. These species were identified previously in **Section 7.3.2** and include the White-flowered Wax Plant, Leafless Tongue Orchard, Illawarra Socketwood, Delicate Cress, Hill Zieria, Illawarra Greenhood and Bauer's Midge Orchid.

The assessments of significance for each species considered the worst case impacts for the project, including:

- Is likely to reduce the long-term viability of a local population of the species, population or ecological community.
- Is likely to accelerate the extinction of the species, population or ecological community or place it at risk of extinction.
- Would adversely affect critical habitat.

The assessments also considered whether or not the project would maintain or improve biodiversity values, after considering actions to avoid, mitigate or compensate or to prevent unavoidable impacts.

The assessments of significance concluded that the project would have a minimal impact on flora species and their potential habitat in the locality based on the following:

- No individuals were recorded in the study area despite targeted surveys, including for those that are considered relatively conspicuous.
- The area of potential habitat impacted within the study area compared to that in the locality is considered small.
- Impacts resulting from the project are largely contained to areas that are already cleared and disturbed and include existing road infrastructure.
- Potential habitat in the study area is currently fragmented and subject to edge effects.
- The project is unlikely to interfere with the pollination and dispersal of native flora species.

As discussed in **Section 7.3.2**, five species listed as endangered under the EPBC Act were considered to have potential habitat and a likelihood of occurrence in the study area. These included White-flowered Wax Plant, Illawarra Socketwood, Delicate Cress, Hill Zieria and Illawarra Greenhood. An additional species, Leafless Tongue Orchard (a vulnerable species), was considered to have potential habitat in the study area but was not expected to occur given the absence of recordings for this species. All six species have been assessed against the relevant significant impact criteria in accordance with the EPBC Act Policy Statement 1.1 Significant Impact Guidelines: Matters of National Environmental Significance (DEWHA 2009) (refer to **Appendix I** of the *Terrestrial Flora and Fauna Technical Paper* at **Appendix F**).

This assessment considered the worst case impacts on these species that would potentially occur as a result of the project, including:

- Lead to a long-term decrease in the size of a population.
- Reduce the area of occupancy of the species.
- Fragment an existing population into two or more populations.
- Adversely affect habitat critical to the survival of a species.
- Disrupt the breeding cycle of a population.
- Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.
- Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species' habitat.
- Introduce disease that may cause the species to decline.
- Interfere with the recovery of the species.

This assessment concluded that the project is unlikely to have a significant impact on these species. Based on the outcomes of the assessment against the relevant significant impact criteria, referral to the Federal Minister for Sustainability, Environment, Water, Population and Communities is not required for the project in terms of potential impacts on listed flora.

Terrestrial fauna

The project may impact on threatened fauna species. In a worst case scenario the project may cause death or injury of individuals, loss or disturbance of limiting foraging resources or loss or disturbance of limiting breeding resources. A number of threatened fauna species listed under the TSC Act and EPBC Act were recorded or were considered to have potential habitat within the study area. The project may impact the foraging habitat and habitat connectivity of these species. However, it is unlikely that the project would have a significant impact on the survival of these species. It is likely that the worst case scenario would be ameliorated by the implementation of appropriate mitigation measures, as outlined at **section 7.3.4**.

Nine threatened species were recorded during the field surveys, including the Gang-gang Cockatoo, Powerful Owl, Yellow-bellied Sheathtail Bat, Eastern Freetail Bat, Grey-headed Flying-fox, Eastern Bentwing-bat, Eastern False Pipistrelle, Southern Myotis and Greater Broad-nosed Bat. These nine species, along with an additional 42 TSC Act-listed fauna species with potential habitat identified in the study area, have been assessed. Eighteen of the 51 species were also specified by the OEH as requiring an assessment.

Eleven species listed as critically endangered, endangered or vulnerable under the EPBC Act have potential habitat in the study area. These include the Regent Honeyeater, Eastern Bristlebird, Swift Parrot, Orange-bellied Parrot, Spotted-tailed Quoll, Green and Golden Bell Frog, Australian Painted Snipe, Long-nosed potoroo, Grey-headed Flying Fox, Koala and the Large-eared Bat.

Table 4.3 of the *Terrestrial Flora and Fauna Technical Paper* at **Appendix F** summarises the possible impacts from the project on threatened or endangered species listed under the TSC Act and EPBC Act with known and/or potential habitat in the study area, and determines the need for further assessments.

After considering information sourced from databases, literature reviews and field surveys, 27 of the 51 fauna species listed under the TSC Act were considered unlikely to be negatively impacted as a result of the project. As such, assessments of significance have not been prepared for these species (refer to **Appendix F**).

Assessments of significance completed for the remaining 24 terrestrial fauna species (refer to **Appendix G** of the *Terrestrial Flora and Fauna Technical Paper* at **Appendix F**), concluded that the project would be unlikely to have a significant impact on any of the species assessed.

Of the eleven terrestrial fauna species listed under the EPBC Act, it was considered that the project may have an impact on the Swift Parrot, Spotted-tailed Quoll, Green and Golden Bell Frog, Long-nosed Potoroo and the Grey-headed Flying-fox and the Koala. Therefore assessments in accordance with the Significant Impact Criteria (DEWHA, 2009) would be required. This was based on the potential for the project to limit foraging habitat and/or impacts on habitat connectivity. For the five remaining species, it was concluded that assessments in accordance with the Significant Impact Criteria (DEWHA, 2009) would not be required.

Of the six fauna species carried forward for assessment against the Significant Impact Criteria, it was concluded that the project would be unlikely to have a significant impact on the species, provided the mitigation measures detailed in **Section 7.3.4** are implemented. Consequently, referral to the Federal Minister for Sustainability, Environment, Water, Population and Communities is not required for the project.

Aquatic flora and fauna

No aquatic threatened or protected species or populations listed under the FM Act or the EPBC Act were observed in the study area during field surveys. The project would not be expected to impact threatened species listed under the FM Act or EPBC Act that may potentially occur in the study area.

Based on literature reviews, databases and survey data (as discussed in **Section 7.3.2**), potential impacts on the following aquatic fauna species were assessed due to the possibility that they might occur in the study area:

- Macquarie Perch, which is listed as vulnerable under the FM Act and endangered under the EPBC Act.
- Australian Grayling, which is listed as protected under the FM Act and vulnerable under the EPBC Act.
- Black Cod, which is listed as a vulnerable species under the FM Act.

These assessments were completed as a precautionary measure and to assess the worst case scenario, even though it is considered that the study area would not support viable populations of the Macquarie Perch or the Australian Grayling. Similarly, a significance assessment was also completed for the Black Cod, as it is possible that Crooked River and Shoalhaven/Crookhaven estuary are habitat for juveniles of this species.

All assessments found that the project would be unlikely to impact on each species, particularly following the implementation of mitigation measures presented in **Section 7.3.4**. A referral to the Federal Minister for Sustainability, Environment, Water, Population and Communities is not required for the project.

It is anticipated that the project would not have any significant impacts on surface or groundwater hydrology that might affect sensitive Syngnathiformes inhabiting distant downstream habitats. Similarly, appropriate erosion and stormwater control measures would eliminate potential downstream impacts related to sedimentation and pollution. Therefore, the project would not be expected to have any impact on Syngnathiformes.

Aquatic communities

No aquatic threatened or protected communities were observed in the study area during field surveys.

Assessments of significance were carried out for two aquatic communities (coastal saltmarsh and freshwater wetlands on coastal floodplains) as a precautionary measure and to assess the worst case scenario. The assessments found that the project would be unlikely to impact these communities given that they do not occur within the study area. A referral to the Federal Minister for Sustainability, Environment, Water, Population and Communities is not required for the project.

Loss of aquatic habitats

In-stream woody debris provides habitat for macroinvertebrates and fish, including refuge from predation, habitat for prey and as damming structures that create pools. Large woody debris was present within the larger watercourses, such as Broughton Creek, Broughton Mill Creek and Bundewallah Creek, and has the potential to be impacted by the project.

Temporary crossings would be constructed near each bridge site and would potentially involve in-stream works. In a worst case scenario it is possible that project works could lead to the removal of large woody debris. However, with the implementation of mitigation measures presented in **Section 7.3.4**, the impact to aquatic habitats would be expected to be minimal. Other than the bridge at Berry, no permanent bridge abutments or piers would be placed within these waterways meaning that the long term removal of woody debris would not be expected at most locations.

Temporary constructions pads are likely to be required during the construction phase of the project to assist with bridge construction. Construction pads may involve the temporary placement of rocks or other construction materials within waterways.

There was little large woody debris in many of the smaller waterways that intersect the project, including Town Creek. Therefore it is unlikely that the project would further degrade large woody debris habitat at these locations such that it would cause a significant impact on aquatic ecology.

Loss of habitat for migratory species

The project would not be expected to impact terrestrial or aquatic migratory species with known or potential habitat within the study area. This is because habitat for these species occurs well outside the project area or because habitat within the project area is not considered to be important for these species.

In a worst case scenario habitat for migratory species within the study area would be reduced. This has the potential to limit migratory species from visiting the region or to reduce the viability of migratory species. It is unlikely that the worst case scenario would occur with the implementation of appropriate mitigation measures, as outlined at **section 7.3.4**.

Fifty-one migratory species (or their habitats) have been previously recorded within 10 kilometres of the study area. Six of these species were recorded during the field surveys including, White-bellied Sea-eagle, Fork-tailed Swift, Cattle Egret, Black-faced Monarch, Rufous Fantail and Australian Reed-warbler. Potential habitat exists in the study area for an additional 21 migratory species.

Migratory waders are the most common migratory species recorded in the locality. Coomonderry Swamp, Seven Mile Beach National Park, Crooked River Estuary and Black Head are used on occasion or regularly by these species. However, individuals of these species that have been, or may be, recorded in the study area are not considered likely to be an ecologically significant proportion of their populations. Similarly, individuals of other migratory birds (such as forest/woodland birds) that have been, or may be, recorded in the study area, are not considered likely to be an ecologically significant proportion of their populations.

Known and/or potential habitat in the study area is not considered important for these migratory species. Habitat and corridor fragmentation is considered unlikely to significantly impact these mobile species. Given the minimal impact expected on the known and/or potential habitat for these species in the study area, assessments in accordance with the Significant Impact Criteria (DEWHA, 2009) have not been carried out.

It is unlikely that the project would cause significant effects on the aquatic habitats and biota of the Shoalhaven/Crookhaven estuary, including aquatic and marine migratory species identified in the expanded EPBC Act search. Impacts are considered unlikely given:

- Their distance downstream.
- The implementation of mitigation measures to control water quality.
- That the species are mostly coastal or oceanic species.
- The Shoalhaven/Crookhaven estuary does not constitute critical habitat for any of these species.
- It is likely that the species would only use the estuary intermittently (if at all), as demonstrated by the limited records of these species in the estuary.

As such, no formal assessments of significance were completed for these species.

Mortality of individuals

Fauna injury or death may occur during the construction phase of the project, when all vegetation has been removed. Many species, such as nocturnal species and smaller ground-dwelling species, would be vulnerable to predators as they are unable to move rapidly over large distances. Fauna mortality may also occur as a result of road kill during the operation of the project. The effects of mortality on general populations of species are difficult to predict. More detailed population data for species in the study area would be required.

RMS has policies and guidelines in place to manage the risk of fauna mortality during construction and operation of the highway (refer to **Section 7.3.4**). While road kill may still occur during operation, these mitigation measures would reduce the likelihood of road kill causing a significant impact on a species.

In a worst case scenario, there would be potential for a higher rate of mortality (of threatened or non-threatened species) as a result of the project. This may be as a result of additional vegetation clearance and associated habitat loss and removal or changes to proposed fauna crossing structures. However, it is likely that the worst case scenario would be ameliorated by the implementation of appropriate mitigation measures, as outlined at **section 7.3.4**.

Invasion of exotic species

Terrestrial species

The project would change the environmental conditions of adjoining native vegetation that may encourage weed invasion. However, all areas of native vegetation recorded in the study area are characterised by existing weed infestation. This is especially the case in areas adjoining Broughton and Bundewallah Creeks, where the understorey of riverbank forest is completely dominated by weed species, including Small Leaved Privet, Lantana, Wild Tobacco Bush, Mistflower and *Tradescantia fluminescens*.

A worst case scenario would see the introduction of WONS or noxious weed species that do not currently occur in the region. In particular the introduction of a Class 1 or Class 2 noxious weed species.

Weed invasion can be a significant problem along the edges of habitat fragments. Along these boundaries there would be changes in the environment including altered light levels, wind speed, temperature, humidity and runoff. These altered conditions allow the colonisation and growth of environmental weeds which would themselves result in environmental changes that further promote the presence of weed species within the area. Due to these environmental changes, weeds may be able to out-compete native flora species and in a worst case scenario could result in the loss of the native plant community in that area.

The implementation of mitigation measures provided in **Section 7.3.4** would decrease the likelihood of increased weed invasion in the impacted patches and the worst case impact is unlikely to occur.

Aquatic species

Alligator weed was not observed at any site within the study area and no records were found for its occurrence. Notwithstanding, this species is known to be present within the Illawarra region. In a worst case scenario, if alligator weed became established within the study area, it is possible that its distribution could be increased by construction activities associated with the project.

Alligator weed would have the potential to impact the viability of native aquatic flora and fauna, if it became established within the study area. The mitigation measures presented in **Section 7.3.4** would be implemented to reduce the potential for the introduction and spread of alligator weed.

Reduction of water quality

Potential water quality impacts to aquatic ecology during the construction and operation of the project would include sedimentation, pollution and disturbance of ASS.

Sedimentation

There is potential for the mobilisation of sediments into the study area's aquatic habitats. Sediment mobilisation may arise from earthworks required for construction of the project and from ongoing erosion of disturbed areas during operation.

In a worst case scenario, an increase in sediment load can degrade water quality and important habitat features resulting in a loss of biodiversity and altered biotic assemblages. Sedimentation has the potential to lead to mortality and decreased growth in flora and fauna, degradation of habitat and reduced water quality. It is likely that the worst case scenario would be ameliorated by the implementation of appropriate mitigation measures, as outlined at **section 7.3.4**.

Increased sedimentation would be a concern for local freshwater habitats and biota downstream of the construction works, such as Broughton Creek, Broughton Mill Creek and Bundewallah Creek. There are also downstream sections of these waterways with relatively intact riparian vegetation and aquatic habitat.

The diversion of Town Creek would have the potential to increase sedimentation in both Bundewallah Creek and Town Creek. The excavation of a new creek bed would potentially facilitate erosion of the creek bed and banks due to the diverted flows. This would increase sedimentation in Bundewallah Creek. The decrease in flow in Town Creek south of the diversion point would increase sediment accumulation within the creek as a result of the decrease in overall flows and flushing flows during flood events.

A large amount of freshwater habitat within the study area is relatively degraded, particularly the smaller, more ephemeral streams. Nevertheless, increasing sediment loads could further degrade existing habitat and impact biotic assemblages. The likelihood and scale of impacts would be greater closer to the construction sites, with aquatic habitat furthest downstream, particularly the Shoalhaven/Crookhaven estuary, least likely to be affected.

The concept design for the project includes a number of strategies designed to mitigate sediment mobilisation into waterways. Construction erosion and sediment control measures outlined in **Section 7.3.4** would also be implemented to reduce the mobilisation of sediments. Combined, these measures would minimise the impact of the project to aquatic ecology within the study area.

Pollution

In general, the project would be expected to have a relatively minor impact on water quality due to pollution. In a worst case scenario the construction and operation of the project has the potential to mobilise contaminants into aquatic habitat. Possible pollution may include (but would not be limited to):

- Pollutants associated with materials used in the process of road construction.
- Pollutants associated with heavy vehicles used on site during construction and from ongoing traffic use of the project, such as aromatic hydrocarbons and heavy metals.
- Contaminant spills of materials transported via the highway.
- Leachate from waste dumps established onsite.
- Overflow from dams/ponds used to trap and recycle contaminated water onsite.
- Organic pollutants in stormwater runoff (such as nitrogen and phosphorus).
- Mobilisation of pollutants bound to disturbed sediments into aquatic habitat.

The project may result in increased pollution, which would be a concern for water quality downstream of the construction. Waterways that may be impacted would include Broughton Creek, Broughton Mill Creek and Bundewallah Creek. These are major waterways which represent major to moderate fish habitat and function as significant environmental corridors.

Previous studies have suggested that regional agricultural land use has had a negative impact on water quality within the study area. However, further pollution would increase the stress on these aquatic ecosystems and may cause a loss of biodiversity, a shift towards biotic assemblages dominated by pollution-tolerant taxa and degradation in ecological function.

Strategies designed to mitigate contamination of aquatic habitat and biota (refer to **Section 7.3.4**) have been included in the concept design for the project. As a result the project would have a relatively minor impact on water quality through careful design and best practice environmental management.

Acid sulfate soils

Floodplain areas within the study area were assessed as having a low risk of disturbing ASS or Potential Acid Sulfate Soils (PASS). In a worst case scenario, if ASS was uncovered in the project area, it would have major environmental impacts and constrain development and construction in affected areas. The worst case impacts on aquatic ecology would include habitat degradation, fish kills, reduced aquatic food resources, reduced migration potential of fish, reduced fish recruitment, altered macrophyte communities, weed invasion by acid-tolerant plants and secondary water quality changes. ASS can also increase the susceptibility of fish to fungal infections which may lead to diseases such as epizootic ulcerative syndrome or 'red spot disease'. Red spot disease is considered a threat to Macquarie Perch.

Construction methodologies, including those used for the diversion of Town Creek, would be carefully considered in order to avoid or minimise the potential impacts of ASS on the aquatic ecology in the study area and in downstream environments. Proposed mitigation strategies described in **Section 7.3.4** would be implemented in order to minimise potential impacts and ameliorate the worst case impact.

Alterations of natural flow regimes

The construction of structures within the floodplain, riparian areas or waterways may alter natural flow regimes in the short-term (in the case of construction) or permanently. This includes piers, abutments, temporary bridge crossings, temporary construction pads and culverts. Potential alterations to natural flow regimes of rivers, streams, floodplains and wetlands have been discussed in **Section 7.4**. There is potential that these alterations would have minor impacts on aquatic ecology.

In a worst case scenario, impacts to aquatic ecology would result from changes to flooding regimes, including:

- Changes to overbank flows that provide infrequent but important passages between different aquatic habitats and can drive temporary booms in the growth of populations. These are important for long term population persistence.
- Changes to seasonal flood flows which a number of native aquatic species require to spawn. Juveniles of these species benefit from the increased productivity during the seasonal flood flows.

The worst case scenario would be ameliorated by the implementation of appropriate mitigation measures, as outlined at **section 7.3.4**.

The four proposed bridge structures, including the three Broughton Creek bridges and the bridge at Berry, would slightly impede channel flow due to the presence and location of bridge abutments and piers and the associated embankments.

The changes to hydrology caused by Broughton Creek bridges 1 and 3 and the bridge at Berry would be negligible for flow events less than the100 year ARI. Therefore these bridges would have an insignificant effect on aquatic ecology and water quality.

The project would have minor impacts on aquatic ecology as a result of changes to flood hydrology at Broughton Creek bridge 2 and Bundewallah Creek from the diversion of Town Creek flows and the placement of piers associated with the bridge at Berry. This is because:

- Broughton Creek bridge 2 and the raised earth embankment would increase flood levels upstream and reduce floodplain storage and capacity. This could result in some productivity decreases for aquatic assemblages.
- Placement of pier structures in Bundewallah Creek would alter the hydrology of the creek. A general decrease in velocity (0.1 to 0.2 m/s) immediately upstream of the piers would be observed, with a corresponding slight increase in water levels. There would also be localised increases in velocity downstream of the piers, of a similar magnitude to those identified above. The increases in velocity would not extend across the entire flow width at the pier cross section and are relative to predevelopment velocities.
- The diversion of Town Creek flows into Bundewallah Creek would:
  - Decrease flow and increase sediment accumulation in Town Creek, altering the aquatic ecology of the creek. However, the impact is expected to be minor when compared to the existing conditions within Town Creek.
  - Increase flow volumes in Bundewallah Creek during large flood events, having a minor effect on aquatic ecology and water quality.

The decrease in flow and associated sediment accumulation within Town Creek south of the diversion would alter the aquatic ecology of the creek. Aquatic habitats nearest the diversion point would be reduced to isolated pools and would experience associated declines in water quality. However, alterations in aquatic habitats, the loss of connected aquatic habitat and reductions in overall flows in Town Creek may have little additional impact on aquatic ecology and water quality. This is because the waterway is currently ephemeral and has been extremely degraded by agricultural and residential land uses. It is also not considered important as fish habitat.

Alterations to aquatic habitats downstream of the diversion, where Town Creek re-joins Broughton Mill Creek, would not be expected. These habitats would continue to receive stormwater inflow from the existing Town Creek.

There is currently no aquatic ecological benefit to overbank flooding in large flood events within the Berry township. As a result, there would be no loss of ecological function caused by the diversion of flooding flows into Bundewallah Creek.

The proposed culverts and bridges would also conform to the 'minimum' recommended crossing types outlined in '*Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings*' (Fairfull and Witheridge, 2003). As such they would have little or no impact on fish passage and aquatic ecology. Where culverts would be required, there would be a residual impact of reduced longitudinal connectivity during low flows. However, these impacts would be temporary in nature.

During construction, the use of bridges as temporary crossings would have an insignificant effect on aquatic ecology given that support structures would be located landward of the creek banks and no other in-stream structures would be used. The use of inappropriate structures for temporary crossings, such as restrictive culverts or fords may obstruct upstream fish passage and reduce longitudinal connectivity. Temporary structures would have minimal impact on aquatic ecology, providing recommended crossing types, discussed in **Section 7.3.4**, are used.

Impacts due to temporary creek crossings, construction pads and ancillary facilities

Temporary creek crossings

Temporary creek crossings are required at each proposed bridge structure during the construction period. Each proposed bridge location was surveyed and preferred temporary crossing sites were identified. Preferred sites for temporary creek crossings were located such that impacts to terrestrial and aquatic ecology and water quality were minimised.

In a worst case scenario, potential impacts associated with temporary creek crossings include alterations of water flow regimes, sedimentation of waterways, aquatic and terrestrial habitat loss and degradation of riparian vegetation. These impacts have been discussed in the relevant assessment sections above.

Temporary construction pads

Temporary constructions pads are likely to be required during the construction phase of the project to assist with bridge construction. Construction pads may involve the temporary placement of rocks or other construction materials within waterways. The main potential aquatic ecology impact would be the blockage of fish passage, in particular for Australian Bass.

The construction method employed should avoid complete blockage of the stream, be of minimum possible duration and involve full removal of all construction material from the waterway.

Ancillary facilities

Impacts due to vegetation clearing and construction activities at ancillary facility sites have been discussed as part of the broader consideration of impacts on the study area provided above.

As discussed in **Section 4.4.7**, ancillary facilities have been located within areas of low conservation significance, which include built-up areas, mown lawns and heavily grazed exotic pastures (with no shrub layer, no trees, no rocks, no logs and no water). Therefore, impacts to terrestrial and aquatic flora and fauna as a result of the establishment and operation of ancillary facility sites are considered unlikely.

Impacts to groundwater dependent ecosystems

Works associated with the project that have the potential to impact on GDEs within the study area include ground conditioning in areas where settlement has been assessed as a geotechnical issue, such as alluvial soils of floodplain areas, and cuttings at various locations along the alignment. As discussed in **Section 7.4**, it is anticipated that the project would have a minor and localised effect on groundwater flows.

The shallow alluvial groundwater systems within the study area support GDEs such as hyporheic habitats, base flows to significant waterways such as Broughton Creek, Broughton Mill Creek, Bundewallah Creek and Connollys Creek and riparian forest areas. The hyporeheic zone is a region where there is mixing of groundwater and surface water. Native riparian forest within the study area is generally the EEC River-flat Eucalypt Forest on Coastal Floodplains.

The natural variability of shallow alluvial groundwater systems can make them more robust and able to tolerate fluctuating water levels but in the worst case, significant changes to groundwater hydrology can lead to ecosystem damage (DLWC, 2002). The exact importance of groundwater to GDEs is unknown and therefore it is difficult to accurately predict impacts associated with the project. GDEs most sensitive to changes in the groundwater regime would be hyporheic ecosystems, shallow aquatic habitat (and associated biota) such as riffles and discontinuous pool refuges and low-lying riparian forest.

Groundwater seepage into road cuttings would be collected by a longitudinal drainage system and transferred to vegetated swales or sediment basins within the Broughton Creek catchment. As discussed in **Section 7.4**, the treatment of soft-soils may cause some reduction in the permeability of underlying soils but groundwater would still flow, particularly through the sandy soil horizon.

Cumulative impacts

The project area occurs in a largely rural landscape. Much of the native vegetation in the local area has been cleared and many of the remaining native vegetation remnants are small, isolated and fragmented. A large area of land in the locality is within the floodplain, which restricts further development, reducing the likelihood of simultaneous developments and cumulative construction impacts.

Existing and proposed development projects are mostly located on already cleared land within or adjacent to existing development, such as near Berry township and to the north of Bomaderry. Recent residential development within the study area at Berry includes the Arbor Retirement Village and Huntingdale Park Estate, both of which are located in previously cleared areas.

Sand quarry, Gerroa

Approved development in the locality includes expansion of an existing sand quarry at Gerroa, about five kilometres east of the project, adjacent to Seven Mile Beach National Park. Based on the flora and fauna assessment undertaken for the quarry expansion (Mills 2006a), a total of about 4.2 hectares of native coastal vegetation would be cleared including 1.7 hectares of Blackbutt Banksia forest, 1.6 hectares of disturbed Bangalay sand forest and 0.9 hectare of littoral rainforest. No cumulative impacts on these vegetation types are considered likely given that these coastal vegetation types are unlikely to be impacted by the project. Given the lack of habitat connectivity and distance between the quarry and the project, the magnitude of cumulative impacts on threatened fauna populations is considered to be low.

Princes Highway upgrade

The project itself forms one part of the RMS's overall upgrade of the Princes Highway to four lanes from Waterfall to the Jervis Bay Road junction, to provide increased road safety and traffic efficiency in the south coast region and needs to be considered in this context. Remaining sections of the highway still to be upgraded include a section between Kinghorne Street and Forest Road, South Nowra and a section between Mount Pleasant and Bomaderry.

The Princes Highway upgrade at South Nowra is located about 20 kilometres south west of Schofields Lane (via the highway). The South Nowra project extends from Kinghorne Street to Forest Road. It involves about 6.3 kilometres of upgrade works, including the construction of a four lane divided carriageway (RTA 2009a; RTA 2009b). This project was approved under Part 5 of the EP&A Act in 2011 and is currently under construction.

Flora and fauna assessments were undertaken for the project in two sections, the Kinghorne Street to Warra Warra Road section (NGH 2009) and the Warra Warra Road to Forest Road section (Hayes Environmental cited in RTA 2009a). Based on these two assessments the following native vegetation would be cleared between Kinghorne Street and Forest Road:

- 2.2 hectares of Currambene-Batemans lowlands forest.
- 2.6 hectares of Southern lowland wet forest.
- 0.05 hectares of Floodplain swamp forest, which is an EEC.
- 0.08 hectares of South Coast lowland swamp woodland, which is an EEC.
- 1.3 hectares of Disturbed edge vegetation.
- 9 hectares of Open eucalypt forest.

Minor cumulative impacts would occur for Currambene-Batemans lowlands forest. Currambene-Batemans lowlands forest is not an EEC but it provides potential habitat for three threatened flora species, including the Leafless Tongue Orchard *(Cryptostylis hunteriana*), the Thick Lip Spider Orchid (*Caladenia tessellata*) and the Austral Toadflax (*Thesium australe*). Only 0.0002 hectares of Currambene-Batemans lowland forest would be directly impacted by this project, which equates to less than 0.01 per cent of the total to be cleared by both projects. including, (*Caladenia tessellate*) and (*Thesium austral*).

Known habitat for the Green and Golden Bell Frog occurs within the South Nowra project (Currambene-Batemans lowland forest) and potential habitat occurs for this species within this project (constructed wetlands). Only 0.4 hectares of potential habitat would be directly impacted by this project, which equates to 15.0 per cent of the total to be directly affected by both projects. The total area to be directly impacted by both projects (2.6 hectares) equates to approximately 0.02 per cent of the same plant communities available within about 30 kilometres of the project (which includes all of the South Nowra project area). Given the lack of habitat connectivity and distance between the project and the South Nowra project, the magnitude of cumulative impacts on threatened fauna populations is considered to be low.

Consideration of the cumulative impacts on vegetation and fauna habitat for the three remaining sections between Mount Pleasant and Bomaderry does not change the conclusions of impact assessments undertaken for threatened biota either occurring or potentially occurring in the study area. This is because the project is considered to include the greatest vegetation losses (about 80 per cent) of all sections to be upgraded. These impacts would be managed in accordance with the mitigation measures that have been proposed in **Section 7.3.4**, which are specific to the Foxground and Berry bypass project.

7.3.4 Environmental management measures

The RMS' Road Development and Impact on Habitat Amelioration policy states that “in principle, the planning and construction of roads should, in order of consideration endeavour to:

1. Avoid impacts on habitat though the planning process.
2. Minimise impacts on habitat through the planning process.
3. Mitigate impacts on habitat, through the use of a range of amelioration measures (RTA 2001).

Where possible, important ecological features identified in the local area, such as patches of Illawarra subtropical rainforest, have been avoided during the options and route selection stage of the project. The project has been designed, where feasible, to minimise vegetation clearance and habitat loss. In areas where significant vegetation is located, the land area of the project area incorporating the road footprint and construction access requirements has been reduced to minimise potential impacts.

Mitigation and management measures would be implemented to avoid, minimise or manage impacts to biodiversity and to improve and/or maintain biodiversity. These mitigation and management measures are listed in **Table 7-50** and have been incorporated in the draft statement of commitments in **Chapter 10**.

Table 7-50 Mitigation and management measures

Potential impacts	Mitigation and management measures
Pre-construction	
General construction impacts on flora and fauna	Prepare a Flora and Fauna Management Plan, including weed management, and ensure that it is integrated with the landscape plan for the project. Prepare a Vegetation Management Plan (VMP) detailing restoration, regeneration and rehabilitation of areas of native vegetation in the vicinity of the project. Preparation of the VMP should involve consultation with local Landcare groups and the CMA.
Construction	
Removal of native vegetation and increased edge effects	Implement the Flora and Fauna Management Plan including all weed management measures. Clear vegetation in accordance with RMS 'Biodiversity Guidelines: Guide 1 – The Pre-clearing process' and 'Guide 4 – Clearing of vegetation and removal of bushrock' (RTA 2011). Ensure that locally indigenous species are used for rehabilitation and revegetation of habitat areas. Seek opportunities to reduce the removal of native vegetation in the detailed design phase. Where clearing would occur, the area would be fenced with highly visible temporary fencing to ensure that clearing does not extend beyond the area necessary, in accordance with Guide 2 Exclusion zones of the RMS Biodiversity Guidelines (RTA 2011). Ensure that ancillary facilities and stockpiles are sited on land that has been previously cleared or disturbed, and is 50 metres away from waterways*. Ensure that environmentally sensitive areas are fenced off and signage erected in accordance with the RMS *Biodiversity guidelines: Guide 2 – Exclusion Zones* (RTA, 2011). Conduct a hollow-bearing tree/stag survey prior to construction. Undertake stag-watching to identify the number and type of nest boxes required and where to install them. The optimal season for stag-watching is spring; a hollow-bearing tree/stag survey however, can be conducted any time of year. Install bat roost and nest boxes at a ratio of 1:1 for each hollow removed by the project. Installation of bat roost and nest boxes would take place at least one month prior to the commencement of construction. Install nest boxes in accordance with RMS 'Biodiversity Guidelines: Guide 8 - Nest Boxes' (RTA 2011) Prior to construction, conduct a survey of any bridges or culverts scheduled for removal in order to detect roosting microbats. If detected, prepare and implement a Bat Management Plan.

Potential impacts	Mitigation and management measures
	Where possible, locate temporary waterway crossings immediately downstream of the proposed bridge alignments and within the existing footprint. This would minimise the clearing of additional riparian habitat for approaches to the temporary crossings. Progressively revegetate and landscape batters and other cleared areas as construction is completed.
Mortality of individuals	Ensure that vegetation clearance complies with RMS *Biodiversity Guidelines*: Guide 4 - Clearing of vegetation and removal of bushrock (RTA, 2011),
Fragmentation of habitat and loss of connectivity	Enhance the existing fauna corridor along Broughton Creek through revegetation including connection to Toolijooa Ridge vegetation. Retain roadside vegetation in the vicinity of rope bridges for arboreal fauna crossings (possums and gliders) and fauna underpasses. Revegetate or augment vegetation in the vicinity of all fauna crossings where vegetation is cleared. Retain riparian vegetation under bridges and at temporary creek crossing sites where feasible. If vegetation clearance is necessary, undertake revegetation as soon as practicable after construction. Implement the following fauna management structures. The location of these structures are presented in **Figures 4-1 to 4-3** and further details are provided in **Section 5.3** of the *Terrestrial Flora and Fauna Technical Paper* at **Appendix F**. • Provide fauna underpasses at Toolijooa Ridge and near Tindalls Lane. The chainages and dimensions of these are presented in **Table 4-3.** • Provide fauna 'furniture' such as rocks, raised log railings and refuge poles where appropriate. • Provide rope crossings for arboreal species at all creek crossings, on Toolijooa Ridge, and east of Tindalls Lane. At Broughton Creek bridges 1 and 2, rope bridges would extend both over and under each of the proposed highway bridges. • Provide fauna fencing extending at least 200 metres either side of the underpass to funnel fauna towards the crossings structures, where appropriate. • Install fauna fencing at the western end of the bridge at Berry but not at the Broughton Creek crossings. Should road kill become an issue at these crossings after the project is opened, fauna fencing may be reconsidered.
Loss of aquatic habitats	Consider lopping or relocation of large woody debris in streams as a first priority before removal. Should removal of large woody debris be necessary, consider the introduction of engineered woody debris as compensation within the offset strategy for residual impacts. Subject to relevant approvals and conditions, there is potential for trees removed as a consequence of the project to be utilised for fish habitat and bank stability within the creeks of the project area.

Potential impacts	Mitigation and management measures
	Consult with the DPI, Fisheries for input, in relation to matters relevant to Fisheries, into relocation of Town Creek. Maintain the flow along the current Town Creek alignment through appropriate design.
Loss of fish passage	Where feasible use low hollow-core bridges or short lengths of pipe culverts for temporary crossings to maintain fish passage with reference to guidelines for the design and construction of waterway crossings to maintain fish passage (Smith and Pollard 1999, Fairfull and Witheridge 2003).
Invasion of exotic species: Terrestrial	Control noxious and environmental weeds in the existing road corridor, construction areas and ancillary facilities during construction in accordance with *RMS Biodiversity Guidelines:* Guide 6 - Weed management and Guide 10 - Aquatic habitats and riparian zones (RTA 2011). This would be achieved by: • Restricting the area of native vegetation disturbed during construction works. • Restricting stockpiling to areas already cleared of vegetation. • Controlling drainage that may contain weed seeds or high levels of nutrients. • Using weed-free topsoil in landscaping and revegetating disturbed sites with locally indigenous species (local provenance). Revegetation using stockpiled soil would also include planting local native species to stabilise the soil as well as ongoing weed control. • Monitoring and controlling weed populations that establish in disturbed areas.
Invasion of exotic species: Aquatic	Train staff in the identification and disposal of alligator weed and inspect heavy machinery regularly to ensure that the species is not spread to new areas. This should be conducted in accordance with *RMS Biodiversity Guidelines:* Guide 10 – Aquatic habitats and Riparian Zones (RTA 2011) Report positive identifications of alligator weed within the construction area to Kiama and Shoalhaven Council
Reduction of water quality	Implement erosion and scour protection in the design and construction of bridges and culverts. This would include energy dissipaters and/or batter treatments to ensure that the diversion of flows from Town Creek to Bundewallah Creek does not cause scour and erosion. Manage erosion and sedimentation impacts during construction in line with the erosion and sediment control plan and measures detailed in **Section 8.1.4,** conduct surface water quality monitoring during construction of the project and incorporate results into the CEMP with protocols to address detected levels above water quality criteria. Implement management measures to minimise the potential impacts of ASS as proposed and detailed in **Section 8.1.4**. Manage any on-site waste dump to prevent leaching of contaminants.

Potential impacts	Mitigation and management measures
	Document procedures for the proper handling, transport, storage and disposal of hazardous substances and include in site inductions for staff. Site all refuelling areas and least 50 metres away from waterways and properly bund.
Alteration of flow regime	Design transverse drainage structures to allow unrestricted passage of most natural flows and allow for changes in the natural flow regime as a result of climate change. This would be achieved by designing bridges and culverts to provide flood immunity from the 100 year flood event and the 50 year flood event respectively. Do not position bridge piers or abutments within the section of waterway channels (wetted width) that carry median flows, where practicable. Implement scour protection to assist with upstream fish passage to mitigate the impacts of localised velocity and water level changes as a result of bridge pier placement in waterways. Structure the layout of the RMS stockpile straddling the southern end of the project area between Schofield's Lane and Andersons Lane to minimise effects on the flow regime of waterways that run through the property. A culvert providing flood immunity from the 50 year flood event would allow sufficient protection to the natural flow regime for this waterway, should the need for a crossing be identified during detailed design phase of the project.
Operation	
Reduction in water quality	Minimise impacts to water quality during operation of the project through the combination of swales, water quality basins and biofiltration. Further detail on these measures can be found in **Section 7.4** and **Section 8.1**. In areas close to or upstream from sensitive receiving waters, implement additional treatment measures to ensure no net increase in pollutant load from road runoff. Biofiltration swales or trenches would likely be used to remove dissolved nitrogen from runoff through biological processes (refer to **Section 7.4**). The configuration and location of the biofiltration systems would be confirmed during the detailed design phase of the project. Locations where the biofiltration systems would be most effective would include areas where runoff would discharge directly to permanent waterways.
Mortality of individuals	Remove vegetation overhanging fauna fences. Overhanging vegetation may allow fauna to enter the road reserve. Consider providing vegetation in the verges and median strip which does not attract fauna. Avoid the use of barbed wire fencing at glider crossing zones.
Fish passage	Design bridges and culverts to maintain fish passage with reference to the guidelines contained in '*Guidelines and Policies for Aquatic Habitat Management and Fish Conservation'* (Smith and Pollard 1999) and *'Why do fish need to cross the road? Fish passage requirements for waterway crossings'* (Fairfull and Witheridge, 2003).

Potential impacts	Mitigation and management measures
Monitoring	
Monitoring impacts during pre-construction, construction and operational phases	Prepare pre-construction, construction and operational monitoring programs which would use the 'Before and After at Control and Impact sites' approach and set out the type and frequency of monitoring to be carried out, allocate responsibilities and monitoring parameters where relevant. Ensure a qualified ecologist is present for staged habitat removal in accordance with the RMS' Biodiversity Guidelines (RTA 2011) and fauna rescue/relocation. Undertake monitoring of sediment and erosion control measures during construction. This would form part of the Erosion and Sediment Control Plan (refer to **Section 7.4**). Undertake monitoring of edge effects and weed management measures as outlined in the Flora and Fauna Management Plan. Undertake bi-annual monitoring of nest boxes and bat roost boxes by a qualified and licensed ecologist during construction and annual monitoring for a period of three years post completion of construction with the provision to review the continuation and/or frequency of monitoring after the completion of three years monitoring. Undertake bi-annual monitoring of dedicated fauna underpasses and rope bridges (using equipment such as remote cameras) by a qualified and licensed ecologist for a period of three years post completion of construction with the provision to review the continuation and/or frequency of monitoring for a further two years.in the event a negative impact on species is detected. Conduct regular checks of fauna fencing to identify and fix any damage. Conduct road kill monitoring during operation of the project over a 12 month period at weekly intervals. The monitoring would include a record of the species (if possible) and the GPS location. The local council road cleansing teams or Wildlife Rescue South Coast may be contracted to undertake the monitoring or alternatively RMS Southern Region would undertake the monitoring. Conduct regular water quality monitoring focusing on wet weather events during pre-construction, construction and operational periods of the project in accordance with the surface water quality monitoring program outlined in Appendix F of the *Aquatic Ecology and Water Quality Management Technical Paper* provided at **Appendix G** of this environmental assessment.. For construction, the frequency of monitoring would be based on a monthly sampling program for minor wet weather events, and event based sampling after major wet weather events. A maximum of three major events would be sampled per year for the duration of the construction phase. During operation, the program would be based on minor wet weather events for one years, or 12 sampling events, whichever is greater.

Potential impacts	Mitigation and management measures
	Conduct aquatic ecology monitoring during the pre-construction, construction and operational periods of the project in accordance with the aquatic ecology monitoring program outlined in Appendix G of the *Aquatic Ecology and Water Quality Management Technical Paper* provided at **Appendix G** of this environmental assessment. Sampling would be undertaken during Spring and Autumn, with the monitoring to continue for a minimum of one year after the project is opened to traffic. Monitoring locations would include the created diversion channel between Town Creek and Bundewallah Creek in order to provide an indication of the successful establishment of a natural creek ecosystem. In accordance with the aquatic ecology monitoring program, periodically review and evaluate the results of the monitoring to identify improvements to existing mitigation measures or maintenance regimes. Use the results of the monitoring to identify the need for additional mitigation or management responses to address any unforeseen impacts on biodiversity.

** Refers to the working footprint of the facility. The property on which the site is located may encompass or may extend within the 50 metre buffer to the watercourse.*

7.3.5 Residual impacts and offsetting

It is unlikely that there would be a significant impact on threatened flora and fauna species that are known to occur in the study area, subject to the implementation of mitigation measures described in **Section 7.3.4**. However, there would be remaining residual impacts following the construction of the project. The residual impacts would include:

- Direct impact to 30.4 hectares of native vegetation, including the loss of 2.9 hectares of River-flat Eucalypt Forest and indirect impact to 26.7 hectares of native vegetation, including 7.1 hectares of River-flat Eucalypt Forest within the project corridor, Town Creek diversion, ancillary infrastructure and temporary crossing footprint. Direct residual impacts to River-flat Eucalypt Forest would be offset as detailed below. Direct residual impacts to other native vegetation and all indirect impacts to native vegetation would be avoided or managed in accordance with the mitigation measures presented in **Table 7-50**.
- Reduced floodplain storage, productivity and lateral connectivity in the region of the Broughton Creek bridge 2 embankment. This could result in some residual productivity decreases for aquatic assemblages. The design of the bridge would be refined during the detailed design phase to in order minimise potential flood impacts associated with the construction of new infrastructure in the floodplain (refer to **Section 7.5.4** for further details).
- Potential reduced longitudinal connectivity at temporary crossings during low flows. As discussed in **Table 7-50**, where feasible, temporary crossings would be designed to maintain fish passage with reference to '*Guidelines and Policies for Aquatic Habitat Management and Fish Conservation'* (Smith and Pollard 1999) and *'Why do fish need to cross the road? Fish passage requirements for waterway crossings'* (Fairfull and Witheridge, 2003). Impacts related to temporary creek crossing would only be expected during the construction period and would be temporary in nature.
- Permanent diversion of Town Creek. The project would cause a residual loss of overall flows and flushing flows from Town Creek which would potentially increase sedimentation in both Town Creek and Bundewallah Creek. However, the diversion would also have the positive residual impact of reducing flood impacts within Berry.

- Changes to flood hydrology at Town Creek, Bundewallah Creek and Broughton Creek from installation of transverse drainage structures. There is potential that the presence and location of bridge abutments, piers and culverts and associated embankments would impede channel flow. However, proposed culverts and bridges would conform to the ‘minimum’ recommended crossing types outlined in *‘Why do fish need to cross the road? Fish passage requirements for waterway crossings’* (Fairfull and Witheridge, 2003) and as such residual aquatic ecology impacts would be minor.

Offsetting

To meet the ‘improve or maintain’ outcomes required by the DGRs, offsetting would be required. Step 4 of the ‘Guidelines for Threatened Species Assessment under Part 3A of the EP&A Act’ (DEC and DPI 2005) states that 'The extent to which measures avoid, mitigate or offset impacts upon threatened species must reflect the conservation value of the feature including its formal status as a critically endangered, endangered or vulnerable species, population or ecological community.' As such the residual direct impact on 2.9 hectares of River-flat Eucalypt Forest would require offsetting. While River-flat Eucalypt Forest in the project area is generally in poor condition, it requires offsetting as it is an EEC and therefore has a high conservation status.

A Biodiversity Offset Strategy has been prepared and is provided in Appendix E of the *Terrestrial Flora and Fauna Technical Paper* (**Appendix F**). The area of restoration would be guided by a simulated assessment of the project impacts and potential offsets using the BioBanking Assessment Methodology with a minimum of 2:1 for riparian vegetation to meet DTIRIS requirements.

A simulated BioBanking assessment undertaken for the project determined that native vegetation removed would need to be offset at an average ratio of 5.3:1 in order to achieve the ‘improve or maintain’ standard.

The following offset actions are proposed in order to achieve this ratio and an ‘improve or maintain’ biodiversity outcome for the region as a result of the project:

- Action 1 – Revegetation and rehabilitation of riparian vegetation in strategic locations.
- Action 2 – Use of an appropriate legal instrument to acquire and/or secure native vegetation to ensure that the land is managed for conservation.

Action 1 is the first priority to achieve the objectives of the Biodiversity Offset Strategy (located in Appendix E of the terrestrial flora and fauna technical paper, **Appendix F**). Action 1 focuses on the strategic revegetation of River-flat Eucalypt Forest that addresses improvements to both terrestrial and aquatic biodiversity. It would enhance native riparian vegetation connectivity at a locality scale, with a focus on River-flat Eucalypt Forest, other coastal plain EECs or closely associated non-threatened plant communities.

Desktop mapping has been carried out to identify areas that would be suitable for restoration and rehabilitation of riparian vegetation. In accordance with the RMS' *Biodiversity Guidelines* (RTA 2011), an investigation area of five kilometres from the project was adopted and a standardised riparian zone of 50 metres either side of drainage lines was applied. Suitable areas have been classified into three priorities (refer to Figures C1 to C7 of the Biodiversity Offset Strategy, in Appendix E of the terrestrial flora and fauna technical paper, **Appendix F**).

Action 1 would also consider:

- Restoration of riparian habitat to Category 1 creeks on RMS owned land to enhance connectivity for terrestrial and aquatic habitats. The RMS owns land with large frontages on Broughton Creek, Broughton Mill Creek, Bundewallah Creek and Connollys Creek.
- Ongoing financial support for existing riparian restoration works within the region (such as programs run by Southern Rivers CMA, Shoalhaven City Council or DTIRIS).

Finalisation of the exact locations for restoration of riparian vegetation would be guided by the outcomes of:

- Further investigation and specialist advice from OEH and/or the Southern Rivers CMA or other specialist ecologists.
- Consultation with Berry Landcare Group and consideration of the strategic priorities or actions of Berry Nature Corridor – Escarpment to Sea (Berry Landcare Group, in preparation).

Action 2 would only be considered if there were residual offset requirements after Action 1 offset measures have been exhausted. The key aims in the delivery of Action 2 are:

- The offsets would be located within a 30 kilometre radius of the project and within the NSW Sydney Basin Bioregion.
- Offsetting native vegetation on a like for like basis.
- Offset land should comprise land that would improve connectivity between areas of remnant vegetation.
- Offset land must be suitable for ongoing management for conservation through an appropriate legal instrument.
- Where it is not feasible to offset on a like for like basis other vegetation types of a similar conservation value in the offset investigation area would be considered. This includes areas of floodplain swamp forest.

Areas of riparian vegetation types that may be suitable for further investigation in the delivery of Action 2 have been identified in the Biodiversity Offset Strategy, and include areas of swamp oak floodplain forest. This includes stands close to Broughton Creek, Kangaroo Valley River and Shoalhaven River (refer to Figures D1 to D6 of the Biodiversity Offset Strategy, in Appendix E of the *Terrestrial Flora and Fauna Technical Paper*, **Appendix F**).

Whether Action 1 or 2 were to be further investigated, an appropriate instrument for ongoing management for conservation may consider one of the following legally binding arrangements:

- A trust agreement.
- A conservation agreement.
- A property vegetation plan.
- A wildlife refuge.
- A BioBanking agreement.

A biodiversity offset package would be submitted to DP&I within 12 months of the approval. The package would be prepared in consultation with OEH and DTIRIS and would include details of the final suite of measures to be implemented based on the Biodiversity Offset Strategy and addressing both terrestrial and aquatic biodiversity. The package would identify a timeline for implementation and the detail of measures, including arrangements for ongoing management of offset lands or other actions.

7.4 Surface water and groundwater

This chapter provides an assessment of surface water and groundwater, which were nominated in the DGRs as a key environmental issue for the project. It represents a summary of the relevant parts of the *Aquatic Ecology and Water Quality Management Technical Paper* (Cardno Ecology Lab Pty Ltd, 2012) and the *Surface water, Groundwater and Flooding Technical Paper* (AECOM, 2012), which were prepared for the project with consideration of the DGRs.

The technical papers are provided at **Appendix G** and **Appendix H**. The relevant extract from the DGRs is presented below.

Director-General's requirements	Where addressed
Surface water and groundwater *- including but not limited to:*	
Water quality taking into account impacts from both accidents and runoff and considering relevant environmental water quality criteria specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality 2000. The assessment must describe measures to control erosion and sedimentation during construction activities and measures to capture and treat runoff from the site during the operational phase.	Section 7.4.3 and Section 7.4.4. Appendix G – Technical paper: Surface water, groundwater and flooding
Identify potential risks of the project on groundwater resources including: characterising existing local and regional hydrology; potential risks of drawdown; impacts to groundwater quality; discharge requirements; and implications for groundwater-dependent surface flows (including springs and drinking water catchments), groundwater-dependent ecological communities and groundwater users.	Section 7.3.3, Section 7.4.2 and Section 7.4.3. Appendix F — Technical paper: Aquatic ecology and water quality. Appendix G – Technical paper: Surface water, groundwater and flooding.
Waterways to be modified as a result of the project, including ecological, hydrological and geomorphic impacts (as relevant) and measures to rehabilitate the waterways to pre-construction conditions or better.	Section 7.3.3, Section 7.3.4, Section 7.4.3 and Section 7.5.4. Appendix F — Technical paper: Aquatic ecology and water quality. Appendix G – Technical paper: Surface water, groundwater and flooding.

7.4.1 Methodology

Surface water

The general approach and methodology adopted for the assessment for surface water includes:

- Compilation and review of available information, such as previous reports, topographical maps, aerial photography, acid sulfate soils (ASS) maps, RMS standards and guidelines, other national and state guidelines or standards for construction and operational water quality. Review of the water quality analyses conducted by Cardno Ecology Lab in 2007, 2009 and 2011 (as reported in the *Aquatic Ecology and Water Quality Management Technical Paper* at **Appendix G**) against trigger values set in *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (Australian and New Zealand Environment Conservation Council (ANZECC), 2000).
- Review of previous geotechnical investigations undertaken between 2007 and 2011 to identify potential geotechnical, soil and fill issues for the project and to assist in identifying mitigation and management measures. Previous geotechnical investigations included (but were not limited to) core drilling, piezometers, electric cone (piezocone), test pits, laboratory testing of soil and rock samples.
- Assessment of soil and erosion risks during construction and identification of appropriate mitigation measures, with consideration of *Managing Urban Stormwater- Soils and Construction, Volume 1* (Landcom, 2004) and *Volume 2D Main Road Construction NSW* (Department of Environment, Climate Change and Water (DECCW), 2008) (known as the Blue Book), and other RMS procedures and guidelines.
- Use of the Australian Water Balance Model (AWBM) for the existing and proposed catchment areas within the project area following the diversion of Town Creek to assess the potential impacts on flow regimes of the impacted watercourses. This model was calibrated using daily stream flow data from the flow gauging station at Broughton Mill Creek, combined with daily rainfall data from Berry Masonic Village and monthly EvapoTranspiration data from Port Kembla.
- Development of performance targets for operational water quality basins based on *Managing Urban Stormwater: Council Handbook* (EPA, 1998).
- Use of the Model for Urban Stormwater Improvement Conceptualisation (MUSIC) (Version 4) water quality modeling package to develop an operational water quality strategy. Using rainfall data collected at the Nowra Royal Australian Navy Air station (number 068072), the following three scenarios were modeled to predict pollutant loadings (kilograms per year) within an one hectare catchment for Total Suspended Solids , Total Phosphorus and Total Nitrogen:
  - Pre-existing (representing rural land uses only).
  - Existing (being the current highway).
  - The project.

The *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000) form part of the National Water Quality Management Strategy and lists a range of environmental values for water bodies. The guidelines are ambient water quality guidelines and have been used in the assessment of existing water quality of creeks in proximity of the project. The guidelines would also be used in future monitoring of ambient conditions (base flow) of the downstream waterways to monitor the impacts of the project on these ecosystems.

Guidelines for the management of stormwater runoff include *Managing Urban Stormwater: Council Handbook* (EPA, 1998). These guidelines have been developed for urban catchments and are not strictly applicable to the rural environment. Instead, the recommended treatment objectives have been used as a basis for developing appropriate design criteria for the project, which are based on the required detention capacity per hectare of road surface. This is discussed further in **Section 7.4.3**.

Section 120 of the Protection of the Environment Operations Act (POEO) Act) prohibits the pollution of any waters. Standard conditions of the EPL would require compliance with the POEO Act and this has been taken into consideration in the design of the project. Mitigation measures would be implemented to prevent pollution of waters as discussed in **Section 7.4.4**.

Groundwater

The general approach and methodology adopted for the assessment for groundwater includes:

- Consideration of guidelines and policies relevant to the protection of groundwater and groundwater dependent ecosystems (GDEs) in NSW. This included the State Groundwater Policy Framework Document (Department of Land and Water Conservation (DLWC), 1997), the NSW State Groundwater Quality Protection Policy (DLWC, 1998), (Draft) NSW State Groundwater Quantity Management Policy (DLWC, no date), NSW State Groundwater Dependent Ecosystems Policy (DLWC, 2002), the Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources 2011 (NSW Office of Water (NOW), 2011) and National Water Quality Management Strategy Guidelines for Groundwater Protection in Australia (Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) & ANZECC, 1995).
- Compilation and review of available information, such as the searches of registered groundwater bores in the vicinity of the project and the review of groundwater quality data obtained from databases maintained by the NOW.
- Consideration of the relevant findings of the *Aquatic Ecology and Water Quality Management Technical Paper* at **Appendix G** with respect to GDEs.
- Consideration of the relevant findings of the assessment undertaken for surface water impacts of the project.
- Review of previous geotechnical investigations undertaken between 2007 and 2011 to identify potential groundwater issues for the project. This included site specific groundwater information derived from a geotechnical investigation (Coffey, 2010) that involved 20 monitoring wells.
- Identification of mitigation and management strategies, which consider the abovementioned groundwater guidelines of the NOW and the former DLWC.

7.4.2 Existing environment

Surface water

Waterways in study area

The main waterways that interact with the project are Broughton Creek, Broughton Mill Creek, Bundewallah Creek, Connollys Creek and Town Creek and their associated catchments (refer to **Figure 7-10**).

A small section of the project area is located within the upper Crooked River catchment, near Toolijooa Ridge. The creeks and streams that form part of the Crooked River catchment start at Currys Mountain and flow in a south-easterly direction into a coastal floodplain before discharging into the ocean via the estuarine Crooked River Lagoon. No significant or ephemeral waterways within the Crooked River catchment are located within the project footprint.

Broughton Creek is the main watercourse in the project area and starts just below the Illawarra plateau at around 500 metres AHD (Australian height datum).The Broughton Creek catchment lies next to and south of the Crooked River catchment, and is separated by the ridge that extends from Currys Mountain to Toolijooa Hill, Moeyan Hill and eventually Coolangatta Mountain. After crossing the existing Princes Highway corridor, Broughton Creek flows in a south west direction. At Berry, Broughton Creek is joined by Broughton Mill Creek at the entrance of a coastal floodplain and eventually discharges into the lower Shoalhaven River. The Broughton Creek catchment upstream of Berry is around 30 square kilometres in area.

To the north and north-west of Berry are the Broughton Mill Creek and Bundewallah Creek catchments, respectively. Broughton Mill Creek originates underneath the Illawarra plateau as a number of secondary streams. It flows south through Broughton Vale and crosses the existing Princes Highway near the Woodhill Mountain Road intersection on the eastern edge of Berry, around two kilometres upstream of its confluence with Broughton Creek.

Bundewallah Creek starts to the north west of Berry and flows eastwards under a bridge at Woodhill Mountain Road to join Broughton Mill Creek. Connollys Creek enters Bundewallah Creek about 600 metres upstream of the point Bundewallah Creek joins Broughton Mill Creek. Bundewallah Creek and Connollys Creek have catchment areas of around 1500 hectares and 630 hectares respectively (RTA, 2008). Broughton Mill Creek has a catchment area of around 2000 hectares immediately upstream of the confluence with Bundewallah Creek (RTA, 2008).

Town Creek is a small ephemeral watercourse that passes directly through the Berry township. It has a catchment area of 70 hectares upstream of Berry. Town Creek crosses the undeveloped section of North Street, on the north west edge of Berry, before crossing the town between Princess Street and Queen Street and exiting via Prince Alfred Street. Town Creek flows south east before joining Broughton Mill Creek near its confluence with Broughton Creek. The reach of Town Creek through Berry is in poor condition.

Hitchcocks Lane Creek, its tributary and an unnamed tributary of Broughton Creek flow across the existing highway, south of Berry. These watercourses join southwest of the existing highway and eventually discharge into the estuarine reach of Broughton Creek. Hitchcocks Lane Creek and its tributary have a catchment area of 68 hectares and 75 hectares respectively. The unnamed tributary of Broughton Creek has a catchment area of 6.2 hectares.

Water quality in waterways

The long term agricultural land use in the region has resulted in significant pollution that is greater than the water quality levels that are considered to be sustainable for maintaining ecosystem integrity. The values of total phosphorus within the Crooked River and Broughton Creek catchments are regularly above the ANZECC guidelines. The application of fertilisers and manure from stock are the likely sources of the high nutrient levels (The Ecology Lab, 1999, 2007).

Broughton Creek, Broughton Mill Creek, Connollys Creek and Bundewallah Creek are considered to be sensitive receiving environments owing to the ecological values of these waterways (refer to **Section 7.3**).

Previous studies within the Crooked River and Broughton Creek catchments have also found that water quality was generally within the ANZECC threshold limits for pH and conductivity, and to a lesser extent, turbidity (The Ecology Lab, 1999; 2007). Sampling carried out in 2007 during a period of low rainfall found that sites within Crooked River and Broughton Creek catchments were frequently below ANZECC lower limits for dissolved oxygen (The Ecology Lab, 2007). Low dissolved oxygen values can be caused by low flow conditions and/or high in-stream organic loads.

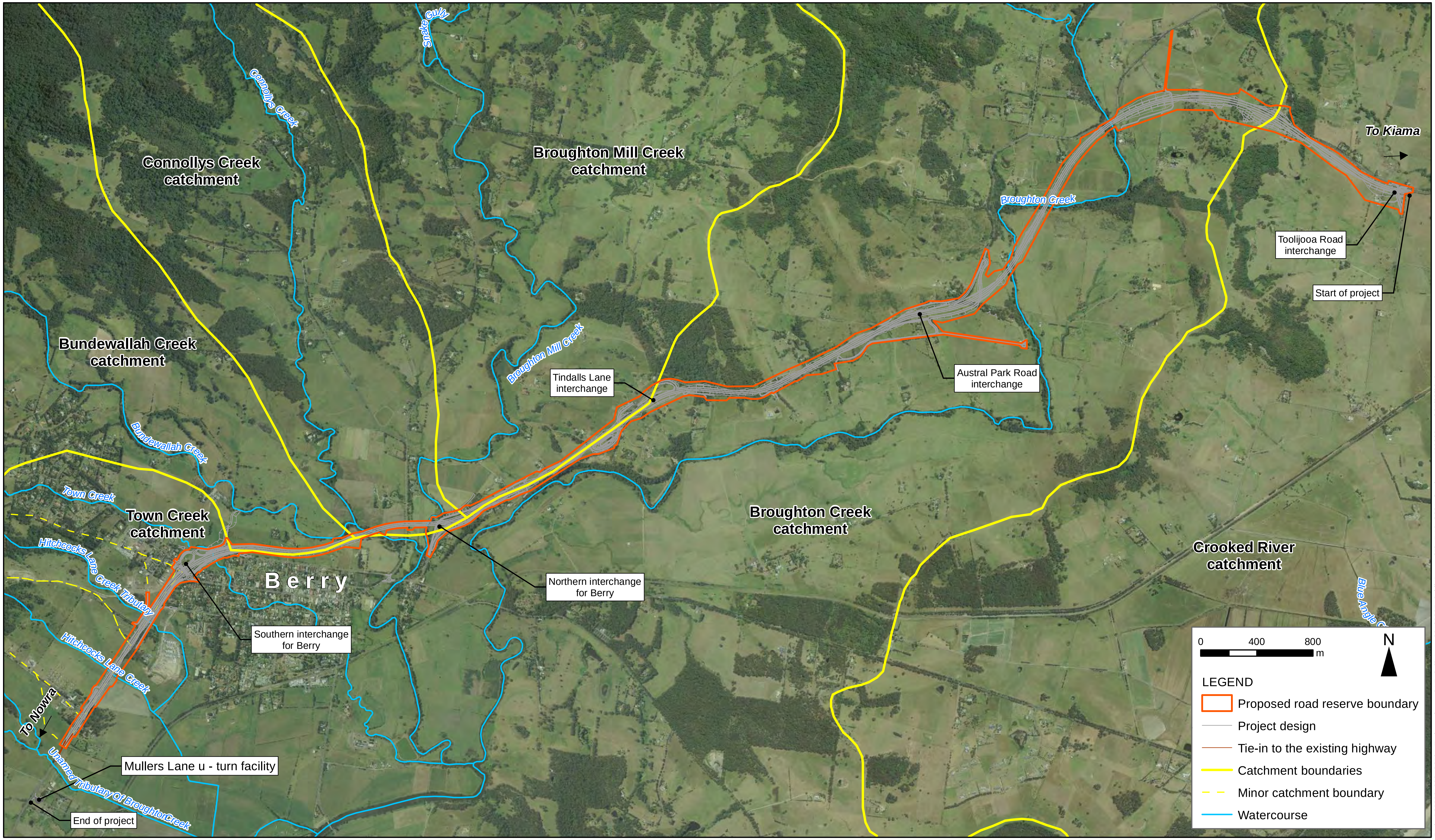

Figure 7-10 Location of catchments within the project area

Source: AECOM (2012), LPMA (2011)

NOTE: No significant or ephemeral waterways within the Crooked River catchment are located within the project footprint

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Crooked River, Broughton Creek and Broughton Mill Creek have previously been found to be within ANZECC aquatic ecosystem threshold limits for a range of organochlorine pesticides, oxides of nitrogen and trace elements, although all were above the ANZECC guidelines for chloride. Crooked River was also above the ANZECC guidelines for copper and recorded concentrations of oil and grease, and suspended solids, that were much higher than samples taken from sites within the Broughton Creek catchment (The Ecology Lab, 2007).

The existing highway, which has no water quality controls, is also likely to be contributing pollutant loads to nearby waterbodies particularly at or near creek crossings. This would include oil, grease and other hydrocarbon products, generated by general vehicular use of the highway.

The water quality within Town Creek is expected to be characteristic of a watercourse with a developed residential and agricultural catchment. The long-term urban and agricultural land use in the area has likely lead to elevated nutrient levels (for example from fertilisers and livestock manure), low dissolved oxygen and raised suspended solids resulting from the erosion of soils.

Aquatic biodiversity

The biodiversity values of waterways within the project area are discussed in detail in **Section 7.3**.

Drainage catchments

The drainage catchments of 29 farm dams are located within the project footprint. The locations of these dams are shown in **Figure 7-11**.

Groundwater

Aquifer systems

The two main aquifer systems present in the project area are the unconsolidated and unconfined alluvial/colluvial aquifers, and the Shoalhaven Group sediments.

The alluvial/colluvial aquifer occurs as sand, silt clay and gravels adjacent to the creek systems and as more widespread floodplain deposits. Within the floodplain sediments, localised perched groundwater is expected above interbedded clay horizons. Groundwater movement within the alluvial aquifer and floodplain sediments would flow towards low lying topographical features, discharging into local creek systems or as springs. Groundwater available for extraction within the aquifer would be limited, and would be of low salinity given low residence times and recharge via infiltration of rain and local runoff.

Groundwater within the Shoalhaven Group sediments is present within the volcanoclastic Broughton Formation, as well as within latite and underlying Berry Siltstone. Groundwater within the Shoalhaven Group sediments occurs in perched horizons within the sandstone, latite and siltstone, and within the deeper regional aquifer. Bores constructed in the Shoalhaven Group sediments in the area have variable yields. The deep aquifers are accessed by the majority of licensed bores in the area, extracting groundwater from depths typically between 30 metres and 50 metres below ground level. Based on limited data, groundwater from the Broughton Sandstone is expected to be of better quality than that derived from the Berry Siltstone. This is due to the poor quality groundwater within the shale lenses leaking into the Berry Siltstone aquifer.

The depth of groundwater along the project alignment is influenced by positioning in the landscape and proximity to discharge features. Typically, the watertable is a subdued reflection of the topography, with it being deepest beneath hills and shallowest adjacent to creeks and wetlands. This was confirmed by groundwater monitoring conducted between November 2009 and January 2010 by Coffey (2010).

Groundwater along the route is shallow and typically less than ten metres below ground level for all lithologies. The elevation of groundwater is variable, ranging from six metres AHD in low lying silts and gravels, up to 100 metres AHD within latite in topographically elevated areas. The watertable naturally fluctuates in response to climatic variation. Groundwater levels increase following significant rainfall and decline following periods of low rainfall. The degree of the groundwater response is variable and dependent upon landscape position and aquifer type. Low to moderate groundwater fluctuations of less than one metre were recorded in the siltstone and sandstone aquifers, whereas larger fluctuations (between three and four metres) were typically measured in the sandstone and latite aquifers.

Groundwater bores

There are 16 registered bores located within 500 metres of the project. Groundwater along the alignment is a valuable resource for stock, domestic and agricultural purposes to supplement surface water supplies collected in dams and pumped from creeks. Groundwater is extracted from a variety of aquifers, including latite, gravels, sandstone, shale and fractured rock. The groundwater yield is variable, but is typically less than two litres per second.

Drinking water catchments

There are no drinking water catchments in the project area. Groundwater has low use within the region because the area receives a relatively high rainfall and Shoalhaven Water provides a reticulated water supply to Berry. North of Berry water users are more reliant on tank water and groundwater.

Groundwater dependent ecosystems

GDEs are flora and fauna communities that depend on groundwater for survival. A GDE may either be entirely dependent on groundwater for survival or it may use groundwater opportunistically or for a supplementary water source (Hatton and Evans, 1998). GDEs are most likely to occur in low lying areas with shallow groundwater close to the surface.

Groundwater from the alluvial aquifer systems associated with the Broughton Creek floodplain discharges into Broughton Creek. Riparian vegetation associated with Broughton Creek is likely to be dependent upon groundwater in some capacity. Groundwater discharge via springs, seeps or spring fed dams may also sustain local small communities.

Foys Swamp and Coomonderry Swamp located east of Broughton Creek are listed under *State Environmental Planning Policy No 14 – Coastal Wetlands* (SEPP 14). Coomonderry Swamp is also identified as a high priority GDE in the Sydney Basin Southern management zone of the Greater Metropolitan Regional Water Sharing Plan. Floodplain swamp forest is a low, dense forest tolerant of brackish groundwater occurring along Toolijooa Road and the railway line between Gerringong and Berry. This community may grade into estuarine fringe forest with increasing groundwater salinity. Refer to **Section 7.3** for further information on GDEs.

7.4.3 Assessment of potential impacts

Surface water

Construction

Clearing, cut and fill operations along the project alignment, including the construction of permanent and temporary creek crossings, represent the primary risk to surface water quality during and following construction. These activities have an increased potential for sediment release and transportation due to runoff from disturbed areas or from roads where sediment has been tracked onto roads by construction vehicles. If uncontrolled, increased sedimentation of watercourses could smother and kill aquatic habitats and organisms. It could also increase the concentration of nutrients, metals and other potential toxicants that attach to sediment particles in surrounding waterways.

Previous water quality studies indicate several waterways in the study area have turbidity levels (a measure of the amount of sediment in water) that are narrowly outside the ANZECC lower thresholds. As a result, an increase in sedimentation could place additional physical stress on aquatic habitats and organisms.

The risk of these impacts, and the severity of the impact should it occur, would be dependent on the effectiveness of the erosion and sediment controls implemented during construction.

Other potential risks to surface water as a result of construction or due to activities at the proposed ancillary construction sites include:

- Sediment release from stockpiles that have not been suitably stabilised and earthmoving activities.
- Dust generation during excavation that could settle in waterbodies.
- Chemical or fuel spills that could pollute receiving waterbodies. This includes fuel or oil leakage from construction equipment, accidental spills or the release of chemicals due to damage to chemical storage areas.
- Exposure of ASS, resulting in acidic runoff that could have major environmental impacts and constrain construction (refer to **Section 8.1** for further detail).
- Construction materials or general waste generation from construction that could enter waterbodies.
- An increase in surface runoff due to an increase in cleared and impervious surfaces.
- Damage to ancillary facilities (including flood damage) that could result in an export of pollutants to receiving waters.
- Tannins leachate from vegetation stockpiles.
- Riparian vegetation removal that could result in sediment release to adjoining watercourses. This could impact on water quality and result in decreased health of aquatic ecosystems.
- The construction of Town Creek diversion could result in reduced water quality, primarily due to erosion. This could lead to excess sediment loads into Bundewallah Creek, leading to impacts on aquatic species and habitats.

Construction water, which would be used for dust suppression, earthwork compaction and planted vegetation maintenance, would be sourced as follows in order of priority, where practicable, and based on the intended use:

- Recycled effluent from the tertiary treatment plant at Gerringong Gerroa and/or Berry.
- Surface water, sourced from on-site detention basins.
- Surface water, sourced from watercourses.
- Potable water.
- Groundwater.

The volume of water required would depend on a number of factors including rainfall, wind direction and intensity, soil type and area of ground disturbance at any one time.

Effluent at the Gerringong Gerroa sewerage scheme undergoes tertiary treatment and 80 per cent of the recycled effluent is re-used for agricultural irrigation. The remainder is currently irrigated on sand dunes, or discharged to an on-site natural wetland that is ultimately released into Crooked Creek. Discharge concentration criteria contained in the Environment Protection Licence (EPL) for the plant is provided in **Table 7-51**. Recycled effluent may also be sourced from the Berry sewerage treatment plant which is owned and operated by Shoalhaven Water. Recycled effluent from this plant is discharged to land and Broughton Mill Creek. Discharge concentration criteria contained in the EPL for the plant are provided in **Table 7-52**. It has higher concentration limits for total suspended solids and biochemical oxygen demand.

Table 7-51 Concentration limits for the Gerringong-Gerroa sewage treatment system as contained in the EPL

Pollutant	Unit of measure	50 percentile concentration limit	100 percentile concentration limit
Oil and grease	milligrams per litre	-	10 (with visible oil and grease)
pH	-	-	6.5-9
Nitrogen (total)	milligrams per litre	3	
Phosphorous (total)	milligrams per litre	0.1	
Total suspended solids	milligrams per litre	3	
Biochemical oxygen demand	milligrams per litre	5	
Faecal coli forms	Colony forming units per 100 millilitres	2	

Source: Environment Protection Licence 11317 (dated 2 July 2009), accessed on 21 September 2011 on www.environment.nsw.gov.au.

Table 7-52 Concentration limits for the Berry sewage treatment system as contained in the EPL

Pollutant	Unit of Measure	50 percentile concentration limit	100 percentile concentration limit
Oil and grease	milligrams per litre	-	10 (with visible oil and grease)
Total suspended solids	milligrams per litre	15	30
Biochemical oxygen demand	milligrams per litre	10	20

Source: Environment Protection Licence 1736 (dated 1 June no year), accessed on 11 November 2011 on www.environment.nsw.gov.au.

The management and use of treated effluent would be undertaken in accordance with RMS' Environmental Direction No: 19 - Use of Reclaimed Water (RTA 2006) and RMS' Tip Sheet – Use of Reclaimed Water (RTA 2006). The recycled effluent, which is fit for discharge for irrigation purposes and eventual discharge into waterways, would be dispersed within the project area at low loadings over a large area, and for a short duration in response to demand. As such, it is expected that no significant water quality impacts would eventuate. Nonetheless, a number of mitigation and management measures are proposed to minimise potential risks to the environment and human health. These are discussed further in **Section 7.4.3**.

To supplement this water source, water may be extracted from the construction and operational sedimentation basins that would collect runoff from the site during construction. While the remaining sources for water supply (being potable water, or extraction from surface water and groundwater sources), are possible options, these are not preferred.

Should surface water extraction from creeks be required, it would be extracted pursuant to clause 18 of the Water Management General Regulation 2011, under which Roads authorities are exempt from Access Licence requirements in relation to water required for road construction and road maintenance.

Operation

Surface water runoff would increase during operation due to an increase in impervious surfaces and concentration of road runoff through drainage infrastructure. This in turn would increase the frequency, volume and velocity of flows in receiving waterways, potentially leading to or exacerbating erosion.

Associated with this risk is the increased potential for the following pollutants to enter nearby watercourses via road runoff:

- Sediments from paved surfaces.
- Nutrients (phosphorus and nitrogen) deposited onto paved surfaces due to atmospheric deposition.
- Heavy metals attached to particles washed off paved surfaces.
- Oil, grease and other hydrocarbon products, generated by general vehicular use of the highway.
- Gross pollutants (roadside litter).
- Fuels and chemicals from spills caused by traffic accidents.
- Contaminants from the erosion of the roadway or road shoulders.

The diversion of Town Creek would lead to flow regime and water quality impacts within Town Creek, and Bundewallah Creek. This is discussed later within this section. The construction of piers within Bundewallah Creek would change the average velocities of water near the piers with reductions to average velocities immediately upstream and increases close to the piers. However, the change would not typically extend across the entire width of the creek.

Studies undertaken in the Broughton Creek catchment generally show that turbidity levels are narrowly outside the ANZECC lower thresholds and values of total phosphorus generally exceeded the ANZECC guidelines. Without appropriate management controls the potential operational impacts may place further stress on waterways as a result of the project.

Heavy metals, hydrocarbon products and nutrients are primarily transported off site by road runoff as particle-bound contaminants. As such, the protection of aquatic ecosystems and the treatment of road runoff are directed at the removal of suspended solids, and the associated contaminants.

Total nitrogen is a more difficult pollutant to remove, when compared to total suspended solids and phosphorus. Total suspended solids and a large fraction of total phosphorus are associated with particulates, which are readily trapped by basins or swales. As only a small fraction of total nitrogen is particulate, the remaining dissolved forms of nitrogen can only be removed by biological processes such as bio-retention systems.

The results of the model for urban stormwater improvement conceptualisation (MUSIC) determined that the existing and proposed highway generate significant increases in pollutant loadings for total suspended solids, total phosphorus and total nitrogen when compared to a pre-developed rural catchment (refer to **Table 7-53**). The model also illustrated that the project, in the absence of any treatment measures, would likely increase the impact on receiving waterways when compared to the existing highway. This is due to the increase of impervious areas and primarily pavement widths.

Table 7-53 MUSIC model pollutant loadings (without water quality treatment).

Scenario*	Total suspended solids (kg/year)	Total phosphorous (kg/year)	Total nitrogen (kg/year)
Pre-developed	235	0.62	6.36
Existing	1260	2.31	10.8
Proposed	1980	3.64	16.6

** Refer to the Surface water, Groundwater and Flooding Technical Paper at* ***Appendix H****.*

Worst case scenario

The worst case scenario for operational water quality treatment would occur if all treatment structures fail or were not installed.

To assess the worst case stormwater runoff scenario, consideration has been given to the lack of installation, or the failure of, all stormwater management measures (as discussed in **Section 7.4.5**). It would be highly unlikely that all these measures could fail, and as such, there is a very low risk of the worst case impacts occurring. If all measures were to fail, there would be an increased volume of water, flowing at a much higher rate due to increased impervious areas. This would result in:

- Pavement drainage systems collecting road runoff, concentrating the flow (together with sediment, oil, grease and atmospheric nitrogen dissolved in rainwater) to a single untreated discharge location.
- Immediate impacts such as erosion, nutrient loading and concentration of sediment and litter.
- The receiving waterways potentially eroding over around one or two decades (depending on rainfall) to result in a new form, which would be wider and deeper than the existing stream. This could impact the geomorphic and sediment diversity of the affected stream.
- Reductions in the biodiversity within receiving waterways.

Untreated stormwater runoff can also lead to the accumulation of pollutants in waterways over time. This would create pressures on the ecology of these waterways and impacts on biodiversity. These impacts would be similar to that generated in other urban or developed areas, where stormwater is discharged untreated into receiving waters.

Further downstream from the pavement drainage discharge location, the relative magnitude of the water quality impacts would be reduced by dilution. The existing highway has no water quality controls and as such, worst case loading of vehicle-generated pollutants from the proposed design would be equivalent to the present day situation, plus an allowance for increased traffic over the design life of the project.

The worst case consequences for vehicle spills would be similar under both existing and proposed situations. The proposed alignment would however improve accident rates and therefore reduce the likelihood of spills occurring.

Impacts resulting from the Town Creek diversion

The diversion of Town Creek would alter the flow regimes in parts of Bundewallah Creek, Connollys Creek, Broughton Mill Creek and Town Creek. The diversion would result in runoff from around 70 hectares of the Town Creek catchment being diverted into Bundewallah Creek. This would result in:

- A maximum increase of five per cent to the catchment area for Bundewallah Creek, Connollys Creek and Broughton Mill Creek.
- A loss of 47 per cent of the Town Creek catchment downstream of Berry.

Based on the results of the Australian Water Balance Model (AWBM) model, the minimal change in catchment area would have negligible impact on flow volumes of Bundewallah Creek, Connolly’s Creek and Broughton Mill Creek. For Town Creek, the results of the AWBM model show that:

- There would be no flow at the upstream end of reach of Town Creek immediately south of the southern interchange.
- The flow volume of Town Creek just before it joins Broughton Mill Creek would be reduced to around one third of the existing flow volumes at this location.

As described in Section 7.4.2, the long-term urban and agricultural land use in the area has likely lead to elevated nutrient levels (for example from fertilisers and livestock manure), low dissolved oxygen and raised suspended solids resulting from the erosion of soils. As an ephemeral stream, Town Creek has intermittent flows during rain events only and has few standing pools located south of Berry.

The reduction in flow volumes in Town Creek would lead to reduced flushing efficiency. This could lead to a decline in water quality due to sediment accumulation, increases in nutrient levels, and decreases in dissolved oxygen. Aquatic habitats nearest the diversion point would be reduced to isolated pools with associated declines in water quality. Given the existing degraded condition of Town Creek through Berry and its ephemeral nature, the reduction in flow volumes should not have any significant adverse impacts on water quality. There is also no aquatic ecological benefit to overbank flooding in large events within Berry. Any further degradation of Town Creek is considered to be acceptable given the positive flood mitigation provided by the diversion of flood flows.

There is the potential for a decrease in water quality where the diversion would connect to Bundewallah Creek due to eddying. The design and revegetation of the diversion channel would ensure that there is no detrimental impact on water quality in the diversion channel and Bundewallah Creek.

The revegetation of the diversion channel would also stabilise the new banks and reduce the risk of erosion. This would enhance the structural integrity of the diversion channel and would provide the following benefits:

- Increased protection to the adjacent landowners land.
- Increased channel roughness, which would reduce flow velocities and erosive flows.
- Increased channel shear strength and soil binding.
- Provision of habitat, habitat corridors, nutrient assimilation and increased biodiversity.
- Minimised risk of water quality impacts in Bundewallah Creek.

The potential impacts on aquatic habitat and riparian vegetation at Town Creek and Bundewallah Creek as a result of the diversion is discussed further in **Section 7.3**.

Farm dams

The project may also cause permanent changes to drainage catchments for existing farm dams. Surface water runoff that currently flows downhill to farm dams may be diverted around road cuttings via catch drains and other drainage infrastructure to a natural waterway. Such a reduction in runoff areas could prevent the natural flow of water into farm dams and potentially reduce their yield.

These impacts would commence during construction. For the majority of the 29 farm dam catchments impacted by the project, the loss of catchment area would be less than 20 per cent of the original catchment (refer to **Figure 7-11** and the *Surface Water, Groundwater and Flooding Technical Paper* at **Appendix H**). Farm dams with the greatest loss of catchment area are typically smaller dams located at higher elevations and with relatively small catchments. Several of the highly impacted dams are located on properties already acquired by the RMS. The impact of these losses would be dependent on the purpose of the dam for farm operations and the availability of alternative water sources.

Groundwater

Construction

Construction activities have the potential to impact groundwater levels as a result of changes to groundwater flow patterns, recharge and discharge characteristics of the site.

Deep excavations and cuttings for the project may experience groundwater inflows as a result of intercepting groundwater. Preliminary assessments indicate that groundwater would seep into the Toolijooa Ridge cutting from the latite and Kiama Sandstone. Other cuts along the alignment are no deeper than 13 metres and may also be subject to groundwater inflows. Additional geotechnical investigations and modelling would be undertaken during the detailed design phase of the project to determine the degree of seepage that may occur at exposed cuttings, especially at Toolijooa Ridge.

Foundations for cased bored piles associated with bridges or other major structures are also expected to intercept shallow groundwater. This may require localised dewatering, which would temporarily alter groundwater flow conditions. However, the original groundwater flows would be re-established once dewatering was completed.

Temporary dewatering may also be required to artificially lower the watertable to maintain dry working conditions within excavations and at bridge footings. This would likely draw down local groundwater levels in the immediate vicinity of the excavation or footing.

Should dewatering of the alluvial aquifer be required during the construction of bridge footings, groundwater drawdown would be limited to the base of the footing, and the zone of influence or induced cone of depression, is expected to be limited due to the highly transmissive nature of an alluvial aquifer. Should dewatering be required during the construction of road cuttings, the impacts would depend on the local hydraulic conductivity of the aquifer matrix and secondary water bearing structural features.

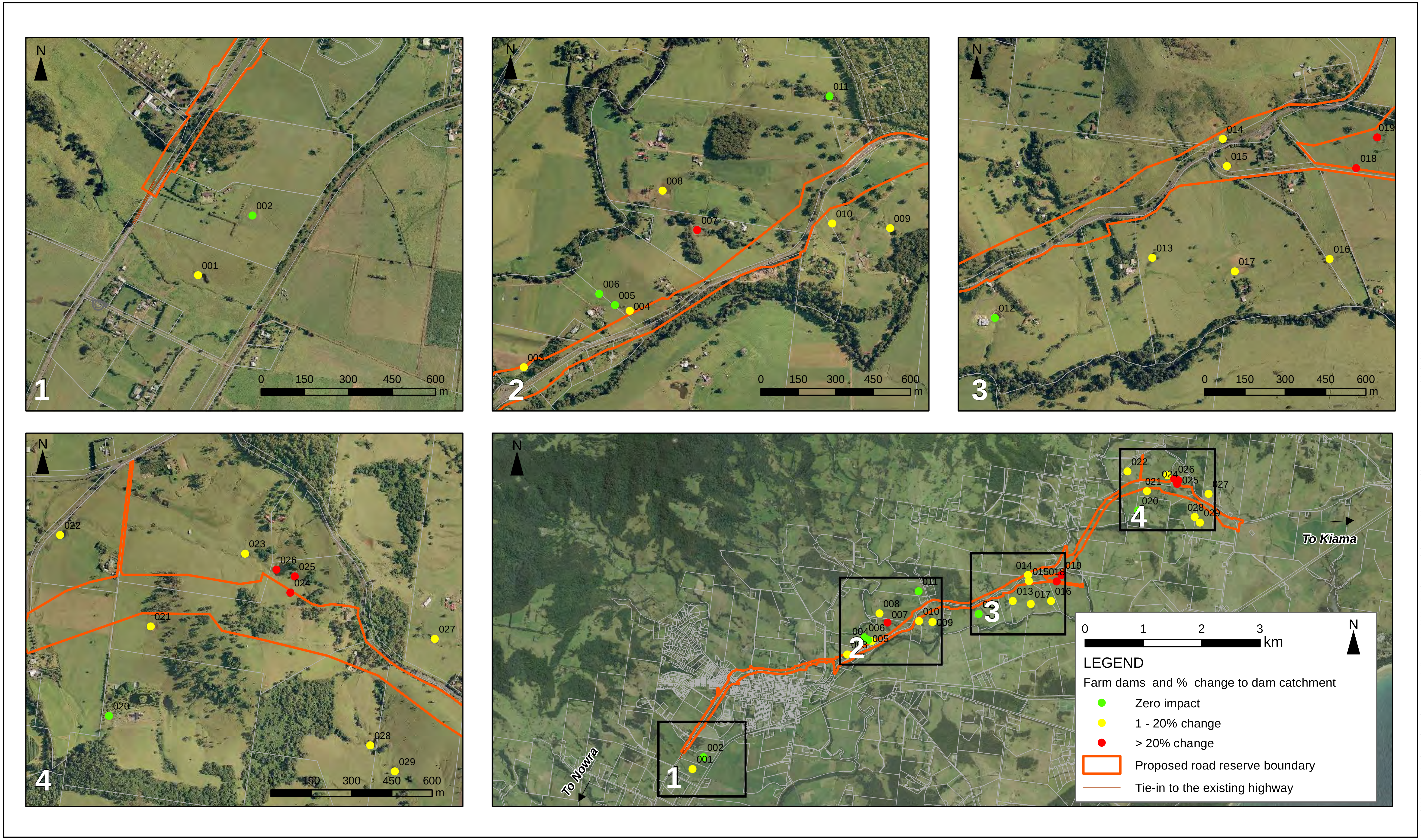

Figure 7-11 Location and impacts on farm dams in the project area

Source: LPMA (2011)

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Additional geotechnical investigations that would be undertaken during the detailed design phase of the project would determine the need for dewatering, the likely dewatering volumes, the impacts on draw down and the quality of groundwater that would be encountered during construction. The manner in which extracted groundwater would be discharged would depend on the groundwater quality and if it would require treatment prior to discharge. Options include discharge to creeks, temporary storage in detention basins to reduce turbidity prior to discharge, or re-use for dust suppression.

Excavation for cuttings beneath the watertable or intersecting perched groundwater also has the potential to reduce groundwater recharge as a result of groundwater draining into culverts, creeks or rivers. Compaction of shallow soils in areas of unconsolidated alluvial sediments, and the construction of access roads, tracks and stockpiling areas could also reduce rates of recharge.

Construction activities may also impact on the water quality of groundwater. Fuel and chemical spills including petrol, diesel, hydraulic fluids, lubricants and explosive residues could potentially contaminate groundwater and GDEs, particularly if a leak or spill occurs on highly permeable sandy soils. Spills as a result of accidents could occur during construction, refuelling operations or from storage areas.

Runoff from construction areas may be highly turbid. The movement of suspended solids to the groundwater is likely to be minimised as it filters through the unsaturated zone, reducing the significance of the impact.

There is a low risk that potential acid sulfate soils (PASS) may be present along the project (refer to **Section 8.1** for further detail and PASS occurrence). Should the watertable be lowered during excavation, if present, PASS would become exposed and oxidation of sulfide minerals could result. Sulfuric acid would then be generated and metal concentrations in solution would potentially increase, leading to groundwater degradation. Rainfall runoff could cause acidic water to migrate within the shallow groundwater system and discharge into surface water systems and groundwater receivers. This risk and any potential impacts would be mitigated and managed using an acid sulfate soil management plan (ASSMP)(refer to **Section 8.1.3**).

The potential risk to GDEs as a result of construction activity is low and is discussed in detail in **Section 7.3**.

Operation

Road runoff, major cuttings and other structures can cause permanent barriers and long term impacts to groundwater flows, recharge rates and groundwater quality.

The increase in hard road surface areas would increase runoff and decrease groundwater recharge, due to the loss of permeability. The decrease in recharge rates would be minor given the small road surface of the project compared to the remainder of the catchment.

Road runoff could contain pollutants associated with vehicular movements, leaks, spills and crashes, which could lead to the contamination of groundwater. The contaminants could include hydrocarbons (petrol, diesel and oils), metals and suspended solids. Measures to minimise surface water impacts (as described in **Section 7.4.4**) would contain the risk to groundwater quality.

Toolijooa Ridge and other shallower road cuttings along the project may also be subject to groundwater inflows during the operational phase. As identified earlier in this section, investigations completed to date suggest that groundwater would seep into the Toolijooa Ridge cutting from the latite and Kiama Sandstone.

Inflow to the cuttings could potentially reduce groundwater recharge (as through flow), lower the local watertable and alter groundwater flow paths. The capacity of water extraction bores in the vicinity of the deep road cuttings may be reduced as a result. Similarly, farm dams and GDEs that are recharged by springs may also be affected by a reduced spring flow due to the altered groundwater flow conditions. The expected drawdown in the vicinity of the Toolijooa Ridge cut is not expected to impact other users, as registered groundwater bores are at a sufficient distance from the cutting not to be adversely affected. Local GDEs are within elevated parts of the catchment and would continue to be sustained.

Potential future groundwater use in this area has not been identified at this stage. The impact on bores would be confirmed as part of the additional geotechnical field investigations that would be undertaken during the detailed design phase of the project.

Worst case scenario

To assess the worst case scenario for groundwater impacts, consideration has been given to the failure of all environmental management measures (as proposed in **Section 7.4.4**) during a major spill or pollution event causing groundwater contamination. Given design standards and the implementation of environmental management measures, it would be highly unlikely that all these measures could fail. As such, there is a very low risk of the worst case impacts occurring.

If this was to happen, the severity of the impact would also be dependent on:

- The type and volume of the pollutant.
- Where in the groundwater system the contamination occurs, which would determine how slow or quickly the contaminant can move.
- The proximity to active groundwater users, including town water supply, irrigation, stock and domestic bores.

Subsequent impacts on ecosystems would also occur as result of this contamination. This includes connected GDEs, such as wetlands, and impacts on surface water systems that are fed by groundwater flows.

Reductions in groundwater flows as a result of groundwater interference may be anything from short-term, to long-term. Localised impacts from dewatering or extraction would generally disappear upon the completion of the activity. In a worst case scenario, dewatering activities may temporarily lower the watertable sufficiently to impact other users. In this case, mitigation measures can be put in place to minimise the effects.

Where a recharge zone or groundwater flow-path is significantly altered, or where a whole section of an aquifer is removed, the impacts are likely to be permanent. The likelihood of a major aquifer disruption, and the effects on users or ecosystems, is not known. The impacts would be considered once the additional geotechnical field investigations have been completed.

7.4.4 Environmental management measures

Mitigation and management measures would be implemented to minimise or manage impacts to surface and groundwater and to achieve compliance with Section 120 of the POEP Act and the EPL for the project. These mitigation and management measures are set out in **Table 7-54** (construction) and **Table 7-55** (operation) and incorporated in the draft statement of commitments in **Chapter 10**.

Table 7-54 Construction mitigation and management measures

Potential impacts	Mitigation and management measures
Construction	
General construction impacts	Prepare a Soil and Water Management Plan (SWMP) prior to construction, which would detail control measures for erosion and sedimentation for implementation before and during construction.
Reduction in surface water quality	Document the following measures in the SWMP and implement them on site: • Construct temporary drainage structures in accordance with the 'Technical Guideline – Temporary stormwater drainage for road construction' (RMS, 2011). Locate sedimentation basins during construction in areas as determined during detailed design. The proposed locations shown in **Figure 7-12** are based on the concept design and would be subject to change during detailed design of the project. These would be in addition to the permanent operational water quality basins that may be used during construction for temporary sedimentation control (refer **Figure 7.14**). • Include 'at source' management measures in areas of residual high risk erosion and sedimentation areas. These areas are where basins are not feasible due to topographical constraints or small catchment areas (as identified in **Figure 7-13)**. Measures would include small scale sedimentation capture devices, designed in consultation with a specialist soil conservationist. • Carry out construction in sequence to minimise the extent of disturbed areas and rehabilitate as soon as practicable. • Install permanent clean water diversions and top of cut drains at the start of construction to limit the volume of water on site. • Construct sediment and water quality basins prior to clearing activities in each area. • Establish water quality swales before or concurrently with clearing activities to enable their use during construction. • Stabilise fill batters progressively as they are constructed. • Manage vegetation stockpiles to minimise the impact of tannins leaching into the surrounding environment. Manage stockpiles in accordance with *Environmental Guidance – Management of Tannins from Vegetation Mulch* (RMS, 2012). • Use dust management techniques, such as water spraying, to suppress dust. • Manage and use treated effluent in accordance with RMS' Environmental Direction No: 19 - Use of Reclaimed Water (RTA 2006) and RMS' Tip Sheet – Use of Reclaimed Water (RTA 2006).

Potential impacts	Mitigation and management measures
Potential impacts to groundwater	Minimise the depth of excavations in areas of alluvium. Limit the need to dewater during construction. Implement a communications procedure to educate construction personnel on groundwater issues. Minimise disturbance and control runoff from construction areas. Provide bunding and spill kits around fuel depots and stockpile areas. Develop response plans to address fuel leaks and spills at machinery compounds or during refuelling, including a hazardous materials plan and spill emergency procedure. Establish a groundwater monitoring network along the project to monitor groundwater quality within each lithology and to establish background groundwater quality. Detail the establishment of a groundwater monitoring network along the route to adequately characterise groundwater quality and establish background water quality within the alluvial/colluvial aquifers and Shoalhaven Group Sediments, including the Broughton Sandstone and latite. Install monitoring wells adjacent to major cuts to confirm existing groundwater levels and to monitor the effect on groundwater levels by construction activity, where groundwater is encountered. Implement a groundwater monitoring plan that would assess the performance of groundwater mitigation measures during and after construction. This plan would provide an assessment of groundwater level and quality trends and identification of exceedances (if any). Utilise a soil conservation specialist during the detailed design and construction phases to assist with the management, design and mitigation of soil erosion issues.
Potential impacts of ASS	During the initial works onsite, undertake further testing for ASS across the Broughton Creek floodplains. Should the presence of ASS be confirmed, avoid or minimise disturbance, and/or activities that may lower the watertable in these areas. Prepare an ASSMP if required, to identify strategies to remove or reduce the risks associated with ASS (refer to **Section 8.1.3** for further detail).
Impacts as a result of the Town Creek diversion	Undertake staged construction of the Town Creek diversion to reduce the exposure of soils. Stabilise banks of the constructed channel prior to diversion of flows from the upper catchment of Town Creek. Maintain flushing efficiency and mitigate erosive forces at the discharge location into Bundewallah Creek through the design of the diversion. This could be achieved by increasing the channel roughness to reduce flow velocities. Revegetate the banks of the diversion channel to stabilise and reduce the risk of erosion.

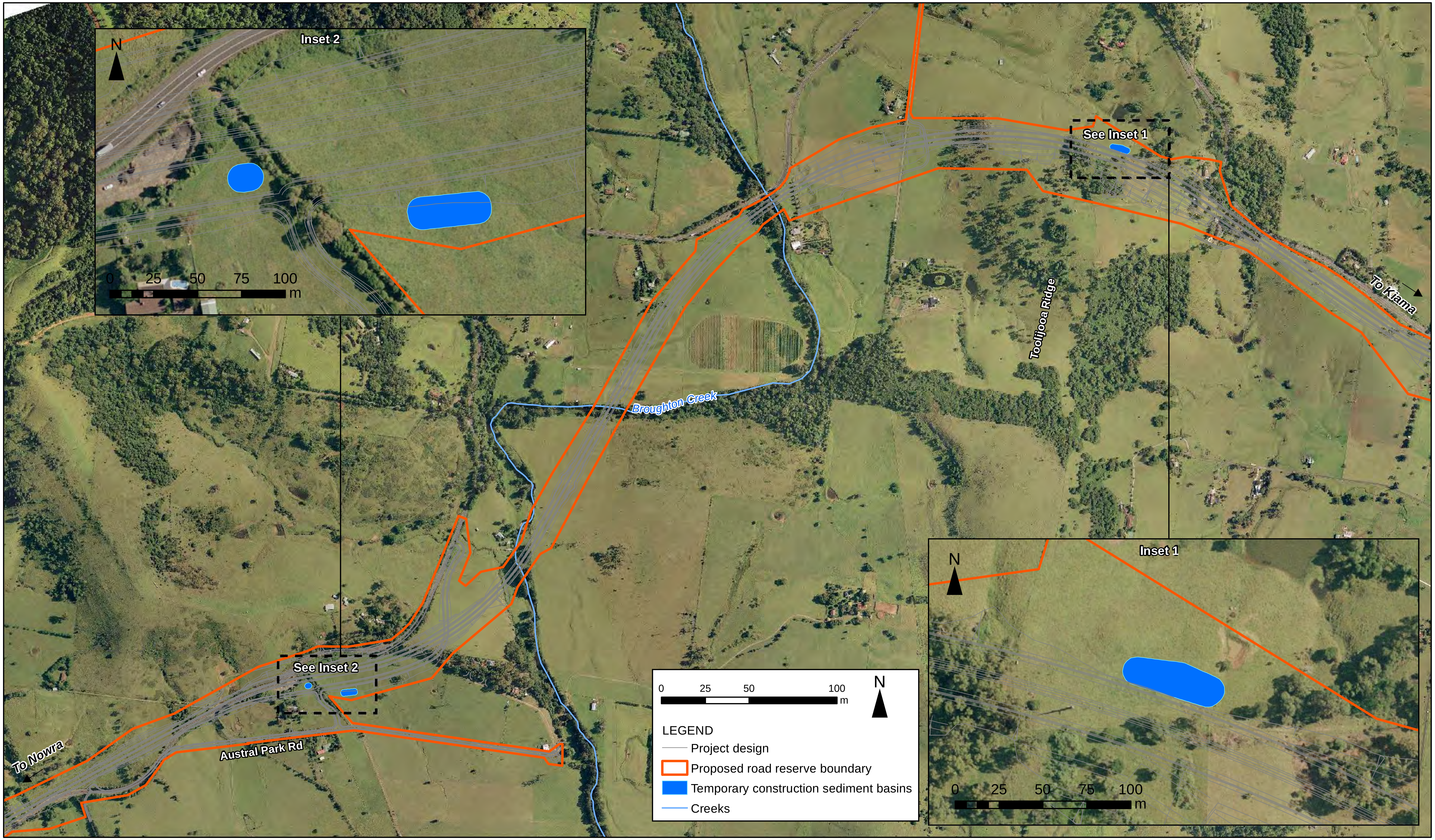

Figure 7-12 Location of construction sediment basins

Source: AECOM (2011)

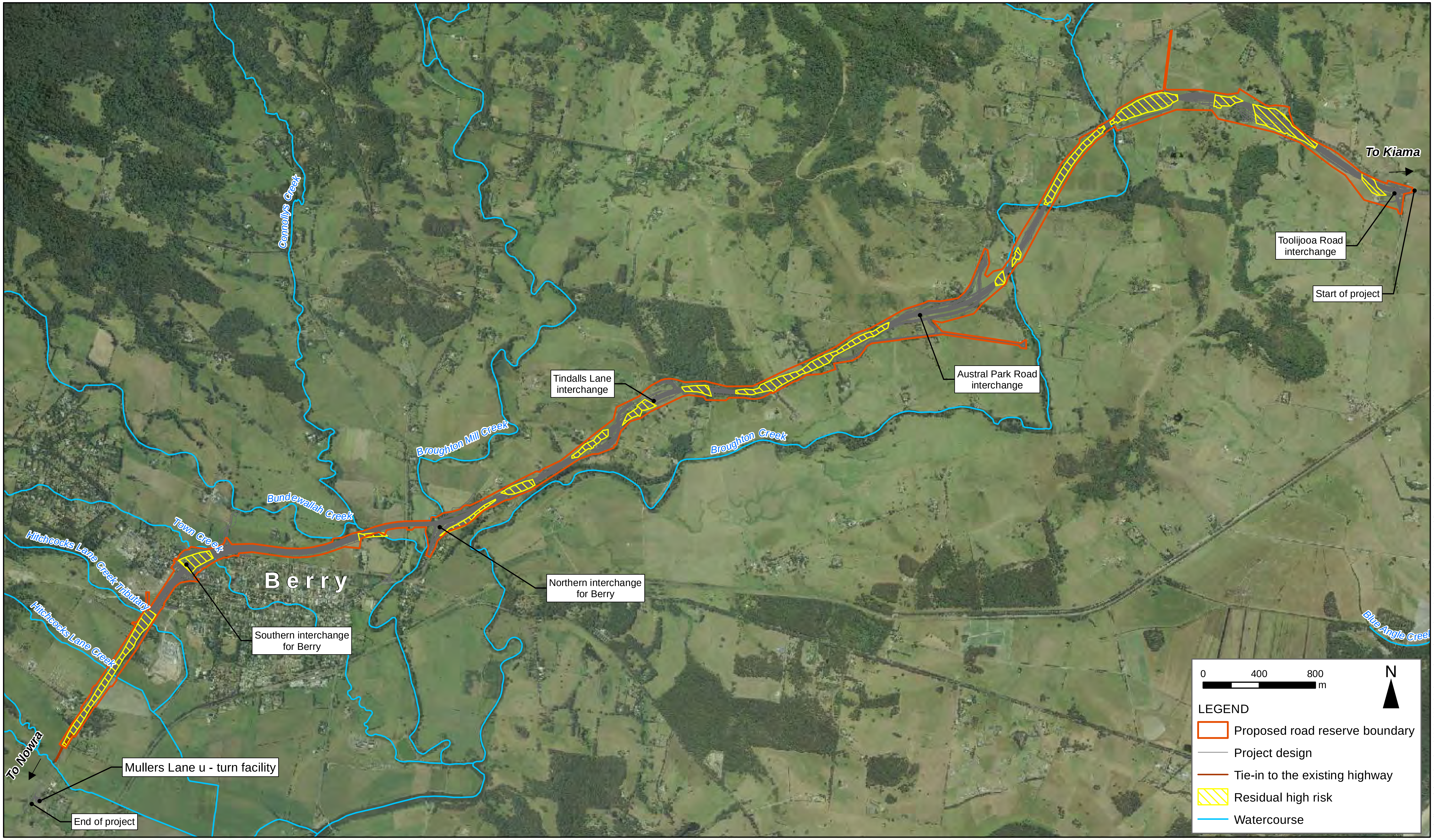

Figure 7-13 Areas of residual high risk of sedimentation and erosion

Source: AECOM (2012)

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Table 7-55 Operation mitigation and management measures

Potential impacts	Management and mitigation measures
Operation	
Reduction in surface water quality	Where reasonable and feasible, water quality treatment targets for the project are: • 80 per cent reduction in total suspended solids load. • 60 per cent reduction in total phosphorus load. For the more sensitive receiving environments of Broughton Creek, Broughton Mill Creek, Connollys Creek and Bundewallah Creek, and where reasonable and feasible, the water quality treatment targets are: • 85 per cent reduction in total suspended solids load. • 60 per cent reduction in total phosphorus load. • 40 per cent reduction in total nitrogen load. Include a combination of swales and water quality basins to treat road runoff and protect downstream receiving environments to achieve the water quality treatment targets and prevent pollution of waters. Provide swales of varying lengths located both in the median and along outer road edges to convey and treat runoff. Example design options include swales that meet the total area requirements of 140 metres by two metres. Provide water quality basins at various locations to achieve the water quality treatment targets for the project. Around 18 basins have been identified, which would be confirmed during detailed design (refer to **Figure 7-14**). Refer to **Table 2-4** to **Table 2-7** in the *Surface Water, Groundwater and Flooding Technical Paper* at **Appendix H** for detailed assumptions and design methodology. Include bioretention systems at sensitive receiving environments where reasonable and feasible. Ensure biofiltration systems comprise a vegetated swale or basin, overlaying a filter media (usually soil-based) with a drainage pipe at the base (refer **Appendix H**). Where reasonable and feasible, size bioretention systems to achieve the water quality treatment targets. Suitable bioretention designs include: • 80 square metres of bioretention with a 140 metre swale. • 85 square metres of bioretention with a 30 cubic metre water quality basin. Confirm the configuration and location of the bioretention systems during the detailed design phase of the project. The total nitrogen target may be reconsidered if hydraulic capacity of the basin is compromised or risk of exposing PASS. Refer to **Table 2-8** to **Table 2-10** in the *Surface Water, Groundwater and Flooding Technical Paper* at **Appendix H** for more detailed assumptions and design methodology. Subject to detailed design, direct runoff from bridges over watercourses and floodplains to water quality basins and swales.

Potential impacts	Management and mitigation measures
	In the event of a spill, initiate emergency response plans to contain and clean up a spill (refer **Section 8.4)**.
Monitoring of surface water quality, swales and water quality basins	Inspect swales, basins and bioretention systems every three months until established and, once established, after large storm events (minimum one inspection per year). Clean sediment basins every five years or as required, Implement an independent surface water quality monitoring program (refer to **Appendix G** for further details). This program would use ANZECC trigger values for the protection of aquatic ecosystems as a starting point to develop locally appropriate thresholds that would trigger operational mitigating management responses. This would include monitoring parameters such as turbidity and pH (to monitor ASS), Nutrients (TP and TN), Metals (Aluminium, Cadmium, Copper, Lead, Zinc) and Total Petroleum Hydrocarbons.
Reduced groundwater quality	Implement a groundwater monitoring program prepared in consultation with the EPA and NOW. Include an assessment of groundwater level data trends and comparison with rainfall data, and an assessment of water quality trends and exceedences, if any in the program. Large cuttings, such as that at Toolijooa Ridge, would be a focus of the groundwater monitoring program. Use the existing groundwater monitoring network, established during construction. Carry out groundwater monitoring every six months during operation with a review after two years to assess data trends and assess if further monitoring is warranted. Provide results to the EPA and NOW. Establish a framework for monitoring in the Sampling Analysis and Quality Plan.
Loss of flow into farm dams	Undertake consultation with affected landowners prior to the commencement of construction where there would be permanent losses in dam catchments.

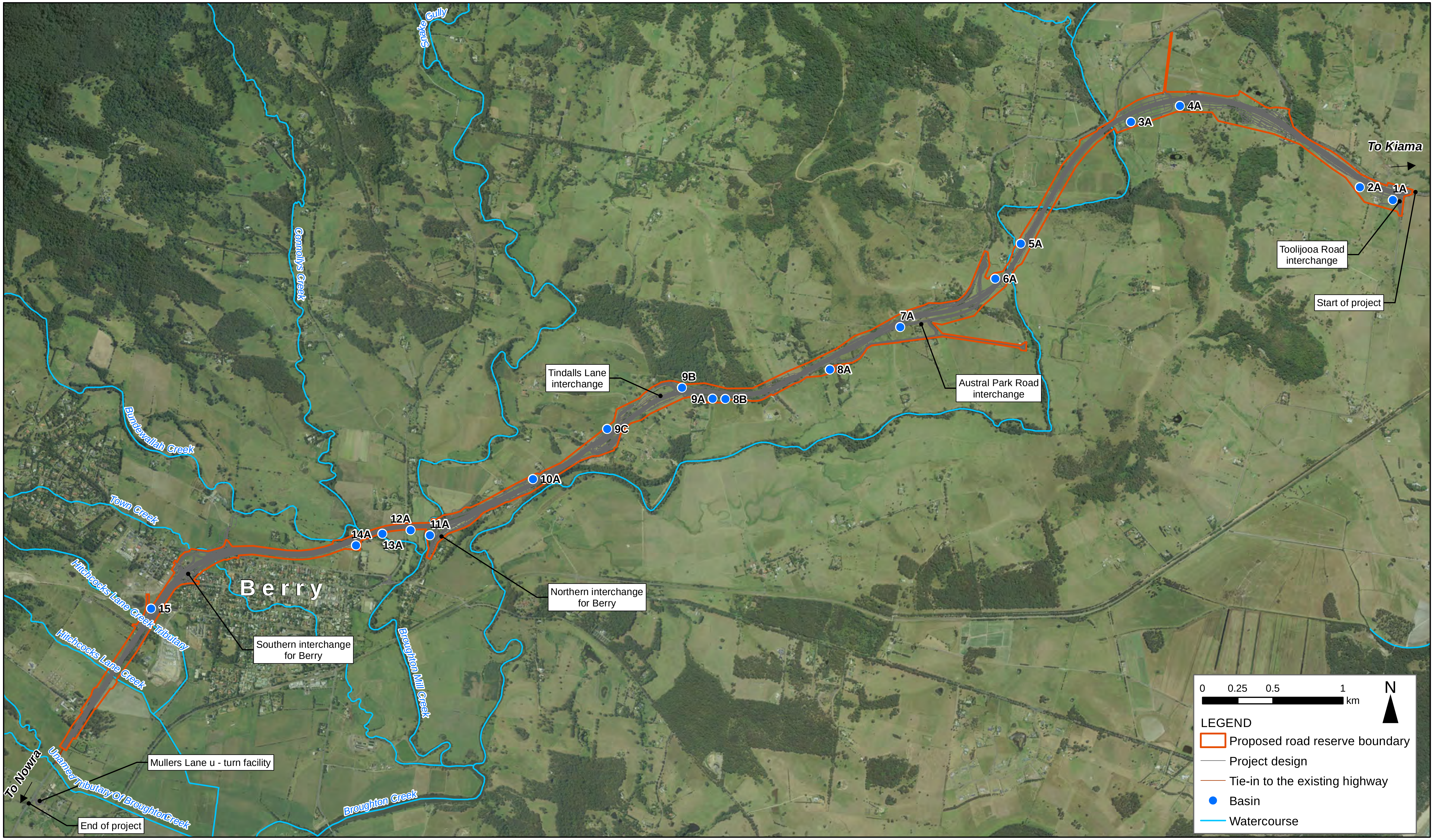

Figure 7-14 Proposed permanent operational sediment basin locations

Source: LPMA (2011)

Note: Refer to Table 2-7 in the *Surface Water, Groundwater and Flooding Technical Paper* at Appendix H for corresponding basin references.

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7.4.5 Residual impacts

Following the construction of the project and implementation of mitigation strategies, there would be residual impacts on surface water and groundwater. These would be confirmed during detailed design and subject to the further investigations to inform the development of mitigation strategies (refer to **Table 7-52** (construction) and **Table 7-53** (operation). These impacts would include:

- Permanent diversion of Town Creek. The project would cause a residual loss of overall flows and flushing flows from Town Creek which would potentially increase sedimentation in both Town Creek and Bundewallah Creek. However, the diversion would also have the positive residual impact of reducing flood impacts within Berry. The design and revegetation of the diversion channel would ensure there is no detrimental impact on water quality within the channel and therefore for flows into Bundewallah Creek.
- Permanent changes to drainage catchments for existing farm dams. Such a reduction in runoff areas could prevent the natural flow of water into farm dams and potentially reduce their yield.
- Increase in surface water runoff during operation due to an increase in impervious surfaces and concentration of road runoff through drainage infrastructure. However, the water quality treatment system selected for the project aims to improve the quality of runoff compared to the existing highway and therefore have a net benefit to receiving waterways.
- Temporary alteration to groundwater flow conditions during construction due to localised dewatering, if required. However, once dewatering is completed, original groundwater flows would be re-established.
- A decrease in groundwater recharge due to the increase in impervious hard surface road area. However recharge decrease would be minor given the small road surface compared to the remainder of the catchment.
- Potential for reduced groundwater recharge, lowering of the local watertable and altered groundwater flow paths due to groundwater inflow to the cuttings along the project. The capacity of water extraction bores in the vicinity of the deep road cuttings may be reduced as a result. The impact on bores would be confirmed as part of the additional geotechnical field investigations that would be undertaken during the detailed design phase of the project.

7.5 Flooding

This chapter provides an assessment of flooding, which was nominated in the DGRs as a key environmental issue for the project. It represents a summary of the *Surface Water, Groundwater and Flooding Technical Paper* (AECOM, 2012), which was prepared for the project to address the DGRs.

The technical paper is provided at **Appendix H**. The relevant extract from the DGRs is presented below.

Director-General's requirements	Where addressed
Flooding *- including but not limited to:*	
Identifying potential impacts of the project on existing flood regimes, consistent with the Floodplain Development Manual (Department of Natural Resources 2005), including impacts to existing receivers and infrastructure and the future development potential of affected land, demonstrating consideration of the changes to rainfall frequency and/or intensity as a result of climate change on the project. The assessment shall demonstrate due consideration of flood risks in the project design.	Section 7.5 Appendix H – Technical paper: Surface water, groundwater and flooding.

7.5.1 Methodology

The general approach and methodology adopted for this assessment includes:

- Compilation and review of available information, such as previous reports, 1:25,000 topographical maps, aerial photogrammetric survey and detailed field survey (where available), and hydraulic structure information. This included consideration of studies conducted by Cardno and SMEC Australia Pty Ltd on behalf of Shoalhaven City Council for floodplain management.
- Development of performance criteria based on the *NSW Floodplain Development Manual* (DIPNR, 2005) and specifications and technical criteria of the RMS.
- Estimation of peak flows for each catchment and for each major drainage infrastructure located along the project alignment based on the Probabilistic Rational Method (PRM) in accordance with *Australian Rainfall and Runoff* (Institution of Engineers, Australia, 1987).
- Provision for potential climate changes within the peak flow estimates to assess the impacts of a six per cent increase in rainfall intensity, in accordance with the Office of Environment and Heritage (OEH) guideline *Practical Consideration of Climate Change – Floodplain Risk Management Guideline* (Department of Environment and Conservation (DEC), 2007).
- Use of XP RAFTS and TUFLOW models developed for the Broughton Creek Floodplain Risk Management Strategy and Plan (Cardno, 2012) to assess major crossings of the project at Broughton Mill Creek, Bundewallah Creek and Connollys Creek floodplain immediately north of Berry. The TUFLOW two-dimensional model, developed by Cardno, covers an area of around nine square kilometres that corresponds to Berry and its immediate surrounds.
- Use of the HEC-RACs one-dimensional model and culvert hydraulic calculations to assess other water crossings at Broughton Creek, as well as Hitchcocks Lane Creek and Hitchcocks Lane Tributary.
- Each model considered the one, two, five, 10, 50 and 100 year flood event for the existing catchment (without the project) and the project.
- Assessment of other culvert crossings using either the Bentley Culvert master or HY-8 culvert hydraulic software packages.

In assessing the performance and/or impacts of the project, the following three scenarios have been considered:

- A representative scenario, which corresponds to the proposed drainage infrastructure (including culverts and bridges) perform as designed.
- A worst case scenario, which represents when all proposed drainage infrastructure becomes blocked during a flood event. The worst case scenario would be ameliorated by the implementation of appropriate mitigation measures, as outlined at **section 7.5.4**.
- The probable maximum flood (PMF) event, which has been assessed for emergency planning purposes only. The PMF is the largest flood that could conceivably occur at a particular location.

7.5.2 Existing environment

A full description of the waterbodies present in the project area is provided in **Section 7.4** of this environmental assessment. This section focuses on flooding matters.

Broughton Creek is a tributary of the Shoalhaven River which drains across the northern side of the Shoalhaven floodplain. Agriculture is the major land use in the vicinity of the project, with extensive areas utilised for dairy and cattle grazing. Downstream of the Berry township, the terrain is flat, swampy and generally below the level of the Broughton Creek levees. Tidal influence extends around 12 kilometres upstream of the point where Broughton Creek and the Shoalhaven River merge, to the vicinity of the Coolangatta Road bridge.

Floods inundate areas of rural land adjacent to Broughton Creek (refer to **Figure 7-15**). There are minimal structures located within the floodplain (1 in 100 year), with the majority of land utilised for agricultural purposes. During large flood events, the banks of the upper Broughton Creek are overtopped with flood waters taking the shorter routes across the floodplains and returning to Broughton Creek some distance downstream.

Berry and its immediate surrounds are also prone to flooding, with Broughton Mill Creek, Connollys Creek, Bundewallah Creek and Town Creek being the main sources of flood waters (SMEC Australia Pty Ltd, 2008). Town Creek presents a particular flood risk to a significant number of properties within Berry, which are impacted by the 100 year flood event.

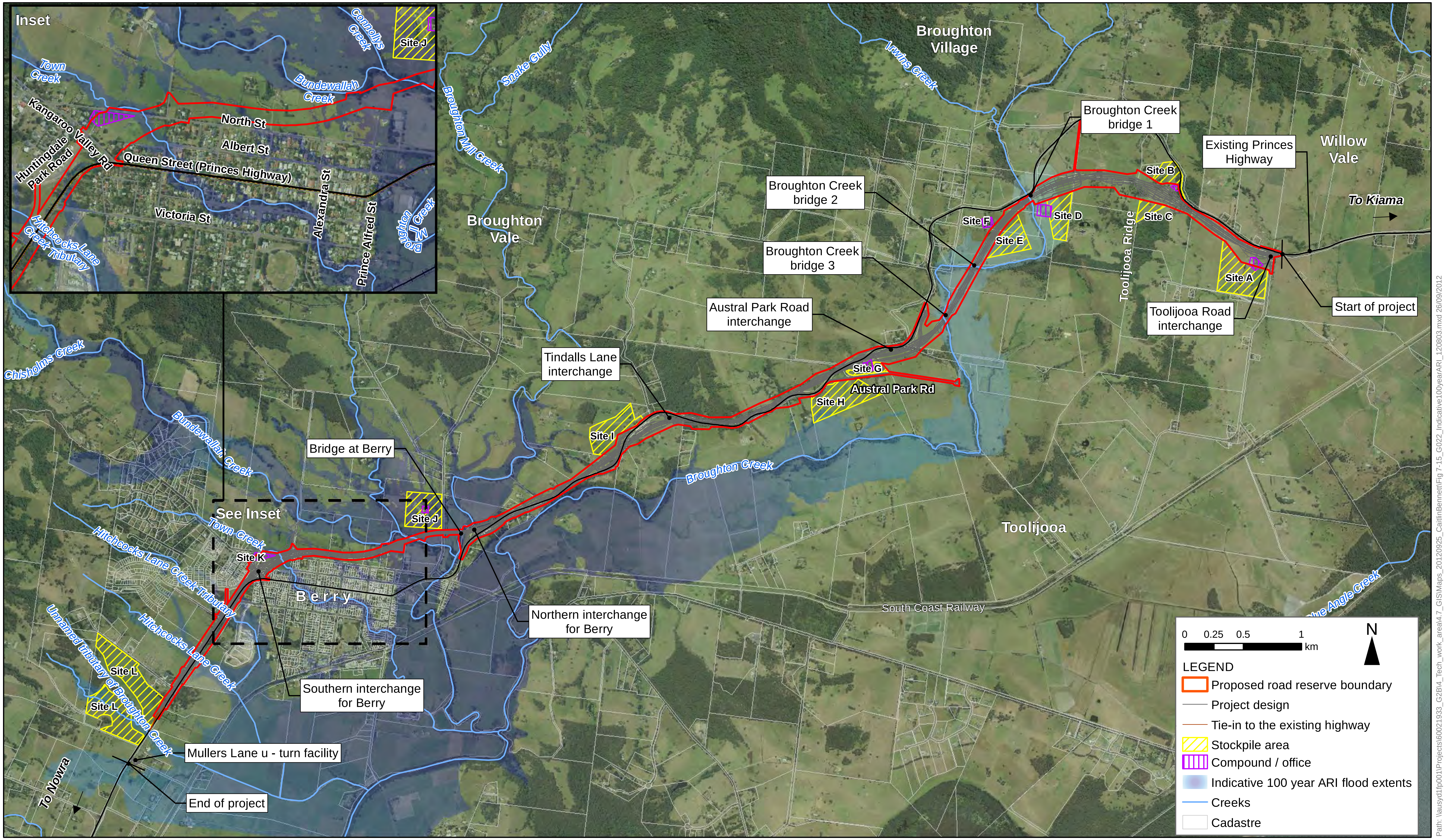

Figure 7-15 Indicative 100 year flood extents along the project alignment

Source: AECOM (2012), Cardno (2011), LPMA (2011)

The existing Princes Highway at Berry is also impacted during major flood events. At the highway crossing at Broughton Mill Creek and Hitchcocks Lane Creek, the highway is overtopped in a 1 in 2 year flood event. The highway is also overtopped as a result of flooding of Town Creek and Hitchcocks Lane Tributary during the 1 in 20 year flood event and 1 in 100 year flood event respectively. Overtopping of the highway during flood events can eliminate access for north and south bound highway traffic. Rural/residential areas near Hitchcocks Lane tributary can also be flooded during the 100 year flood event.

7.5.3 Assessment of potential impacts

Construction

A number of ancillary construction sites would be provided along the project alignment. Some of these sites would be located within the floodplain, including those that would be located near Broughton Creek and would be inundated during the 1 in 100 year flood event (refer to **Figure 7-15**). This includes stockpiling sites adjacent to Broughton Creek, the site located adjacent to Woodhill Mountain Road and the site located south of Schofields Lane. If inundated during a flood, material, fuel, chemicals and equipment stored in stockpile and compound sites could wash away. This could impact the surrounding environment, particularly adjacent waterbodies. Compounds and stockpiles could also affect flood flow paths, if inappropriately located.

Operation

Broughton Creek, Connollys Creek, Broughton Mill Creek, Bundewallah Creek, Town Creek and Hitchcocks Lane Creek have the potential to be impacted by the project. Culverts, bridges and embankments proposed as part of the project would potentially impact the existing flooding regime by:

- Reducing the capacity of the floodplain to store flood water due to the road being constructed on floodplains and taking up area previously available for water storage. This could lead to increases in the extent and level of flooding.
- Affecting the existing flood conveyance due to the restriction of waterways by bridges or culvert crossings. This could lead to increases in flood levels and velocities.
- Affecting flood behaviour through interfering with existing flow patterns, leading to the re-distribution of flows that could impact on flood levels, overland flow paths and flow velocities. This includes the piers of the bridge at Berry at Bundewallah Creek and the diversion of Town Creek flows to Bundewallah Creek, upstream of Connollys Creek.

These potential impacts to the existing flooding regime could provide negative or beneficial impacts to structures, roads and stock access due to increases or reductions in flood levels and flood extents.

High flow velocities resulting from flooding would also potentially lead to bed and bank scour and erosion both at and downstream of culvert outlets and bridge crossings. Such erosion could potentially lead to structural failure of infrastructure components and could lower water quality of nearby waterways.

The main objectives for the drainage design for the project are to provide the required flood immunity for the project and to minimise changes to the existing flood behaviour. The proposed road level, bridges and culverts have been designed to achieve the following:

- Flood immunity for the project during the 1 in 100 year flood event, with adequate freeboard.
- Flood immunity for local roads during the 1 in 20 year flood event.
- Cross drainage structures, such as culverts, to convey a 1 in 100 year flood event where surcharge is undesirable, or the 1 in 50 year flood event where surcharge is allowable.

The design of the project has taken into consideration the requirement to minimise potential flooding impacts on upstream and downstream properties. The design has also factored in an increase in rainfall intensity of six per cent to take into account the effect of climate change.

Details of each proposed bridge or culvert is provided in **Table 7-56**. **Figure 7-16** illustrates the catchments corresponding to **Table 7-56**.

The impacts of the project on flooding, and the performance of the proposed drainage were considered for both the representative scenario and the worst case scenario. The worst case scenario would be ameliorated by the implementation of appropriate mitigation measures, as outlined at **Section 7.5.4**.

During the representative scenario, flood water levels would be no higher than the existing situation between Broughton Creek bridge 3 and Tindalls Lane. However, changes in flood levels to varying degrees have been predicted at all the proposed major bridge structures at Broughton Creek, and north of Berry. Changes to flood patterns would also occur as a result of the proposed diversion of Town Creek. These impacts are considered individually in detail further in this section.

In terms of regional impacts resulting from the loss of flood storage capacity on the floodplain and/or in the flood fringe area, the project is not considered to have any significant effect on flooding in the Shoalhaven River. This is because the footprint of the proposed project is relatively small when considered against the total flood storage of the Broughton Creek floodplain. As identified earlier, localised flooding impacts would occur as a result of the project.

Table 7-56 Description of project structures

Catchment*	Infrastructure description	Waterway	Design flow (m^3/s)	Number of cells or piers	Span or diameter (m)	Length of bridges (m)	Comments
LB	Culvert drop structure	Unnamed ephemeral	2.7	1	1.5		Existing structure.
K	Bridge	Broughton Creek	646	6 piers	4	122	Broughton Creek bridge 1.
KA	Pipe	Broughton Creek	32	4	1.8		Pipe culvert at northern embankment of Broughton Creek bridge 1.
LA	Box culvert	Unnamed ephemeral	n/a	1	4.6h x 3.0w		Oversized to provide access therefore would not create upstream impacts.
L	Bridge	Broughton Creek	661	4 piers	3	76	Broughton Creek bridge 2.
M	Bridge	Broughton Creek	715	10 piers	6	200	Broughton Creek bridge 3.
N	Pipe culvert	Unnamed ephemeral	4.8	2	1.5		To provide drainage under the main carriageway and secondary roads on each side of the project.
O	Pipe culvert	Unnamed ephemeral	4.8	2	1.5		
P	Pipe culvert	Unnamed ephemeral	4.1	3	1.5		
Q	Box culvert	Unnamed ephemeral	48	7	1.8		A minimal water level impact is desirable due to existing upstream property. Dual use fauna underpass.
R	Box culvert	Unnamed ephemeral	9.0	1	1.5		Dual use fauna underpass.
S	Pipe culvert	Unnamed ephemeral	12.1	1	1.5		
TC	Pipe culvert	Unnamed ephemeral	0.6	1	1.5		
TA	Pipe culvert	Unnamed ephemeral	2.6	1	1.5		

Catchment*	Infrastructure description	Waterway	Design flow (m^3/s)	Number of cells or piers	Span or diameter (m)	Length of bridges (m)	Comments
TB	Pipe culvert	Unnamed ephemeral	0.7	1	1.5		
T	Bridge	Broughton Mill Creek/ Bundewallah Creek/Connollys Creek	896	54 piers	54	600	The bridge at Berry. Some piers may be located within Bundewallah Creek as a visual impact mitigation measure.
WA	Box culvert	Town Creek diversion under Rawlings Lane	33.9	5	2.4h x 2.1w		Designed to carry the 1 in 100 flood event with appropriate freeboard.
XA	Pipe culvert	Duck pond ephemeral	3.23	1	1.5		Culvert would provide flows to existing duck pond (Mark Radium Park).
X	Pipe culvert	Tributary to Hitchcocks Lane Creek	36.0	1	1.8		
Y	Pipe culvert	Hitchcocks Lane Creek	33.1	1	1.8		
Z	Pipe culvert	Unnamed ephemeral	2.0	1	1.5		Designed for the 1 in 5 year flood event. A lower design year has been proposed as it is a temporary structure that would be replaced as part of the Berry to Bomaderry upgrade proposal.

** Refer to* ***Figure 7-16*** *for the location of the catchments and Surface Water, Groundwater and Flooding Technical Paper* (AECOM, 2012) found at **Appendix H***. Catchment TB has not been shown on* ***Figure 7-16*** *.*

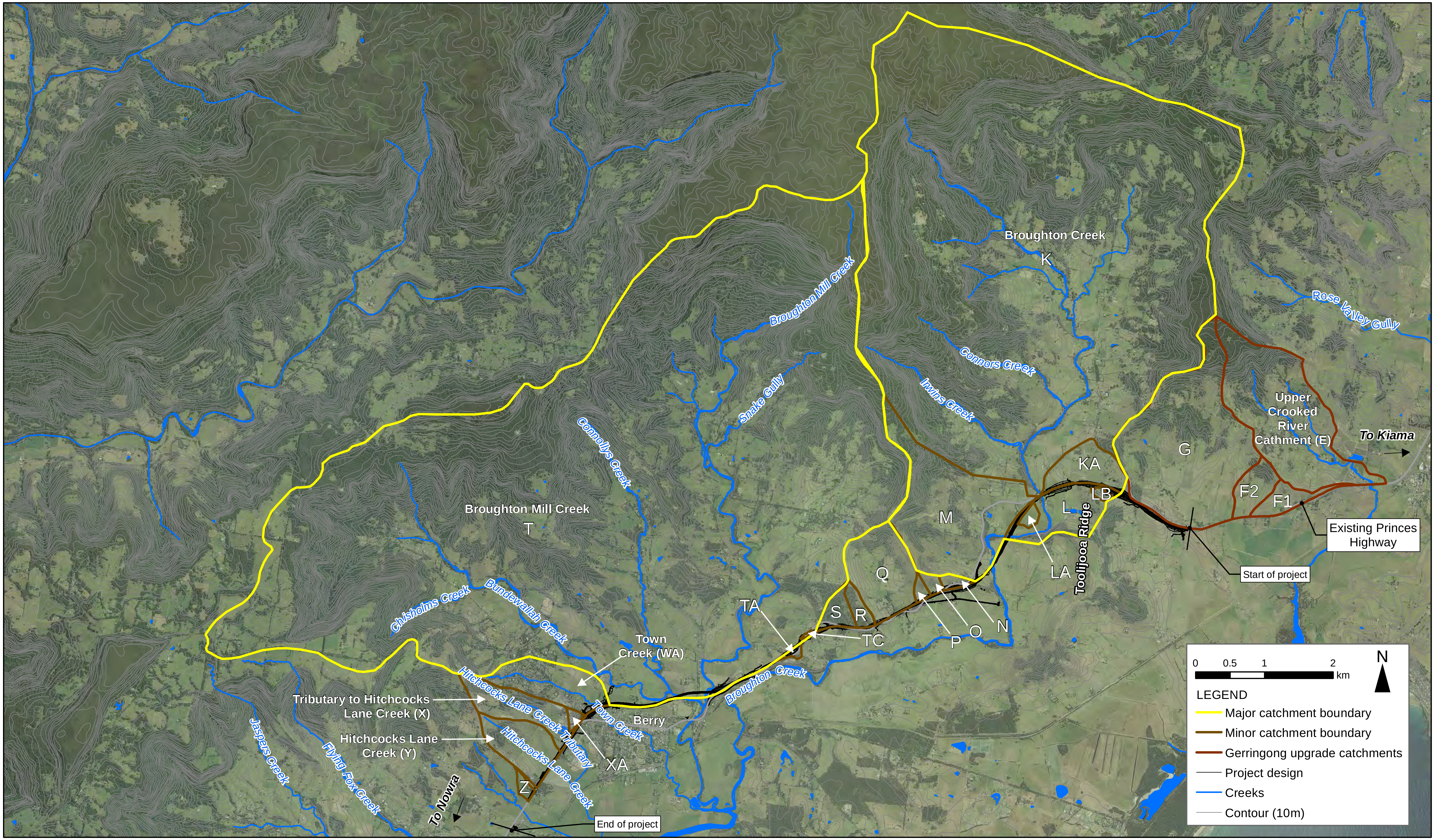

Figure 7-16 Catchment map (catchment lettering corresponds to Table 7-54)

Source: AECOM (2012), LPMA (2011)

Note: Catchment TB has not been shown on the figure for clarity reasons

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Broughton Creek

At Broughton Creek bridge 1, the project increases peak flood levels by 0.4 meters upstream of the bridge due to the bridge abutments extending into the existing 1 in 100 year flood extents. This would impact the flood immunity of the existing highway bridge, located 20 metres upstream at this location, with the potential for some localised overtopping of the existing highway bridge during the 1 in 100 year flood event. However, the project would provide the alternative flood immune access in this area. Otherwise, the impacts would generally be limited to agricultural land and due to the steep slopes at the edge of the floodplain, it would not result in any significant increase in the extent of the 1 in 100 year flood. Structures and accesses (other than the existing highway bridge) would not be impacted.

In the vicinity of the proposed Broughton Creek bridges 1 and 2, events above the 1 in 5 year flood event currently lead to the Broughton Creek banks being overtopped with flood waters flowing across the floodplain. The general flow paths for these events without the project are shown in **Figure 7-17**.

The proposed construction of the embankment linking Broughton Creek bridges 2 and 3 would split this overbank flow at Broughton Creek into two paths on the eastern and western side of the alignment, as shown in **Figure 7-18**. This change would impact flood levels by the following three mechanisms:

- The separated flow would produce turbulence and energy loss that would increase flood levels upstream.
- The placement of fill within the floodplain would potentially reduce the storage and capacity of the floodplain. However, this is deemed relatively insignificant due to the large width of the floodplain.
- The overland flow distribution across the floodplain would be altered with more flow along the eastern side of the alignment. This could increase flood levels upstream of Broughton Creek bridge 2 and along the eastern side of the embankment between bridges 2 and 3.

The area where there would be an increase in upstream flood levels, due to these mechanisms is shown in **Figure 7-18**. The change in flood levels during peak flood events has been estimated at 0.3 metres in the 1 in 100 year flood event. The impacts of the increase would be limited to agricultural land and would not impact on any structures or accesses. The impacts would also not result in any significant increases in the 1 in 100 year flood extents due to the steep slopes at the edge of the floodplain.

On the western side of the embankment upstream of Broughton Creek bridge 3, flood level impacts are expected to be minimal due to the diversion of more flood flows along the eastern side of the embankment. However, the embankment would change flow paths and could have localised impacts to rural pastures of properties along Broughton Creek where flows are redistributed.

A small tributary flows across a property immediately upstream of Broughton Creek bridge 3 and joins Broughton Creek around 200 metres downstream of the bridge. The Austral Park Road interchange with the existing Princes Highway could affect the flow patterns of this tributary and depending on the distribution of flows on either side of the embankment between bridge 2 and 3 could cause localised flood impacts to the property immediately upstream of bridge 3. The maximum impact immediately upstream of the bridge is around 0.1 metres. However, the impact at the residence itself is likely to be less.

Floodwaters flowing parallel to the embankment between bridges 2 and 3 also pose a risk to the structural integrity of the embankment due to scouring.

The construction of the embankments and bridges would also isolate an area of private land, which could pose a risk to stock and/or humans if there isn't the provision of stock refuge or evacuation routes. This is discussed further in **Section 7.5.4**.

At Broughton Creek bridge 3, the bridge abutments are on the fringe of the 1 in 100 year flood extents and therefore have minimal impacts on flood levels. No infrastructure or buildings would be impacted.

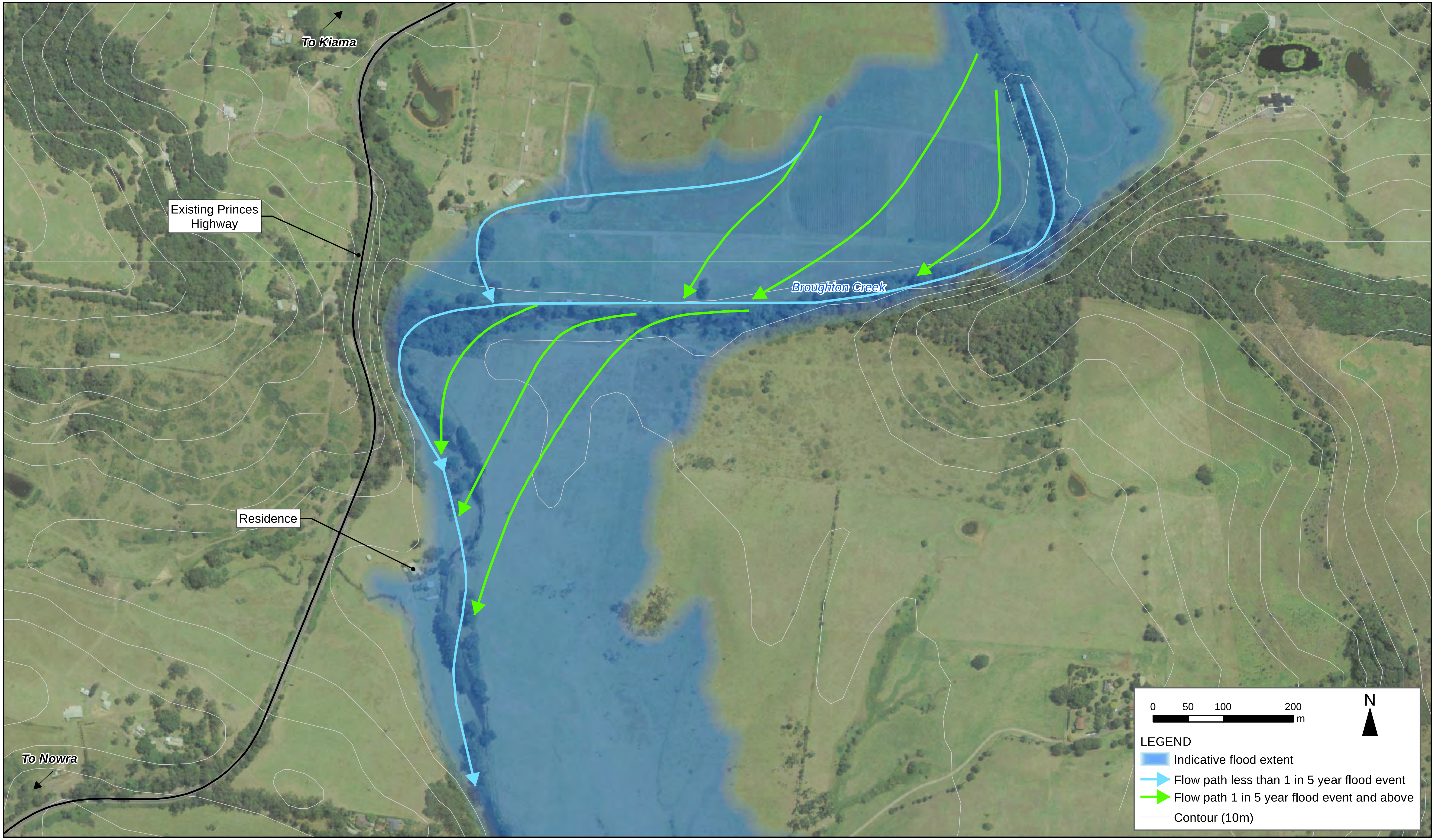

Figure 7-17 Broughton Creek overbank flowpaths without the project

Source: AECOM (2007), LPMA (2011)

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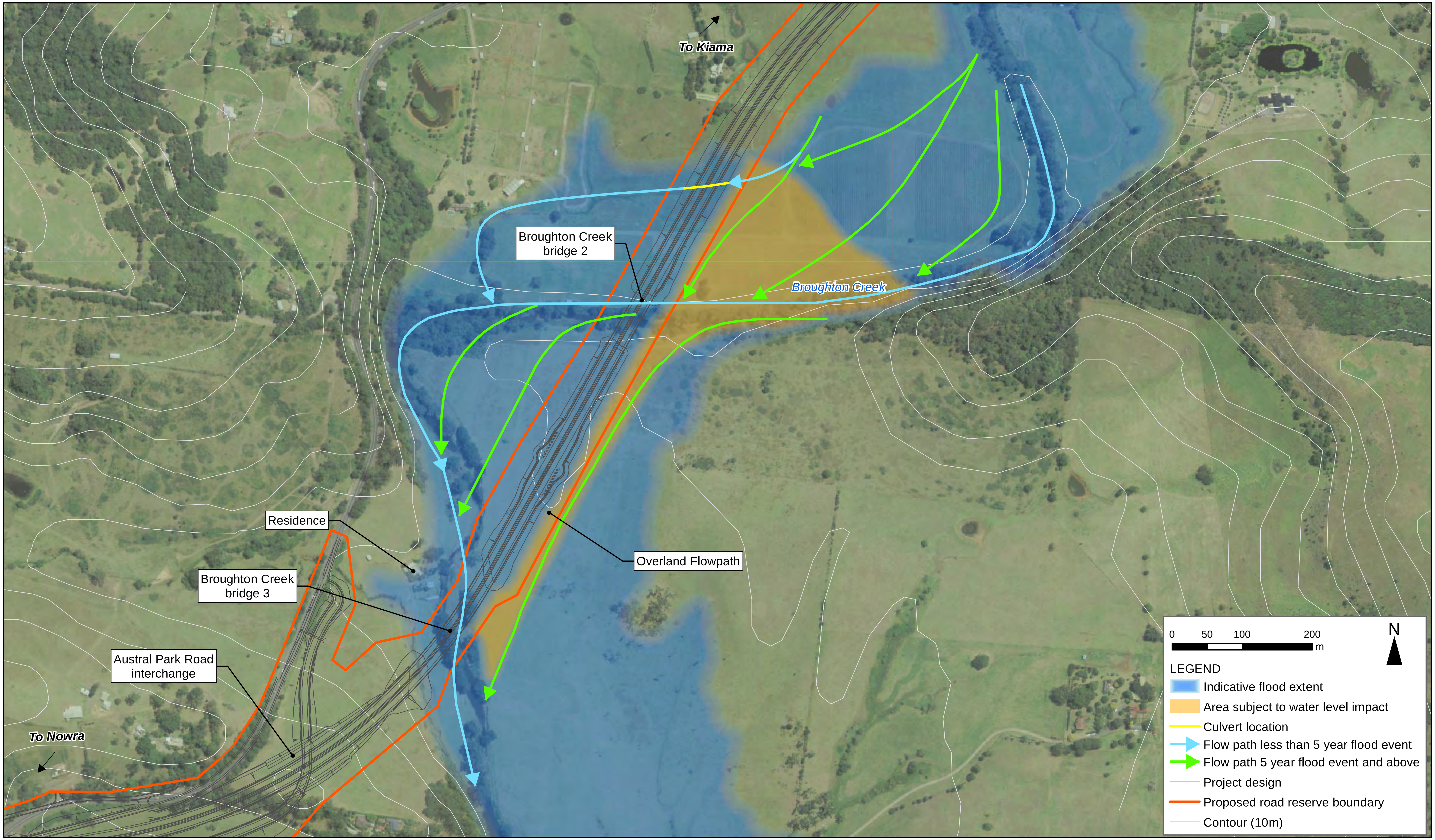

Figure 7-18 Broughton Creek overbank flowpaths with the project

Source: AECOM (2007), LPMA (2011)

Broughton Mill Creek, Bundewallah Creek and Connollys Creek

The bridge at Berry crosses the point where Connollys Creek, Broughton Mill Creek and Bundewallah Creek merge. The height of the bridge is constrained by the height of the ridge to the north of Berry and the requirement to provide adequate clearance for Woodhill Mountain Road. As such, the bridge itself would be considerably higher than the peak flood level of the 1 in 100 year event.

The southern bridge abutment would extend approximately 200 metres into the existing 1 in 100 year flood extents. Piers and water quality structures under the bridge would also be within the flood extents. As a result of these structures, an increase of 0.3 metres in flood levels is expected around the upstream side of the southern abutment (refer to **Figure 7-19**).

Immediately downstream of the project there would be an increase in flood levels due to the loss of floodplain storage, the concentration of flows through the structures of the bridge at Berry combined with the additional flows from Town Creek. As a result, 11 properties are potentially affected by changes in flood levels as a result of the project as shown in **Figure 7-19**.

Flood levels would increase by around 0.06 metres at property 1 and 0.08 metres at property 2 and 3 due to the loss of floodplain storage. This would reduce the freeboard at the buildings located at these properties. However, property 1 and 2 would still have a freeboard in excess of 0.5 metres. The freeboard at property 3 would be reduced from 0.18 metres to 0.11 metres. Other areas impacted by the increase in flooding are used for agriculture and are zoned for rural purposes under the Shoalhaven Local Environmental Plan (LEP) 1985. This land is already flood affected as it is within the existing 1 in 100 year flood extents and as such, the project would not be expected to alter the development potential of this land

Property 4 would be impacted by the combination of the diverted flows of Town Creek together within the concentration of flows through the bridge opening. No detailed floor level or ground level data is available for this property. However, the results of the flood model suggest that it experiences significant inundation around the building. Further survey data is required to confirm the susceptibility of the building floor level to flooding and if mitigation would be warranted.

Property 5 is also impacted by the diversion of Town Creek and changes in the flow regime at the bridge at Berry. As the floor level survey of property 5 shows that the building is elevated over three metres above the 1 in 100 year flood event, an increase of around 0.03 metres is not considered significant.

Properties 6, 7, 8, 9 and 11 are predicted to experience an increase of 0.03 metres due to the diversion of Town Creek. This increase is considered minor relative to the existing level of inundation during the 1 in 100 year flood event.

Property 10 is the sports amenity building at the Berry sportsground. Increases at this building based on the current project design are considered negligible or minor.

The impact on properties 1 to 10 needs to be considered in the context of the improvements within Berry that would be achieved through the diversion of Town Creek flows.

Town Creek

Town Creek currently causes flash flooding within Berry. The construction of the proposed highway around the northern side of Berry presents an opportunity to alleviate the existing flash flooding during large events for the residents of Berry and the wider community to the south of the highway, by diverting flows from the northern catchment of Town Creek into Bundewallah Creek. The location of the diversion is shown in **Figure 4-3** and is described in **Chapter 4. Figure 7-19** illustrates the potential change in flood levels as a result of the diversion.

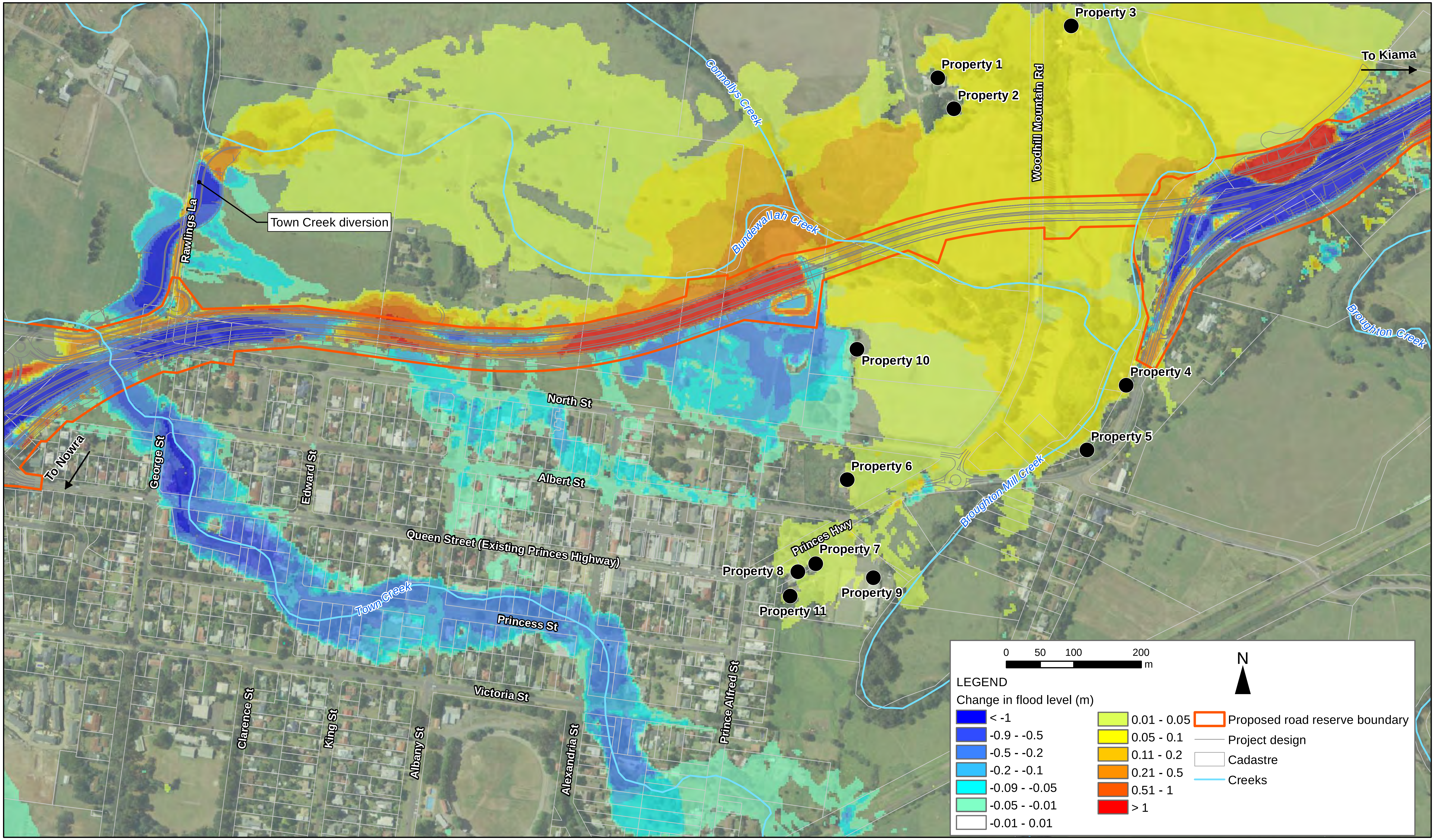

Figure 7-19 Changes in flood levels at Berry in the 1 in 100 year flood event

Source: AECOM (2012), Cardno (2011)

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The diversion channel would be sized to fully convey the 1 in 100 year flood flow event (with the required freeboard) from Town Creek into Bundewallah Creek. As such, there would be minimal flood level impacts along the diversion alignment. Further, the culverts constructed under Rawlings Lane, where the diversion would cross under the lane, would also be designed to convey the flows of a 1 in 100 year flood event without overtopping the lane. The diversion would also be designed to prevent high velocities (which can be a hazard during floods) and to limit scour in the diversion swale, at the culvert outlets and where the diversion connects to Bundewallah Creek.

The diversion of Town Creek has the potential for positive flood impacts for Berry, with a reduction in flood levels in a 1 in 100 year flood event through town in excess of one metre (refer to **Figure 7-19**). This would provide a significant benefit to many of the properties within Berry that currently experience flooding. Around 80 residences and structures would receive a flood depth decrease within Berry as a result of the Town Creek diversion and the predicted reductions in flood levels at North Street (in the vicinity of Albany Street). Of the 80 residences, nine properties that currently experience above floor inundation in the 1 in 100 year flood event would become flood free (but with a relatively small freeboard).

The diversion would result in a loss of 47 per cent of the total Town Creek catchment downstream of Berry. However, the loss of flood flows from the north of the highway would have little effect on water quality south of the highway. This is because the waterway is ephemeral and has been extremely degraded by agricultural and residential land uses. Impacts on aquatic ecology and riparian vegetation would also be minor, and are discussed further in **Section 7.3**.

North of Berry

The construction of the bypass north of Berry and the diversion of Town Creek has the potential to change flood levels immediately north, as shown in **Figure 7-19**.

For the agricultural property located immediately north of the project, there would be potential increases in flood levels. This would not impact the dwelling at the property. The area that would be impacted is used for agriculture, is already within the existing 1 in 100 year flood extents and is zoned for rural purposes under the Shoalhaven LEP. As such, the impact of the project would not significantly alter the already limited development potential of this area.

A new access to the property would be provided off Rawlings Lane as the project severs the existing direct access to North Street. This new access would be designed to provide the same level of flood free access to the property as provided by the current access via North Street.

Changes in flood behaviour for more frequent events

The proposed works would impact on flood behaviour during more frequent flooding than the 100 year flood event (such as the five year flood event and the 10 year flood event) through the same mechanisms as described above, namely:

- The narrowing of the floodplain caused by the embankment and abutment works at Berry Bridge.
- The diversion of flows from Town Creek into Bundewallah Creek.

Generally, the impacts experienced during more frequent events would be of a similar or lesser nature than those described for the 100 year flood event. During more frequent flood events the proposed embankment and abutment works associated with the bridge at Berry would encroach into flooded areas to a lesser extent compared to the 100 year flood. Consequently, this would be expected to result in smaller relative impacts on flooding during the more frequent flood events.

The diversion of flows from Town Creek into Bundewallah Creek would result in similar changes in flood behaviour during more frequent flood events as those described for the 100 year flood event. However these impacts would be relative to smaller flood extents and levels associated with these more frequent events

Worst case scenario

The worst case scenario considered involves the complete blockage of drainage infrastructure. There is a very low risk of this scenario occurring, due to the provision of appropriate environmental management measures and design standards. These measures are discussed further in **Section 7.5.3**.

The potential flood impacts, in terms of flood water flow behaviour, would be similar to those expected during a PMF (as discussed later in this section), but with lower flood volumes. During this scenario, flood waters would follow new overland flow paths where possible. There would also be increased scour and erosion due to increased flow velocities at partially blocked culverts or bridge openings. This could affect ecosystems, impact on flood levels and could ultimately affect the structural integrity of the road infrastructure. At certain locations, this could also impact on buildings, as discussed later in this section.

Regional flooding

The PMF is the largest flood that could conceivably occur at a particular location and is a theoretical maximum event.

During the PMF:

- The project would be overtopped by about three metres between Broughton Creek bridges 1 and 2. This would not change flood evacuation routes, as the existing highway is already overtopped during a PMF under existing conditions.
- An increase in flood levels up to two metres above existing levels upstream of Broughton Creek bridge 1 and at Broughton Creek bridge 2 could occur due to the raised road embankment blocking flood flows. No critical infrastructure would be affected, however dwellings on private properties could be affected.
- Drainage crossings, that convey much smaller flows, would have localised impacts during these events but would not affect any critical infrastructure.
- There would be minimal impact on Broughton Creek bridge 3 and the bridge at Berry due to the large bridge waterway openings and the elevation of the bridge above the floodplain.
- North of Berry, the project would reduce the flood risk to Berry as well as some access routes, such as the South Coast railway line.
- An increase in flood levels of around 0.2 to 0.6 metres to the north of the bridge at Berry. Downstream of the bridge, an increase of 0.15 metres is predicted.
- The diversion of Town Creek would provide flood relief to much of the Berry township, with a reduction of up to 0.9 metres at properties within Berry.
- Raised road embankments across the creeks to the west of Berry could result in flood impacts upstream of the project, especially to properties located below the proposed road level.
- At Hitchcocks Lane tributary, impacts would be limited to the area between the project and Huntingdale Park Road. At this location, the project would be three metres above the existing road level and the flood impacts could extend as far as the northern boundary of the property through which the creek runs.

The scope for managing flood impacts on surrounding development includes events up to and including the 1 in 100 year flood event. Events above the 1 in 100 year flood event, such as the PMF, are considered in terms of regional flood behaviour, such as impacts to critical infrastructure and emergency response planning.

It is generally not physically or economically possible to provide complete protection against the PMF. As flood mitigation measures are designed to be effective for events up to the 1 in 100 year flood event, the project would have impacts during the PMF. However, the consequence of flooding during the PMF even without the project will already be significant. Impacts of the project would not affect critical infrastructure and evacuation routes. Further, the project would reduce the flood risk to Berry. As a result, the project should not impact on emergency responses during a PMF.

Climate change

The project has been designed with an awareness of the potential for climate change and the range of potential impacts associated with the project factor in an increase in rainfall intensity of six per cent to take into account the effect of climate change.

The potential increase in rainfall intensities has been assessed as part of the flood modelling assessment (refer to the *Surface Water, Groundwater and Flooding Technical Paper* located at **Appendix H**), and has applied a sensitivity analysis for increases in rainfall intensity of 10, 20 and 30 per cent during a 1 in 100 year flood event.
The assessment focused in two key areas of the project, being the three bridges that cross Broughton Creek and the western abutment of the bridge at Berry (as it has the least amount of freeboard provided in its design). This assessment indicated that:

- For the three bridges at Broughton Creek, a 10 per cent increase in rainfall intensity would increase flood levels by around 0.1 metres and a 30 per cent increase would increase flood levels by 0.4 metres.
- At the western abutment of the bridge at Berry, a 10 per cent increase in rainfall intensity would increase flood levels by around 0.05 metres and a 30 per cent increase would increase flood levels by 0.13 metres.

The potential impacts due to climate change at some point in the future are at worst expected to reduce the freeboard which would normally be available. The changes are within the available freeboard provided at this location and no additional allowance for climate change is considered necessary.

7.5.4 Environmental management measures

Mitigation and management measures would be implemented to minimise or manage impacts to flooding. These mitigation and management measures are identified in **Table 7-57 a**nd have been incorporated in the draft statement of commitments in **Chapter 10**.

Table 7-57 Mitigation and management measures

Potential impacts	Mitigation and management measures
Construction	
Flooding of ancillary sites, stockpiles and hazardous substances	Store chemicals and fuel above the 1 in 100 year flood level where possible. Locate stockpiles and ancillary sites above the 1 in 100 year flood level where possible. If sites cannot be located above the 1 in 100 year flood level, locate them above the 1 in 20 year flood level subject to the implementation of appropriate mitigation measures to reduce flood risk and impacts on the surrounding environment (such as provision of a sufficient freeboard for storage areas). Provide appropriate bunding and scour protection where storage on floodplains is essential, such as in areas where bridge works are required.
Impacts of significant weather events	Implement on the ground environmental controls and response procedures to mitigate the potential impacts of significant weather events. Procedures typically include relocation of equipment or materials to higher ground, the implementation of erosion and sediment control shut down procedures, installation of additional protection measures, such as scour protection controls, and arrangements for the remediation and re-installation of these controls. Consider the use of automatic weather stations to provide a weather response monitoring program if flood prone ancillary sites are used. The Construction Environmental Management Plan would include a requirement to undertake appropriate checks of the Bureau of Meteorology weather bulletins.
Operation	
Increase in flood levels	Design drainage structures to allow for the natural flow of floodwaters and existing overland paths to be maintained post-construction where possible. Locate piers outside the main creek channels where possible, and minimise the intrusion of bridge abutments into the 1 in 100 year flood extent. Design bridges to minimise increases in flood levels and velocities where possible. Design and orient bridge piers to avoid the generation of turbulence and subsequent bed and bank erosion. Undertake rock shielding to protect steepened batters along the bank.

Potential impacts	Mitigation and management measures
	Use scour protection measures or energy dissipation measures along the bed and banks upstream and downstream of any bridge crossing or culvert where high velocities of surface water runoff cannot be minimised by design or by energy dissipaters. This may include flow velocity management measures to minimise erosion and scour in watercourses, or collection and management of runoff waters.
Flood impacts at Broughton Creek bridge 2 and Broughton Creek bridge 3.	Undertake further detailed modelling, and refine the bridge design during the detailed design stage of the project to minimise flood and scour impacts at Broughton Creek bridge 2 and Broughton Creek bridge 3. Provide a stock refuge at Broughton Creek bridge 2 by including access roads under the bridge to provide a flood evacuation route for stock. Alternatively provide mounds within the floodplain located in fringe areas or at the base of the proposed embankment. Stock refuge would be investigated further during the detailed design phase of the project.
Flood impacts at Berry	Confirm potential flooding impacts at Berry during detailed design and develop necessary mitigation measures. Based on project design, the following mitigation options would be considered, and where relevant: • Option 1 – Use of methods such as diversion swales, local bunding, flood proofing of buildings or other agreed solutions at properties 1, 2, 3 and 5 (subject to landowner agreement). Similar mitigation measures would be considered for property 4 should further floor survey data warrant a need for flood mitigation responses following detailed design. • Option2 – Consideration of changes during detailed design to the bridge design at Berry, retaining walls and associated drainage structures as an alternative to mitigation at properties 1, 2 and 3.
Climate change impacts	Provide a freeboard of around 0.5 metres minimum for Broughton Creek bridge 1, 2 and 3, as well as the bridge at Berry. Design the project with additional drainage capacity in order to provide flood immunity on the carriageway for a 1 in 100 year flood event. This would be based on a six per cent allowance for increased rainfall intensities. Use an adaptive approach to the management of the impact of climate change on flood behaviour and the performance of the highway drainage structures. If required, local adaptive measures for minor waterway crossings could include culvert amplification and/or lifting of the level of the highway.

7.5.5 Residual impacts

The potential impacts on property and structures during the 1 in 100 year flood flow event, and mitigation options to minimise the impact have been described in **Section 7.5.3** and **Section 7.5.4**. Specifically, residual flooding impacts would include:

- Reduced floodplain storage and alteration to the overland distribution of flood flows in the region of the Broughton Creek bridge 2 and Broughton Creek bridge 3. This would change flood levels in this region.
- Changes to flood hydrology at Town Creek, Bundewallah Creek and Broughton Creek from installation of transverse drainage structures.
- Increased flood levels at several properties due to the concentration of flows through the structures of the bridge at Berry and the addition of flows to Bundewallah Creek from Town Creek.
- Permanent diversion of Town Creek. The project would cause a residual loss of overall flows and flushing flows from Town Creek, which would potentially increase sedimentation in both Town Creek and Bundewallah Creek. However, the diversion would also have the positive residual impact of reducing flood impacts within Berry.

As part of the detailed design stage of the project, the flood impacts at these locations would be confirmed. This would inform the final mitigation options that could be implemented into the project design to minimise changes in flood levels and velocities, or mitigation options at properties (refer to **Table 7-57**). These mitigation options would be determined during detailed design and in consultation (where relevant) with the affected landowners.

7.6 Landscape character and visual amenity

This chapter provides an assessment of landscape and visual amenity impacts, which were nominated in the DGR's as a key environmental issue for the project. It represents a summary of the *Urban Design, Landscape Character and Visual Amenity Technical Paper* (AECOM 2012), which was prepared for the project with consideration of the DGR's.

The technical paper is provided at **Appendix I**. The relevant extract from the DGR's is presented below.

Director-General's requirements	Where addressed
***Landscape and Visual Amenity** - including but not limited to:*	
Assessment of visual significance of the area, including the escarpment and ridges and the township of Berry, and impact of the proposed alignment.	Section 7.6.2 Section 7.6.3 Appendix I
Design of the project (including noise barriers, retaining walls and landscaping) consistent with the existing (and desired) character of affected localities, including consideration of the Noise Wall Design Guideline (RTA 2006). The assessment should also consider highway/street lighting and the potential lightspill impacts on nearby residents.	Section 7.6.3 Section 7.6.4 Appendix I

7.6.1 Approach to assessment

The assessment of landscape character and visual impacts has been based on the RMS 'Environmental Impact Assessment Guidance Note: Guidelines for landscape character and visual impact assessment'. In accordance with these guidelines, the following assessments have been undertaken:

- Visual assessment – to evaluate the impact of the project on views.
- Landscape character assessment – to evaluate the impact of the project on the areas combined built, natural and cultural character or sense of place.

In order to assess landscape character and visual impacts, the study area was broken down into four landscape character units- Toolijooa Ridge, Broughton Creek, North Berry and Berry (refer to **Figure 7-20**). The landscape character units have been defined based on broadly similar characteristics or strongly defined spatial qualities. Three additional zones were also assessed within the Berry landscape character unit (refer to **Figure 7-21**). The three zones within the Berry landscape character unit were developed in order to determine the visual significance of the township of Berry and the visual connection between Berry and the surrounding ridges and escarpment.

The assessment of landscape character and visual impacts has been based on an evaluation of the sensitivity of the area and the magnitude of the project within the landscape character units. Sensitivity refers to the quality of the view and how sensitive that view or character is to the proposed change. Magnitude refers to the nature and scale of the project and its proximity to the viewer.

The combination of sensitivity and magnitude has been used to provide an overall rating of the landscape character and visual impact of the project as displayed in **Table 7-58**.

Given the close proximity of the project to Berry and the associated high level of expected impacts on town, CM+ were engaged to undertake a series of community workshops and an independent urban design study focused on the three zones identified in **Figure 7-21** (refer to **Appendix I**). Feedback gathered during that community engagement process was developed by the project team and carried through into the concept design and the mitigation measures documented in **Section 7.6.4** and **Appendix I**.

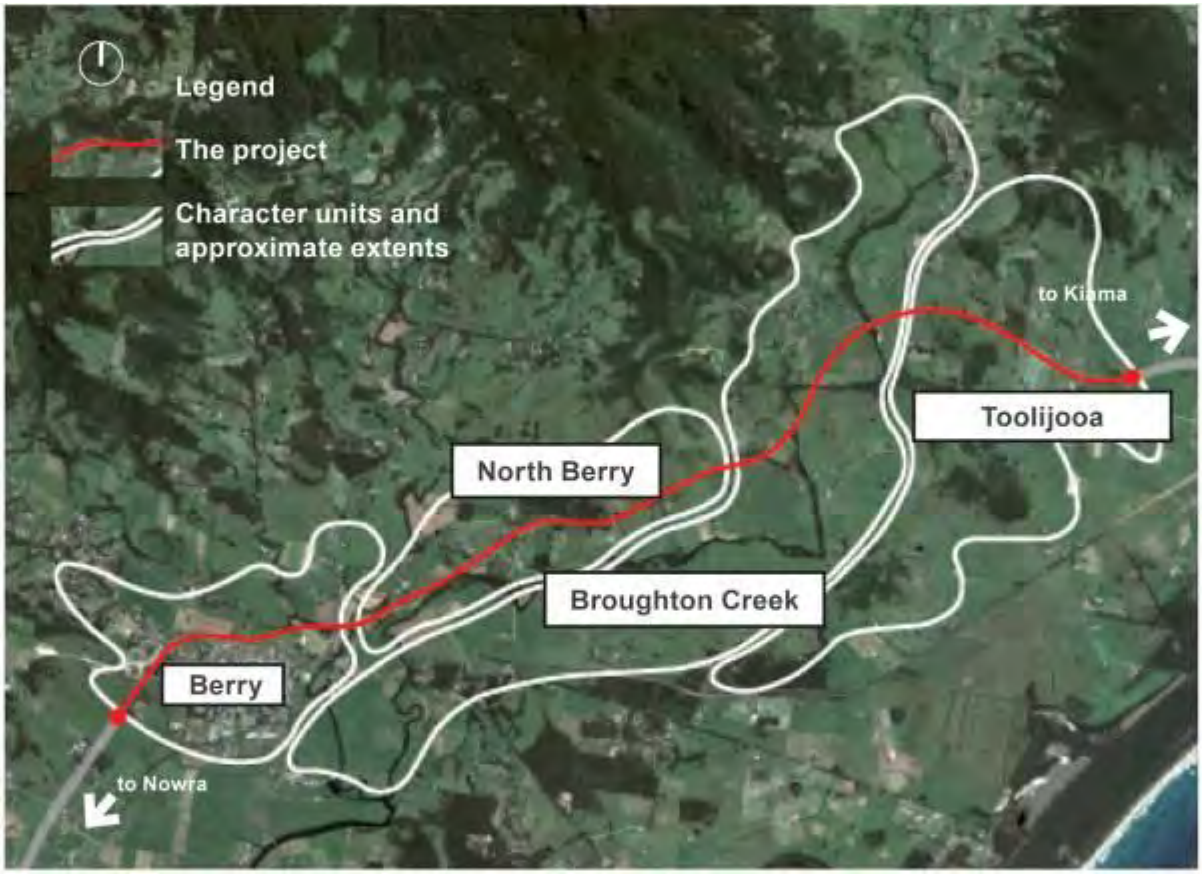

Figure 7-20 Landscape character units

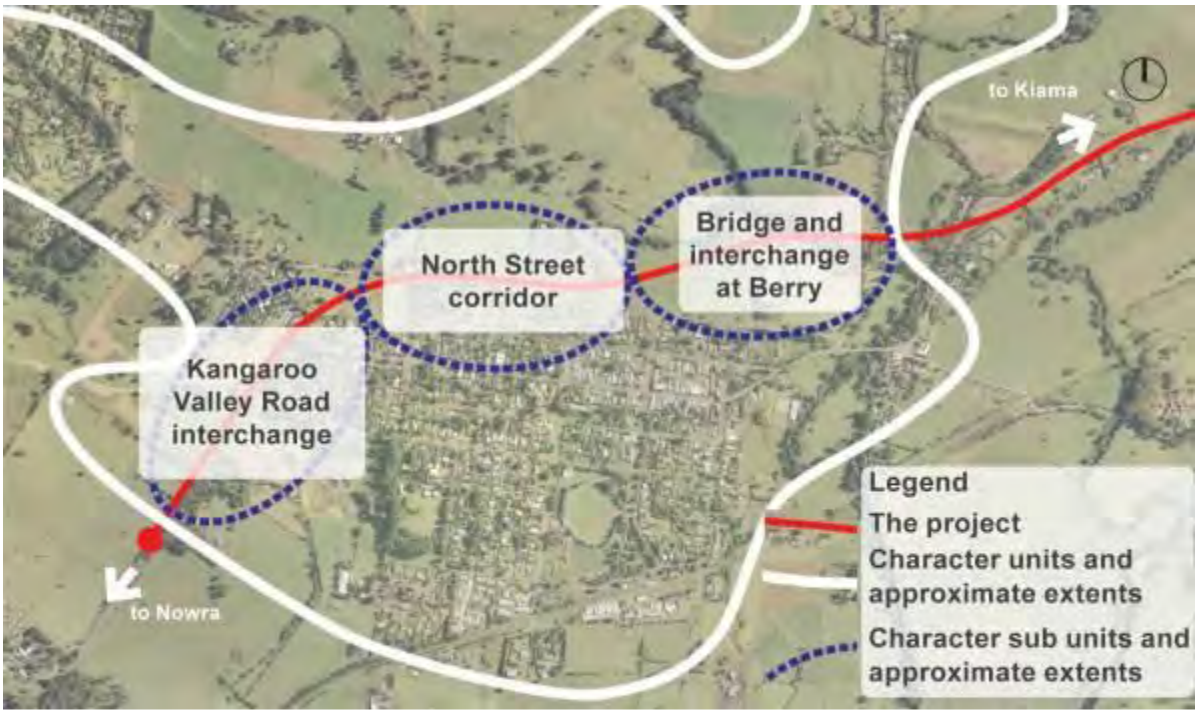

Figure 7-21 Landscape character sub units around Berry

Table 7-58 Landscape character and visual impact grading matrix

Potential visual impact		Magnitude of change				
		High	High to moderate	Moderate	Moderate to low	Low
Sensitivity	High	High impact	High impact	High to moderate impact	High to moderate impact	Moderate impact
	High to moderate	High impact	High to moderate impact	High to moderate impact	Moderate impact	Moderate impact
	Moderate	High to moderate impact	High to moderate impact	Moderate impact	Moderate impact	Moderate to low impact
	Moderate to low	High to moderate impact	Moderate impact	Moderate impact	Moderate to low impact	Moderate to low impact
	Low	Moderate impact	Moderate impact	Moderate to low impact	Moderate to low impact	Low impact

7.6.2 Existing environment

Within the study area, the combination of the natural and cultural landscape forms a uniquely rich and engaging experience for both residents and visitors. Local residents strongly identify with this landscape and its character and it is widely recognised as a key regional asset.

The naturally occurring interaction between ocean, beaches and rocky headlands, narrow coastal floodplains, rolling hills, ridges and escarpments has greatly influenced the settlement patterns and land use types. Within the study area the combination of the natural and cultural landscape forms a uniquely rich, engaging and tangibly enjoyable experience. This harmonious and attractive character is strongly identified with by local residents and widely recognised as a key regional asset.

To the north and west, the forested ridgelines and escarpment have a prominent visual presence from many locations along the existing highway and within Berry. The route constantly interacts with existing creeks and drainage lines with crossings proposed at a number of locations.

Corridors of native vegetation are often retained along drainage lines within the pastureland, while isolated native trees, particularly larger specimens of fig, remnant gum trees and cabbage tree palms, also occur. The extent of vegetation cover appears much more substantial when experienced from ground level rather than viewed in plan. This is likely due to the scale of the existing trees many of which are mature and greater than 15 metres in height.

The landscape surrounding the project is strongly influenced both culturally and physically by the dairy industry. This activity has defined the general pattern of vegetation clearance, defined rural boundaries with linear cultural planting and influenced the distribution of rural houses and farm buildings. The road user also experiences constantly changing open and enclosed views including broad expansive pasture, well vegetated portals and valleys.

As described below, the nature of the terrain varies greatly between the four landscape character units identified as part of the assessment. It changes from the steep slopes on Toolijooa Ridge through to the flat floodplain of Broughton Creek. From there it progresses to the quickly changing and variable slopes north of Berry and the flatter flood prone land around the northern and western sides of the Berry township.

Toolijooa Ridge

At the northern end of the project, the prominent Toolijooa Ridge extends south from Currys Mountain. Travelling south west from Gerringong, the open pastoral landscape extends to the north and south of the existing highway as it makes its way along the eastern spur of Toolijooa Ridge. Here, the ridge contains the view and separates the coastal plain from Broughton Creek to the west. Its landscape consists of a mix of agricultural land and larger tracts of remnant vegetation, including some endangered ecological communities (refer to **Section 7.3**). A small number of rural residences are located mostly to the north of the existing highway.

Broughton Creek

Broughton Creek and its adjacent floodplain form the valley between the western side of Toolijooa Ridge and the east facing lower slopes of the Cambewarra Range. The Broughton Creek valley runs in a north-south direction, while the creek line meanders back and forth across the floodplain. Its landscape is characterised by small rural residences, working farms, isolated clumps of native vegetation and cultivated landscapes featuring hedge rows and avenues set within broad open pastoral fields. The main areas of remnant vegetation, in particular mature River She Oaks, are located adjacent to Broughton Creek which divide the open pasture. Small rural dams punctuate the landscape and the patterns of land ownership, reinforced by fence lines, access drives and other cultural plantings, providing an organised element.

North Berry

To the east of the Broughton Creek floodplain, the existing highway follows the ridgeline that separates the Broughton Creek catchment to the east and the Broughton Mill Creek catchment to the west. The landscape is comprised of open rolling pasture, remnant trees and isolated stands of forest. The existing trees are large in stature, including a number of isolated large Eucalypts that provide scale and frame views. The terrain varies from undulating to steep, changing quickly in terms of slope steepness and aspect, and provides occasional views across the valley to the escarpment. Travelling south into Berry, the ridge line becomes narrower and views from the highway become more restricted.

Berry

Berry is recognised as the first truly rural town south of Sydney with its heritage visibly cultivated to promote it as a popular stopover point and destination for tourists and travellers. The town originally developed to support rural activities that were occurring within the area.

Presently the town can be considered as having three component parts, these being:

- Original Berry or the Pulman Street Heritage Precinct.
- Established Berry, the main area of town which follows the traditional street grid pattern.
- West Berry, where the majority of future expansion and growth is planned to occur.

The original section of Berry is a small area occupying a narrow piece of flood free land just upstream of the confluence of Broughton Creek and Broughton Mill Creek.

The established section of Berry occupies the area of flat land west of Broughton Creek, just above the flood prone pasture of Bundewallah Creek, Broughton Creek and Broughton Mill Creek. Its overall growth has been restricted to the north and south by the limits of flood immunity and to the south east by the railway line which forms a physical barrier.

The town is a rich mix of traditional European cottage style gardens, hedges and isolated deciduous ornamental trees set against a back drop of remnant large Eucalypts, and has a grid street pattern representative of early development patterns. The escarpment to the north and west is visually prominent and serves as a reference point within the town.

To maintain the town's growth, development is occurring on the higher ground along Kangaroo Valley Road to the north-west. Here, the landscape is less rigid in its street layout, and responds to existing topography.

North Street forms a clear boundary between the northern edge of town, the adjacent rural landscape to the north and the sports grounds to the east. This land is flood prone and has limited the expansion of the town in this area. North Street is well used by locals as a walking or jogging track and as a connection between the town and the Berry sports grounds and Camp Quality Memorial Park. It also experiences uninterrupted views across the rural landscape to the escarpment beyond.

Town Creek is a small ephemeral watercourse that passes directly through the Berry township. Upstream from the area around North Street, Town Creek is a degraded channel through highly modified grazing lands that only flows during or following a rainfall event.

To the north and west, the forested ridgelines and escarpment have a prominent visual presence from many locations within Berry. They provide a strong connection with the surrounding natural environment influencing the character of the town (particularly that of Queen Street). Views towards the flatter pastureland to the east and south east are generally less prominent from within town, being most evident from the southern and eastern fringes of town.

Mark Radium Park is located at the corner of the Princes Highway and Victoria Street and features a large stand of tall mature Eucalypt trees. The park incorporates a small pond, picnic tables, playground, public toilets and a small car park area.

7.6.3 Assessment of potential impacts

Assessment of the potential impacts considers a representative and a worst case level of impact. A representative scenario corresponds to the proposed mitigation measures and landscape treatments performing as designed. A worst case scenario considers the project being undertaken without the implementation of mitigation measures to minimise visual impacts or the mitigation measures implemented failing to achieve the desired outcome. The worst case scenario is unlikely to occur with the implementation of appropriate mitigation measures, as outlined at **Section 7.6.4**.

Construction impacts

Landscape character and visual impacts would be likely to occur as a result of construction activities undertaken in both offline and online sections of the project.

Offline works would involve active construction sites located in areas where there is currently no major infrastructure or interruptions to the landscape. Online works occur in areas where infrastructure or interruptions to the landscape currently exist, such as following the existing highway alignment. Offline construction would generally occur through the Toolijooa Ridge and Broughton Creek landscape character units and also to the north of North Street. Therefore, a reduction of visual amenity as a result of offline construction activities would be experienced by isolated and clustered rural residences and the properties in the vicinity of North Street.

Construction activities that would occur in online sections of the project would predominantly occur in the North Berry landscape character unit where the project tracks along the existing highway alignment. Works associated with online construction activities would result in reduced visual amenity for a small number of rural residences. However, changes to landscape character would be reduced given the presence of the existing highway in these sections. Online construction works would also impact on the users of the existing highway. Construction activities would be highly visible to road users and they may experience a loss of views to the adjacent rural landscape during the construction period.

Major project elements in the vicinity of Berry would be highly visible during the construction of the project. These elements would include the bridge at Berry, construction in the vicinity of North Street, including the diversion of Town Creek and the large cutting and bridge required at the southern interchange for Berry. Construction activities associated with these elements would have landscape character and visual impacts within Berry and also when Berry is viewed from the adjacent rural landscape. The extent of these impacts would be similar to those that would be experienced during the operation of the project and are discussed in more detail within the operational impacts section below.

During construction, the greatest visual impacts would occur following the removal of existing vegetation and prior to landscaping works. Construction works and new road infrastructure would be clearly visible during this stage of the project.

Visual amenity and landscape character impacts would also be associated with the establishment and operation of temporary ancillary facilities such as site offices and compounds during construction. The ancillary facilities would be located directly adjacent to the project alignment and in places, would increase the extent of the project footprint and clearing temporarily during construction.

Operational impacts

The project would result in landscape character and visual impacts along the length of the project. These impacts would be different for each landscape character unit as described below.

Toolijooa Ridge

The project elements that would impact landscape character and visual amenity in the Toolijooa Ridge landscape character unit include:

- New project alignment through Toolijooa Ridge.
- Large cut batters through Toolijooa Ridge.
- Introduction of new infrastructure into a landscape where there presently is none.
- Loss of vegetation due to corridor widening in online sections of the project.
- Lighting of interchanges and intersections.

The nature of the Toolijooa Ridge terrain means that the majority of the cutting would not be exposed to surrounding rural residents, minimising the visual impacts. The cutting would cross Toolijooa Ridge in a perpendicular fashion which would minimise the extent of exposure to the east and west, where most viewers are located. The cutting would be most visible to road users and a small number of rural residences. The introduction of new road infrastructure, the cutting and light spill from the Toolijooa Road interchange would impact the rural character of the landscape. This impact is expected to be moderate given the viewer distance from the project and the orientation of the project with respect to the location of the majority of viewpoints.

The scale of the project would cause a moderate change to the Toolijooa Ridge profile and form. However, the landscape character of Toolijooa Ridge would be maintained and it would continue to function as the divide between the immediate coastal landscape and the broader rural valley and escarpment.

The sensitivity to and magnitude of impacts arising from the project would be moderate. Therefore, the overall landscape character and visual impacts of the project within the Toolijooa Ridge landscape character unit would be **moderate**. These impacts would be diminished with the implementation of mitigation measures provided in **Section 7.6.4**.

An artist’s impression of the concept design within the Toolijooa Ridge landscape character unit is provided in **Figure 7-22**.

Figure 7-22 Artists impression of the concept design within the Toolijooa Ridge landscape character unit.

Broughton Creek

The project elements that would impact landscape character and visual amenity in the Broughton Creek landscape character unit include:

- Large embankments and bridges in a generally flat landscape.
- Three large bridges over Broughton Creek.
- Elevated embankments across the floodplain between bridges 1 and 3.
- Introduction of new infrastructure into a landscape where there presently is none.

The project would be highly visible within the landscape due to the elevation of the road deck across the whole Broughton Creek landscape character unit. Local residents with existing views of the Broughton Creek floodplain would experience a reduction in visual amenity. The removal of some existing riparian vegetation would further contribute to this reduction. However, the number of residences within this visual catchment is relatively low, as the catchment is contained by the western slope of Toolijooa Ridge and the slopes south of Broughton Village.

The visual dominance of the project within the Broughton Creek landscape character unit would result in landscape character impacts. These impacts would include the severance of some larger agricultural properties and a change in character of the Broughton Creek floodplain, which is historically a flat landscape. The three large bridges over Broughton Creek within this landscape character unit would increase the visual scale of the project as the structures would sit within this flat landscape and would be visually dominant in places. The bridges would be designed to provide refined and elegant forms in accordance with RMS Bridge Aesthetics Design Guidelines (RTA 2003).

There would be minimal visual amenity impacts associated with light spill in the Broughton Creek landscape character unit given that there would be no major intersections or interchanges and lighting is generally not proposed along the alignment, except at major intersections and interchanges.

The sensitivity of the landscape within the Broughton Creek landscape character unit to the impacts of the project would be high to moderate. The magnitude of the project within the area would be high to moderate. Therefore, the overall landscape character and visual impact of the project would be **high to moderate**. These impacts would be alleviated with the implementation of mitigation measures provided in **Section 7.6.4**.

An artist's impression of the concept design within the Broughton Creek landscape character unit is provided in **Figure 7-23** and an artist's impression of the refined and elegant form that would be applied to the design of the three bridges within this landscape character unit is provided in **Figure 7-24**.

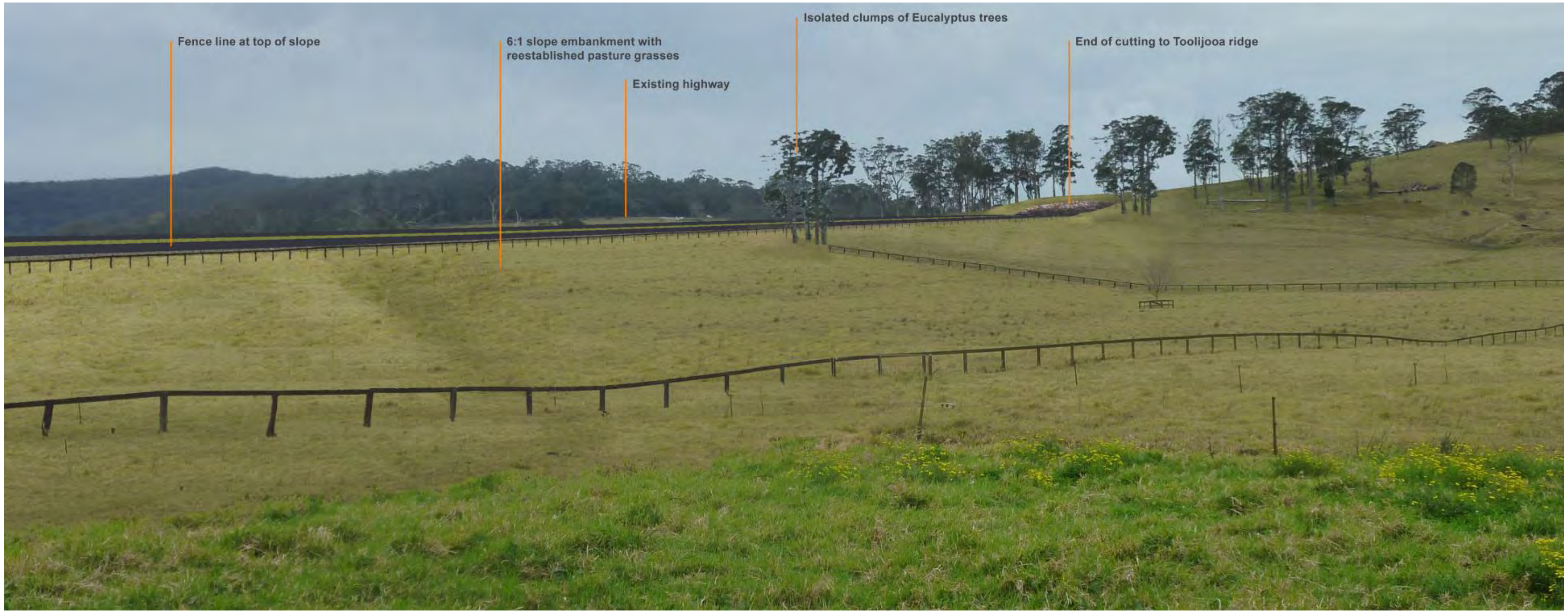

Figure 7-23 Artists impression of the concept design within the Broughton Creek landscape character unit.

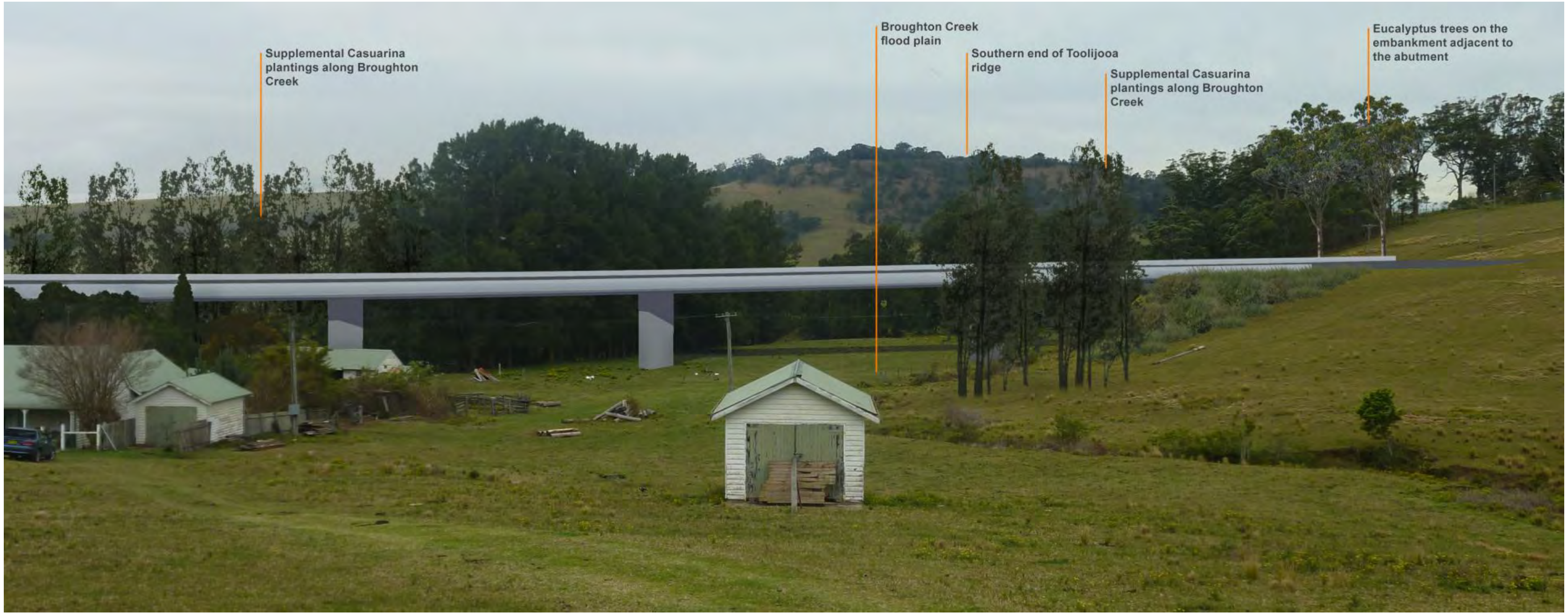

Figure 7-24 Artists impression of the proposed refined and elegant bridge form within the Broughton Creek landscape character unit.

North Berry

The project elements that would impact landscape character and visual amenity in the North Berry landscape character unit include:

- Areas of significant earthworks (cut and fill) required to improve the vertical alignment of the highway.
- Removal of vegetation along the roadside and along the ridgeline just north of Berry.
- Alteration to property accesses along the existing highway.
- Two bridges on the top of ridgelines at Austral Park Road and Tindalls Lane.
- Lighting of interchanges and intersections.

Through this section of the study area, the project would generally involve widening and straightening of the existing alignment, with the development of some large embankments that would quickly transition from cut to fill through the undulating landscape. Visual impacts associated with the project would generally be moderate given the screening nature of the landform, surrounding vegetation cover and the relatively low numbers of surrounding rural residences. Primary viewing locations would be from rural residences along Austral Park Road and Tindalls Lane. Widening along the existing alignment would require the removal of some screening vegetation, including large trees, which would result in the project being more visible, particularly to the south west.

There would be two grade-separated interchanges at Austral Park Road and Tindalls Lane which would increase the visual scale of the project. Both interchanges would include bridges on top of ridgelines and would be well lit for safety reasons. These features would be visually dominant in the surrounding landscape.

The North Berry landscape character unit would have moderate sensitivity to impacts associated with the project. The magnitude of the project within the area would be high to moderate. Therefore, the overall landscape character and visual impact of the project would be **high to moderate**. These impacts would be mitigated with the implementation of mitigation measures provided in **Section 7.6.4**.

An artist’s impression of the concept design within the North Berry landscape character unit is provided in **Figure 7-25**

Figure 7-25 Artists impression of the concept design within the North Berry landscape character unit

Berry

In general, Berry's character is one of an intimate historic rural town. This strong and well established identity suggests that a bypass of the town should enhance its visitor and resident experience, by eliminating through traffic and in particular heavy vehicles from the town centre.

However, the project would be highly visible when viewed from within Berry or from the surrounding area. The project elements that would impact landscape character and visual amenity in the Berry landscape character unit include:

- A bypass of Berry involving a large bridge and new alignment directly to the north of North Street.
- Introduction of new road infrastructure into a landscape where there presently is none.
- A new interchange requiring major earthworks and structure, located to the north east of town.
- A new interchange requiring a large cutting and bridge structure, located to the south west of town at Kangaroo Valley Road.
- Loss of existing vegetation, mainly around creek crossings.
- Noise attenuation structures, including planted earth formations, along North Street and near the northbound off-ramp at the southern interchange.
- The diversion of Town Creek to the north of the highway to connect into Bundewallah Creek.
- Partial loss of parkland area at Mark Radium Park.
- Closure and introduction of a new cul-de-sac at the western end of Victoria Street.
- Lighting of interchanges and intersections.

Key viewing locations for the project within Berry include North Street, the Berry sports grounds, around Kangaroo Valley Road, Huntingdale Park Road and Mark Radium Park. These areas are all key elements of the landscape identity and functionality of Berry and would be sensitive to the landscape character and visual impacts associated with the project. The Berry sports grounds and the Camp Quality Memorial Park, located just to the north-west of the playing fields, are focal points for the local community.

An artist's impression of the concept design with the proposed southern interchange for Berry to the left is provided in **Figure 7-26**.

Discussion of each of the sub units around Berry is provided below to inform the assessment of the impacts for the overall Berry landscape character unit.

Figure 7-26 Artist's impression of the concept design with proposed southern interchange for Berry to the left. **Image by CM+ (2012)**

The bridge and northern interchange at Berry

The design of this interchange, its footprint and elevation and the adjoining bridge has been the focus of community workshops undertaken as part of the independent urban design study. Feedback has been incorporated into the concept design. The development of this process and the urban design principles applied to this zone in response to community feedback are documented in detail in **Appendix I**.

As discussed in **Section 3.3.6**, during the evaluation of the preferred access options for Berry, the footprint and bulk of the northern interchange was reduced by consolidating the ramps and passing the northbound ramp exiting Berry under the highway. However, the interchange would still be relatively large in scale and located on a narrow ridge, meaning that it would likely be seen from a number of locations to the east, south and west. Significant earthworks would also be required for the construction of the interchange, resulting in changes to the visual landscape. An artist's impression of the interchange from the west is provided in **Figure 7-27**.

The bridge at Berry would introduce a large length of new road infrastructure into the visual landscape.

The elevated nature of the bridge would have a visual impact when viewed from the north and south. The visual dominance of the bridge would be somewhat reduced by existing vegetation along Bundewallah Creek, which would filter views towards the bridge when viewed from north of Berry (Bong Bong Road) looking south as displayed in the artist's impression in **Figure 7-28**. North of town, the longest unbroken view of the bridge would be from Woodhill Mountain Road as there would be minimal cover from existing vegetation. **Figure 7-29** provides an artist's impression of the bridge at Berry from Woodhill Mountain Road based on the current concept design.

The impacts outlined for the bridge and northern interchange for Berry are considered as part of the overall assessment for the Berry landscape character unit that follows the discussion of each of the sub units.

Figure 7-27 **Artists impression of the northern interchange concept design at Berry from the west.**
(Woodhill Mountain Road is approximately below the viewer)
Image provided by CM+ (2012)

Figure 7-28 Artist's impression of the concept design looking south from Bong Bong Road towards the bridge at Berry

Figure 7-29 Artist's impression of the concept design looking south from Woodhill Mountain Road towards the proposed bridge at Berry

North Street corridor

The project would impact on existing views and the landscape character of Berry and would alter existing pedestrian access and movement patterns along North Street. A 2.5metre shared cyclist and pedestrian pathway would be incorporated along the northern side of North Street and would provide for connectivity between Kangaroo Valley Road, the southern interchange and the sports ground at the eastern end of North Street. Landscape character impacts in this area would be reduced by maintaining as much open space as possible between North Street and the project and screening the required noise attenuation measures with a gentle embankment. This would maintain the visual connectivity to the escarpment and ridgelines where possible.

The noise attenuation measures associated with the project, which would be approximately four metres in height above the proposed highway road surface, would be visible from North Street and north-south cross-streets in Berry including Alexandra, Albany, Edward and George Streets. North Street is a quiet street that provides delineation between the edge of town, the rural foreground and the background of the escarpment. The closeness of the project and associated noise attenuation structures as well as the loss of the pastoral foreground and middle ground views would alter the character of North Street and surrounding streets on the northern side of Berry, and their relationship with the surrounding landscape. **Figure 7-30** shows the existing view from North Street looking to the north west. **Figure 7-31** shows the likely view from North Street following completion of the project and the extent of the visual and landscape character impact that would be expected following establishment of landscaping. **Figure 7-32** and **Figure 7-33** show cross sections of North Street at various locations with the project and noise attenuation structures.

The impacts associated with the diversion of Town Creek are expected to be low and would only be viewed from the north of the project by a limited number of receivers.

The proposed new infrastructure required for this zone has been the focus of the community workshops undertaken as part of the independent urban design study and feedback has been incorporated into the concept design. The development of this process and the urban design principles applied to this zone in response to community feedback are documented in detail in **Appendix I**.

The urban design principles applied to the zone have considered RMS' '' (RTA, 2006), as illustrated in **Figure 7-33**. This included consideration of the existing landscape context and character in the potential design solutions for the noise attenuation structures, the use of available space for design treatments (such as mounding), and the use of landscaping. The design of the noise attenuation structures are subject to further detailed design and consultation with the community. The design guidelines would continue to be considered as part of that process.

The impacts outlined for the North Street corridor are considered as part of the overall assessment for the Berry landscape character unit that follows the discussion of each of the sub units.

Figure 7-30 Existing view from North Street looking north west

Figure 7-31 Artist's impression of the concept design looking north west from North Street, following the establishment of landscaping. Image by CM+ (2012)

Figure 7-32 **North Street cross sections as illustrated in Figure 7-33**
Image by CM+ (2012).

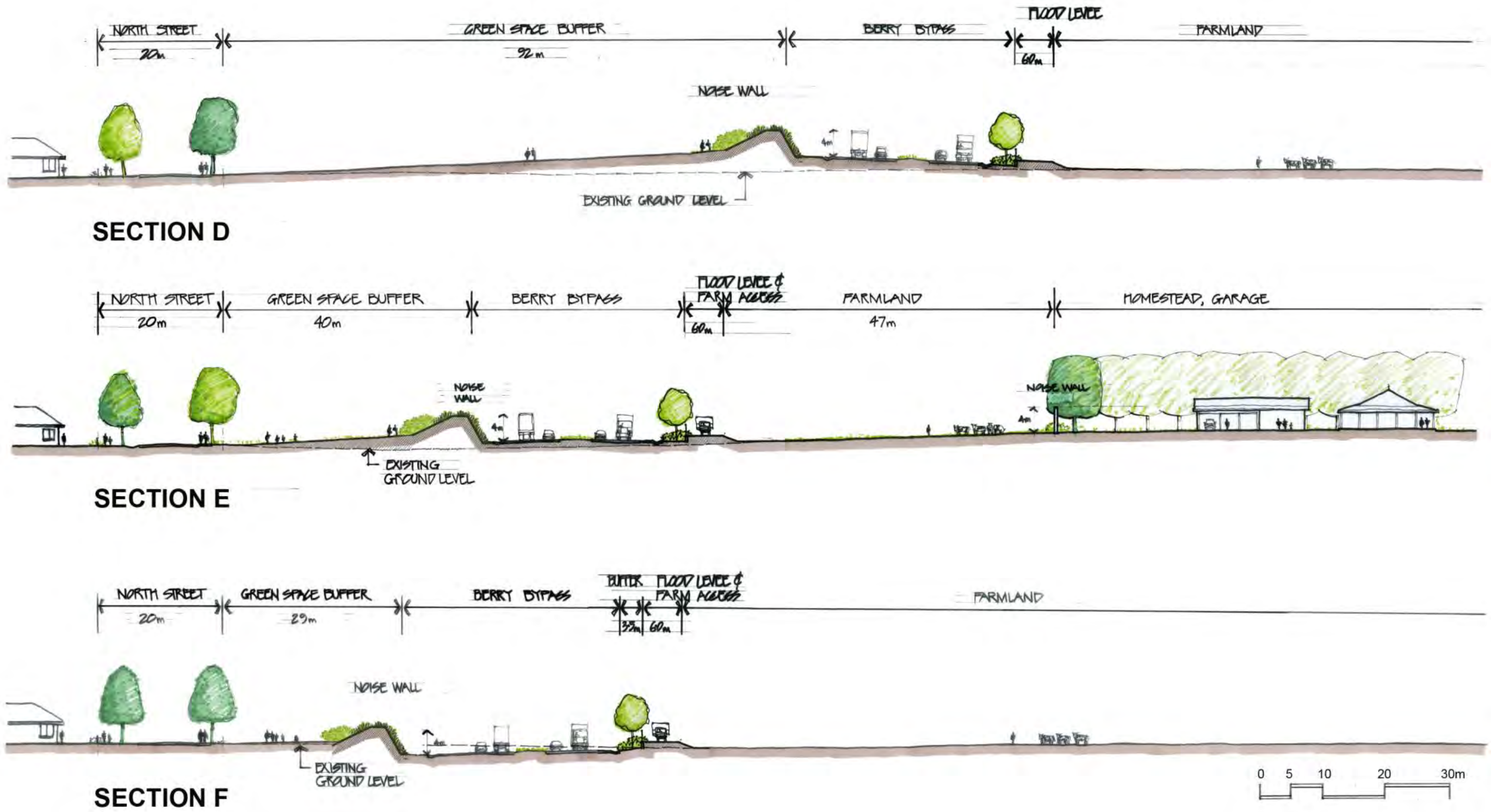

Figure 7-33 North Street cross sections with the project and associated noise attenuation structures
Image by CM+ (2012).

The ridges and escarpment

Given the value placed on the views to the ridges and escarpment by the Berry, further assessment was undertaken which particularly focussed on the landscape character and visual impacts associated with the northern side of Berry and the proximity of the project to the North Street corridor. This assessment looked at the visual connection from Berry to the ridges and escarpment and the visual significance of the township of Berry.

Interruptions to the views of ridges and the escarpment from Berry would be due to two main factors. Firstly, the introduction of the new highway infrastructure in the vicinity of North Street, which would be elevated in parts above the existing ground level. Secondly, noise attenuation measures would be required in the vicinity of North Street.

A relative impact intensity map has been produced to show the level of impacts on the views to the ridges and escarpments to the west and north of Berry (refer to **Figure 7-34**). When considered on a block by block basis the level of impact would decrease exponentially moving further south and further east. Based on the level of impact, three zones were established and the results of the assessment are provided below.

Figure 7-34 Relative impact intensity map for views to the ridges and escarpment from Berry

Zone 1 – North Street observer location A

For North Street residents in Zone 1, the sensitivity to and magnitude of change would both be considered moderate. With regard to the impacts on views to the ridges and escarpments and the visual significance of township of Berry, the project would:

- Have **moderate impact** for residents and users of the western end of North Street as the scale of the noise attenuation measures would alter the foreground and middle ground views. Views to the ridges and escarpments would only be partially impacted. A before and after comparison is illustrated in **Figure 7-35** below. It should be noted that observer view point illustrations do not show landscape and urban design treatments that would be implemented.

Figure 7-35 Before and after illustration from observer location A on North Street, zone 1

Zone 2 – Edward Street observer location B

For Albert Street residents and some residents of George, Edward, Albany and Alexander Streets in Zone 2, the sensitivity to and magnitude of change would both be considered moderate to low. With regard to the impacts on views to the ridges and escarpments and the visual significance of township of Berry the project would:

- Have **moderate to low impact** on residents and users of Albert Street. Views to the ridges and escarpment would not be impacted but foreground and middle ground views would experience some impact, especially at the north - south cross streets. A before and after comparison is illustrated in **Figure 7-36** below.

Figure 7-36 Before and after illustration from observer location B on Albert Street, zone 2

Zone 3 – Queen Street observer location C

For Queen Street residents and the commercial core in Zone 3, the sensitivity and magnitude of change would both be considered low. With regard to the impacts on views to the ridges and escarpments and the visual significance of township of Berry, the project would:

- Have **low impact** to residents, commercial property owners and users of Queen Street and the commercial core. A before and after comparison is illustrated in **Figure 7-37** below.
- There would be some impact associated with the loss of open vistas along the streets that run north-south as views would be partially obstructed by the noise attenuation measures. This would include views from Queen Street along George, Edward, Albany and Alexandra Streets. However, the impact would be relatively minor in comparison to the Zone 1 and 2 impacts. The overall landscape character and visual impact would be **moderate to low**.

Figure 7-37 Before and after illustration from observer location C on Queen Street, zone 3

Kangaroo Valley Road and southern interchange precinct

The southern interchange at the western end of North Street requires road, ramp, overbridge; and noise attenuation infrastructure of substantial scale. A substantial cutting that is up to seven metres deep is also required as the main alignment passes under Kangaroo Valley Road. Feedback gathered during community consultation suggests that this cutting has the potential to create a feeling of severance between established Berry and the developing areas of west Berry along the Kangaroo Valley Road corridor. **Figure 7-38** shows an artist's impression of the southern interchange and the new infrastructure required. The design of this significant infrastructure has been the focus of the workshops undertaken as part of the independent urban design study and feedback gathered through that community engagement process has been incorporated into the concept design.

A 20 metre wide bridge would be built over the main alignment incorporating formal pedestrian and cyclist access physically separated from the traffic lanes by planting and landscaping in order to lessen any sense of severance between Berry and the Kangaroo Valley Road corridor. It would maintain Kangaroo Valley Road at its current level in relation to the surrounding landscape in order to minimise landscape character and visual impacts. Two roundabouts, one at each end of the overbridge would be required.

Figure 7-39 and **Figure 7-40** show the expected views of this infrastructure from a road user viewpoint and from a pedestrian viewpoint on Kangaroo Valley Road. The development of the concept design and the urban design principles applied to this zone in response to community feedback are documented in detail in **Appendix I**.

Figure 7-38 Artist's impression of the Kangaroo Valley Road and southern interchange precinct. Image by CM+ (2012)

Figure 7-39 Artist's impression of the expected view from the southbound lanes of the upgrade to the Kangaroo Valley Road overbridge following the establishment of landscaping. Image by CM+ (2012)

Figure 7-40 Artist's impression of the pedestrian view looking east across the Kangaroo Valley Road overbridge following the establishment of landscaping. Image by CM+ (2012)

Victoria Street would be closed at its western end and a new cul-de-sac would be introduced to the landscape adjacent to Mark Radium Park. This closure is not expected to have a substantial visual impact, but it would affect the distribution of traffic in Berry as discussed in **Section 7.1**.

South of Berry, on the western side of the upgrade, between the southern Berry interchange and Schofield's Lane, a permanent variable message sign (VMS) that would service northbound traffic would be installed. The VMS would be around 6.1 metres in height and would be designed and constructed in accordance with the *Guidelines for the location and placement of variable message signs* (RTA, 2008). The VMS would introduce a large element into the visual landscape. There would be a requirement for the VMS to be located so that it is conspicuous, legible and comprehensible to road users. However, the impact to surrounding receivers would be minimal following the implementation of mitigation measures provided in **Section 7.6.4**.

The impacts identified for the Kangaroo Valley Road and southern interchange precinct are considered as part of the overall assessment for the Berry landscape character unit that follows.

Overall assessment of impacts for the Berry landscape character unit

Considering the impacts in each of the sub units around Berry as discussed above, the Berry landscape character unit as a whole would experience high to moderate sensitivity to impacts associated with the project and the magnitude of the project within the character unit would be high. Therefore, the overall landscape character and visual impact of the project would be **high**. These impacts would be managed with the implementation of mitigation measures provided in **Section 7.6.4**.

7.6.4 Environmental management measures

Mitigation and management measures would be implemented to avoid, minimise or manage landscape character and visual amenity impacts. These mitigation and management measures are listed in **Table 7-59** and incorporated in the draft statement of commitments in **Chapter 10**.

Table 7-59 Mitigation and management measures

Potential impacts	Mitigation and management measures
Construction	
Loss of visual amenity	Avoid excessive clearing of vegetation by clearly demarcating areas to be cleared. Progressively stabilise cut batters and exposed areas with appropriate sprayed seed mixes for cover crop and install landscape plantings as soon as practicable. Use fast-growing species such as wattles for vegetative screening for permanent ancillary facility sites and other facilities.
Loss of landscape character and visual amenity of the project area due to unsuccessful revegetation	Review plantings and supplement where necessary. Produce and implement an approved stockpile management procedure to maintain soil and seed health; and minimise weed and dust issues.
Operation	
General loss of landscape character and visual amenity along the project	With reference to the mitigation measures and reference design parameters in **Appendix I**: Utilise RMS owned land along the corridor to facilitate flattening out of batters. Replace, at a minimum, any tree and/or large shrub planting lost as a result of the project in this corridor.

Potential impacts	Mitigation and management measures
	Integrate new vegetation with the existing landscape character by using culturally relevant species planted to existing patterns. Engage with the local community to gather feedback as the design develops and foster broader community support and ownership for the design outcome. Define the transition points between the highway and local street networks, through landscaping and road design. Design retaining wall structures, noise attenuation, cut embankments, fill slopes and bridges and associated elements in accordance with the Urban and Landscape Design Strategy. Engage with adjacent land owners to determine whether early works mitigation (for example landscape planting) can be achieved to help reduce or soften the visual impacts of the upgrade. Ensure the detailed design meets the minimum reference design requirements of the following project components: • All bridges within the project, with consideration of the 'Bridge Aesthetics Design Guidelines' (RTA, 2003). • Noise attenuation measures along the length of the project, in accordance with the 'Noise Wall Design Guideline' (RTA, 2006). Light all intersections to 'flag' standard in accordance with *AS/NZS 1158 Code of Practice for Public Lighting* and direct the light source towards carriageway only.
Visual impacts at specific locations and precincts – Toolijooa Ridge	With reference to the mitigation measures and reference design parameters in Appendix **I**: Ensure close to vertical cuttings and steepened rock batters at the base of cuttings, where possible, to minimise the overall footprint of the cutting. Keep the cutting benches (the flattened parts of the cutting that provide stability) at a consistent profile and in parallel with the vertical geometry of the highway. Provide a smooth, rounded edge at the top of the cutting and re-establish pasture grasses and scattered trees. Establish vegetation to the edge of the cutting to provide visual integration with the adjacent landscape and to satisfy environmental requirements for fauna connectivity. Enclose the view at the end of the cutting to frame views.
Visual impacts at specific locations and precincts - Broughton Creek	With reference to the mitigation measures and reference design parameters in **Appendix I**: Decrease the apparent height of the large embankments at the interface between Toolijooa Ridge and Broughton Creek, where feasible. The embankments could be flattened by widening the project footprint, which would be returned to pastureland following construction.

Potential impacts	Mitigation and management measures
	Design the three bridges over Broughton Creek to provide refined and elegant forms in accordance with RMS Bridge Aesthetics Design Guideline. Flatten batters across the floodplain to 10:1 through 4:1 instead of 2:1, to utilise surplus spoil from Toolijooa Ridge and re-establish pasture landscape as close to the road edge as possible. Re-establish riparian vegetation adjacent to the bridges to maintain the viability of existing fauna corridors, to integrate bridges into the surrounding environment and to maintain the portal experience, transitioning from open pasture to the closed riparian vegetation. Re-establish pasture grasses and rural fencing to top of embankment slopes. Plant isolated clumps of Eucalypts consistent with the immediate local context.
Visual impacts at specific locations and precincts – North Berry	With reference to the mitigation measures and reference design parameters in **Appendix I**: Revegetate areas of existing highway left as residual landscape. Reinstate vegetation along cuttings and embankments to help reduce the visual scale of the works, particularly close to ridge lines. Establish the appropriate screening for adjacent rural residences. Plant single or small clumps of eucalypts to reinforce the broader landscape pattern. Provide a smooth, rounded edge at the top of cut slopes. Reinstate pasture grasses on flattened embankments where feasible. Use farm style fencing in residual spaces between the existing highway and the project. Integrate the water quality basins and swale systems within the landscape. Provide consistent detailing for the two over bridge structures. Use vegetation to soften the sudden transitions from cut to fill slope.
Visual impacts at specific locations and precincts – Berry (general)	With reference to the mitigation measures and reference design parameters in **Appendix I** and the findings of the CM+ Urban Design Study, also in **Appendix I**: Define the town entry at the northern and southern interchange for Berry with culturally relevant plantings. Provide an appropriate entry statement at the northern interchange for Berry and the roundabout at the intersection of Woodhill Mountain Road and the existing highway (such as the Alexander and David Berry memorial).

Potential impacts	Mitigation and management measures
	Ensure that the scale and rhythm of noise attenuation, street lighting and ornamental tree planting reflect the Berry street grid and unify the existing local road network with the new bridges and roundabouts. Design noise attenuation structures in accordance with 'Noise Wall Design Guideline' (RTA 2006). Consider and integrate the project with the overall pedestrian access mobility plan (PAMP) for Berry. This would include considering a shared path link from the western end of North Street through to the southern interchange at Berry and allowing for a 2.5 metre wide shared path on both sides of the Kangaroo Valley Road bridge.
Visual impacts at specific locations and precincts – the bridge at Berry	With reference to the mitigation measures and reference design parameters in **Appendix I** and the findings of the CM+ Urban Design Study, also in **Appendix I**: Reinforce existing vegetation, such as casuarinas and eucalyptus, to integrate the bridge within the landscape and minimise the lengths of unbroken façade, particularly around Bundewallah Creek. Provide minimum reference design requirements for the bridge structure. Design the bridge with as simply and elegantly as possible so that it best complements the surrounding landscape setting. Minimise the number of columns for the bridge by maximising the span length where reasonable and feasible. Minimise the loss of vegetation at the point where the bridge crosses Bundewallah Creek.
Visual impacts at specific locations and precincts – North Street	With reference to the mitigation measures and reference design parameters in **Appendix I** and the findings of the CM+ Urban Design Study, also in **Appendix I**: Consider the town grid layout and view corridors of the north-south streets in the layout and rhythm of noise attenuation measures (the form of which would be determined through detailed design in consultation with the local community). Use extensive mounding with maximum slopes of 2:1 at pinch points with a preferred maximum of 4:1 to reduce the overall free standing height of the noise walls. Blend the existing landscape up to the edge of the highway in the gazetted North Street road corridor by reducing the steepness of the embankments. Use clumped and or isolated vegetation to the top of mounding to break down the visual dominance of the road embankment and noise attenuation measures. Use plantings on the northern side of the noise attenuation that are consistent with RMS planting guidelines and include canopy and ground cover species consistent with the local landscape character.

Potential impacts	Mitigation and management measures
	Use plantings on the southern side of the noise attenuation that are consistent with the existing character along North Street.
Visual impacts at specific locations and precincts – Kangaroo Valley Road and southern interchange precinct	With reference to the mitigation measures and reference design parameters in **Appendix I** and the findings of the CM+ Urban Design Study, also in **Appendix I**: Consider the broader context of the project including the roundabouts and the connections into Queen Street and Kangaroo Valley Road. Allow for a 2.5metres wide shared path on both sides of the bridge that connects with the shared path along the North Street corridor and the broader PAMP for Berry. Include a planted verge between the shared path and the traffic lanes on both sides of the Kangaroo Valley overbridge. Ensure that lighting on the Kangaroo Valley Road bridge is of a scale that is consistent with the local road network and not the highway. Design plantings within roundabouts and landscaped verges to the Kangaroo Valley Road bridge that reinforce the landscape garden character of Berry.
Visual impacts associated with the VMS	With reference to the mitigation measures and reference design parameters in **Appendix I**: Locate the VMS on a gradual downslope between chainage 18650 and 18700 (as shown in **Figure 3.14** of the *Urban Design, Landscape Character and Visual Amenity Technical Paper* at **Appendix I**) to: • Reduce any affects associated with silhouetting against the sky. • Avoid impacts on any vistas or views to the ridges and escarpment to the north and north west. • Maximise the distance of the VMS from the southern interchange for Berry and signage and lighting associated with the Kangaroo Valley Road precinct.

7.7 Aboriginal cultural heritage

This chapter provides an assessment of Aboriginal cultural heritage, which was nominated in the DGRs as a key environmental issue for the project. It represents a summary of the *Aboriginal Cultural Heritage Technical Paper* (Navin Officer Heritage Consultants (NOHC), 2012), which was prepared for the project with consideration of the DGRs.

The technical paper is provided at **Appendix J**. The relevant extract from the DGRs is presented below.

Director-General's requirements	Where addressed
Aboriginal Heritage *- including but not limited to:*	
• *An assessment of the project on Aboriginal cultural heritage consistent with the draft Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation (DEC, July 2005), specifically considering artefacts, potential archaeological deposits and landscape cultural values. The EA must demonstrate effective consultation with indigenous stakeholders during the assessment and on developing mitigation options (including the final recommended measures). The EA must describe the actions that will be taken to avoid, mitigate or offset impacts.*	Section 7.7.1 – Section 7.7.4 Technical Paper J: Aboriginal Cultural Heritage Assessment

7.7.1 Approach to assessment

The Aboriginal cultural heritage assessment included:

- Consultation with Aboriginal stakeholders and the local Aboriginal community.
- A review of relevant literature and databases.
- Field survey.
- Archaeological test excavation.
- Provision of mitigation measures based on the results of the investigation and the anticipated impacts of the project.

Aboriginal consultation

The DGRs for the project require RMS to undertake an assessment consistent with the 'draft *Guidelines for Aboriginal Cultural Heritage Impact Assessment and Community Consultation* (NSW Department of Environment and Conservation (DEC) July 2005)'. The draft Guidelines refer to the '*Interim Community Consultation Requirements for Applicants* (NSW Department of Environment and Climate Change (DECC) 2004)' for guidance on undertaking Aboriginal community consultation.

In mid- 2010, the '*Aboriginal cultural heritage consultation requirements for proponents* (2010) published by the Office of Environment and Heritage (OEH superseded the *Interim Community Consultation Requirements for Applicants* (DECC, 2004). Following consultation with NSW Department of Planning and Infrastructure (DP&I) and OEH, RMS agreed to undertake consultation and assessment in accordance with the new requirements to ensure a comprehensive and up-to-date approach. This involved the re-advertisement for Aboriginal stakeholders (in addition to persons already part of the Aboriginal focus group (AFG)) and satisfying the consultation periods with registered stakeholders at various stages in the assessment as specified in the guideline.

Consequently, for this project, RMS has undertaken Aboriginal community consultation and investigation consistent with the '*Aboriginal cultural heritage consultation requirements for proponents*' (NSW Department of Environment, Climate Change and Water (DECCW), 2010).

Consultation with the Aboriginal community has occurred as part of the project and as part of the wider Princes Highway upgrade between Gerringong and Bomaderry. An AFG was originally formed as part of investigations for the Princes Highway upgrade between Gerringong and Bomaderry in February 2007. The AFG consisted of all Aboriginal parties who registered an interest in being consulted regarding the project.

Aboriginal consultation activities that have been conducted to date include 13 AFG meetings, a bus trip and field inspection (carried out in June 2009 to visit and review areas where investigative works were proposed) and participation of AFG representatives in test excavations. AFG meetings will continue throughout the project.

Aboriginal stakeholder consultation was undertaken having regard to the methodology for the assessment proposed by NOHC. A copy of the proposed methodology was posted to all registered Aboriginal stakeholders by RMS on 8 July 2011 with an invitation to provide a written response by 5 August 2011. An AFG meeting was also held by RMS on 14 July 2011 to discuss the proposed methodology. The minutes of this meeting noted that the AFG was in agreement with the extent, frequency and location of the test excavation methodology. By the end of the consultation period, no written responses from stakeholders had been received by either RMS or Navin Officer Heritage Consultants.

Following the completion of test excavations, a draft copy of the Aboriginal cultural heritage assessment technical paper was provided to all registered Aboriginal stakeholders on 20 October 2011, with an invitation to comment by 21 November 2011. One submission was received, which was considered in the finalisation of the technical paper. An AFG meeting was convened on 10 November 2011 to discuss the draft report and its findings. At the conclusion of this meeting, several resolutions were made. The resolutions relevant to the management and mitigation of impacts are discussed later within this section. A full record of the resolutions can be found in the *Aboriginal Cultural Heritage Technical Paper* at **Appendix J**.

Subsequent to the Aboriginal stakeholder review of the draft Aboriginal cultural heritage assessment technical paper, a number of design refinements were made to the project. Further consultation with the stakeholders was not undertaken as the changes that resulted in a modified project footprint had been surveyed and reported in the draft report, occur within an area most of which was included in the draft report, or fall within areas previously disturbed by road construction activities.

Literature and database review

A range of archaeological and historical data was reviewed for the project area and its surrounds. This literature and data review was used to determine if known Aboriginal sites were located within the area under investigation, to facilitate site prediction on the basis of known regional and local site patterns, and to place the area within an archaeological and heritage management context. The review included heritage registers and schedules, local histories and maps, and archaeological reports.

Aboriginal literature sources included the Aboriginal Heritage Information Management System (AHIMS) maintained by OEH, associated files and catalogue of archaeological reports; and, theses held in the library of the School of Archaeology and Anthropology at the Australian National University.

Searches were undertaken of the following heritage registers and schedules:

- AHIMS (OEH).
- World Heritage List (World Heritage Committee, UNESCO).
- The National Heritage List (Australian Heritage Council).
- The Commonwealth Heritage List (Australian Heritage Council).
- Section 170 Heritage and Conservation Register(s) compiled by RMS (*Heritage Act 1977*).
- Heritage Schedule(s) from the Shoalhaven and Kiama Local Environmental Plans (LEPs).

Field survey

The project area subject to survey and assessment consisted of the project alignment and the additional area of investigation, identified by RMS in August 2011, for the refinement of the project north of Berry (refer to **Section 3.3**).

Field survey was conducted over a period of two months (February to April 2009) in multiple survey events across the project according to property access availability and local weather conditions. Field survey of the project north of Berry was conducted in August 2011 (as part of the archaeological test excavation program). Field survey was also conducted in March 2012 at the eastern end of the project as part of a separate assessment for the neighbouring Gerringong Upgrade. The results of that assessment, where relevant, have been considered in this assessment.

Survey involved inspection both on foot and via vehicle, depending on property access and ground visibility. The field assessment involved the detection of surface archaeological material, and an assessment of the potential for archaeological material to be located below the ground surface.

Archaeological test excavation

Archaeologically sensitive landforms identified within the project area have been termed potential archaeologically sensitive areas (PASA).

The identification of PASA to inform the archaeological test excavation program was based on:

- The predictive model – developed in the route options assessment stage of the project, and refined based on the results of the Gerringong upgrade test excavation program. This concluded that zones of archaeological sensitivity would be associated with riparian corridors, the elevated margins of wetlands and the valley floor, and the crests of major ridges and spurs.
- Ethno-historical information.
- A review of landscape characteristics relative to known archaeological site patterning and landscape disturbance.
- Locations suggested by local Aboriginal community representatives.

Twenty-three PASAs were identified as occurring within the project. Of these PASAs, test excavations were undertaken at 21 of the PASAs between 8 and 30 August 2011. Two PASAs were excluded from the test program because these sites were not expected to be impacted by the project or the impact would be to a highly disturbed section of the PASA.

Two hundred and ninety eight archaeological test pits were excavated in the 21 PASAs in the project. Wherever possible, test pits for subsurface testing at these sites were situated within the anticipated construction footprint of the project. For the purposes of this assessment, the construction footprint is defined as the area subject to direct impact.

Test pits were excavated using mechanical excavation, unless evidence was present to indicate that excavation was required by hand. Excavation by hand was only required at one location where access to the area with an excavator was not feasible. The methodology used for the excavation of test pits is provided in **Section 2.3** of the *Aboriginal Cultural Heritage Technical Paper* at **Appendix J**.

Of the 21 PASAs subject to test excavation, 19 PASAs were found to contain archaeological deposits (stone artefacts) relating to Aboriginal occupation.

7.7.2 Existing environment

Aboriginal tribal boundaries

Aboriginal groups within the lower Shoalhaven area have tended to be described as having a single cultural character. This means that the Shoalhaven tribes are generally treated collectively and are thought to speak one dialect.

Many modern researchers use the term Dharawal or Tharawal to refer to the tribal group within the Illawarra. Amongst contemporary local Aboriginal people the term Wodi Wodi is preferred. The Aborigines of the Nowra region refer to themselves as Wandiwandian people (pers. comm. Sonny Simms 2007).

Generally speaking, the term 'tribe' is employed to describe a large group of people who, for the most part, speak a common language and occupy a broad tract of land. Inside of these tribes are 'clans' which consist of loosely-related families who own the land. There are also smaller groups referred to as bands that perform the daily tasks of group maintenance.

Boundaries between local bands and clans were flexible and permeable, allowing groups to move about (Poiner 1976). The Aboriginal people of the Shoalhaven banded together for specific activities, were together for a time, and then split apart. Later they formed new groups which most likely had at their core a number of closely-related families.

It is likely that Aboriginal groups were able to maintain their structure throughout the early period of European settlement. In response to European settlement, Aboriginal groups may have sought refuge, established camps either at a distance or close to European properties, been partially integrated into maritime or pastoral activities, or remained on the fringes of European communities.

As the land-use patterns of the new colonists intensified, there would have been a demand on natural resources, and the food sources of the Aboriginal people would have diminished radically. In the 1840s and 1850s, the introduction of dairy farming (Bell 1960) further reduced the availability of game in the Shoalhaven District. The issuing of rations by the government encouraged a clustering of people into camps, which would have caused some breaking down of the previous social structures.

By the 1880s, it appears as if most of these structures were weakening and Aboriginal people were being pressed into reserves or missions. Although the missions provided places for ration distribution they also may have been inappropriately sited or offered constraints and other forms of control.

Local Aboriginal Land Councils

The project and the surrounding area falls within three Local Aboriginal Land Council (LALC) boundaries. These are Illawarra LALC, the Jerringa LALC and the Nowra LALC. The boundaries of the LALCs are shown on **Figure 1-2**.

Historical overview

The first reference to interaction between the Shoalhaven tribes and Europeans came from the recollections of survivors of the wreck of the 'Sydney Cove' who walked up the south coast from Gippsland to north of the Illawarra before being picked up. As the party came towards the Shoalhaven they met with 'unfriendly natives, at whose hands it is thought some of the exhausted ones lost their lives' (Cambage 1916).

The first Europeans to venture into the coastal escarpment of the Illawarra range were almost certainly cedar getters, both legal and illegal. An undocumented and probably violent story of culture contact and exploitation followed the cedar cutters.

Early in 1822, Alexander Berry spent several days exploring the Shoalhaven River, up as far as Burrier. Six months later Berry returned with the aim of establishing a permanent settlement. This marked the start of permanent European settlement in the Shoalhaven River valley.

Berry chose an area of elevated ground at the foot of a hill variously referred to as Coolungatta, Cullengatty, Coloomgatty or Cooloomgatta (Antill 1982:10, Bayley 1975:24, 27, Mitchell 1834 NSW Map) for the site of his settlement. Berry's selection of this location was apparently treated with apprehension by the local Wodi Wodi. Berry notes that in June of that year, during construction of a hut and a canal near the Shoalhaven Heads, a native called Wagin (a local chief), confronted the workers and claimed the ground where they had been working (in Jervis 1942:235). This action falls into context when it is acknowledged that the Coolangatta Mountain was a place of ancestral significance to local Aboriginal people.

Berry's settlement grew steadily with the immediate introduction of herds of cattle and the establishment of plant crops at Numbaa. Berry initially considered the local Aborigines to be ferocious and his timber workers tried to drive them away. Several weeks after Berry's arrival a party of twenty Aborigines camped near his settlement. The probable band groupings observed by Berry suggested that most of the Aboriginal population was centred on the more fertile coastal plains.

There are a number of historical accounts of hostility in the early to mid nineteenth century between tribal groupings of the northern and southern Illawarra Dharawal speakers. These consist of clashes between the 'Illawarra' tribes and apparent northward offensives of the Bong Bong, Broughton Creek, Kiama and Shoalhaven tribes. This has been interpreted as a consequence of changes in social order, resource distribution and political alliances brought about by the European settlement and occupation of tribal lands (DEC 2005:16).

In the 1830s, there are reports of Aboriginal employment in the Berry estate industries and the provision of space for vegetable gardens tilled by Aboriginal employees.

Through the 1840s and 1850s Aboriginal communities were increasingly impacted by the spread and consolidation of European settlement. In response, Aboriginal people either settled on the pastoral stations, in 'fringe camps' adjacent to European settlements, or were forced into adjacent rough and mountainous country. Egloff (1981) concludes that by the 1840s the Shoalhaven Aborigines had been reduced to remnant groups either wandering large tracts of the coast, or subsisting at the edge of the now permanent European settlements.

Reports from the 1850s onwards suggest a trend in Aboriginal occupation and subsistence such that camps and most food gathering and hunting became concentrated along the coast. This pattern was shaped by European settlement which pushed Aboriginal people onto country unsuitable for agriculture, notably the coast and the adjacent wetlands (DEC 2005:25). Permanent Aboriginal camps became established on Broughton Creek (Berry), Crooked River (also referred to as Black Head or Gerongong), around Jervis Bay (notably Bilong on Currambene Creek), and in a gully on the northern side of the Coolungatta Mountain on the Berry Estate (Egloff 1981).

Other encampments known from the latter half of the nineteenth century include the banks of Broughton Creek at Broughton Village (Donlon 1991a:12), and the banks of Broughton Mill Creek adjacent to Berry (Barbara Timberry in DEC 2005:39-41).

Reclamation of the Shoalhaven wetlands began on a major scale from 1873. By 1909 a total of 600 kilometres of drains had been constructed. The draining of the wetlands effectively alienated the last terrestrial wild food areas open to the remaining local Aborigines.

Aboriginal groups responded to the dispossession of their lands in a variety of ways including fostering camps close to pastoral properties, as well as at places of refuge away from settlement. Some people moved into areas of settlement and communities grew on the edges of rural towns. In response to moves into areas of settlement, the New South Wales government established a system of Aboriginal reserves in the 1880's.

In 1899 a government Aboriginal reserve of 43 acres was established near the northern end of Seven Mile Beach. The reserve was revoked in January 1953 (AR 29911, McGuigan nd:39). Although the exact nature of Aboriginal occupation on this reserve is not well documented, its location and duration supports the documentary evidence for a historical focus of Aboriginal occupation in the Crooked River (Black Head/Gerringong) area.

In a census conducted by the Commonwealth in 1901, the Aboriginal population of the Illawarra was distributed across seven camps with 33 people at Port Kembla, 13 at Minnamurra River, eight at Dapto, 18 at Bombo, 20 at Gerringong, three at Jamberoo and three at Kiama, giving a total of just 98 people (DEC 2005:24).

From 1940 to 1969 the Aborigines Protection Board vigorously pursued a policy of assimilation. Reserves were reduced in size or were revoked (Long 1970). Houses and facilities were allowed to deteriorate in an attempt to force Aboriginal people to move off the reserves.

Today, Aboriginal people live throughout the Illawarra and South Coast as residents of the larger towns and cities – Bega, Nowra, and Wollongong, as well as maintaining communities on former reserves, and are found throughout the region in family groups.

Literature and database searches

Seventy four Aboriginal sites had been recorded in an area 26 by 19 kilometres, around and including the project, prior to the commencement of the cultural heritage studies for the Princes Highway upgrades between Gerringong and Bomaderry. Sites comprised 32 artefact scatters, 19 shell middens, seven isolated finds, seven rock shelters with art and/or deposit and/or rock engravings, one natural mythological site, one bora/ceremonial site, one midden/artefact scatter, one potential archaeological deposit (PAD), four axe grinding groove sites, and one Aboriginal Place at Foxground.

No Aboriginal sites had been recorded within the project area prior to the commencement of studies for the Princes Highway upgrades between Gerringong and Bomaderry. However, information collected from a local community questionnaire for a previous highway upgrade options analysis (Donlon 1991:12-13) revealed the following anecdotal information:

- Aboriginal artefacts have been observed and collected along the banks of Broughton Creek in the vicinity of 'Brookside', Broughton Village.
- A stone arrangement and bora ring is reportedly located in a 'fairly open area associated with Lilli Pilli trees on Toolijooa Hill'. The location of this reported site is not known.

Identified sites and assessment of significance

Based on the findings of the literature and database review, field surveys, test excavations and consultation with the Aboriginal stakeholders, 42 Aboriginal heritage recordings were identified within the project area. The locations of the recordings are shown in **Appendix C** of the *Aboriginal Cultural Heritage Technical Paper* at **Appendix J***.* These include:

- Archaeological recordings:
  - Surface artefacts, identified by previous investigations in the area (G2B A3).
  - An isolated surface scatter associated with a PAD (G2B A38).
  - The 23 sites determined to contain subsurface artefacts based on the test excavation of PASAs conducted for this project.
- Places or landscapes of reported historical and cultural Aboriginal significance:
  - Three ethno-historical recordings and one cultural landscape, being the 'Brookside' Aboriginal encampment, Dicky Wood's Meadow battleground, the historical Aboriginal encampments at Berry and Toolijooa Ridge Aboriginal cultural landscape (TRACL).
  - Twelve fig trees (cultural landscape feature).

Subsequent to the finalisation of the test excavations, changes to the project were made at the Austral Park Road interchange. The topography at this location is considered to be a sensitive landform and has been identified as a G2B PAD1 for the purposes of this assessment.

Archaeological recordings

The 23 sites identified within the project area have been labelled G2B A15, G2B A 16, G2B A 17, G2B A 18, G2B A 19, G2B A 20, G2B A 21, G2B A 22, G2B A 23, G2B A 24, G2B A 25, G2B A 26, G2B A 27, G2B A 28, G2B A 29, G2B A 30, G2B A 31, G2B A 32, G2B A 33, G2B A 34, G2B A 35, G2B A 36 and G2B A 37. The main conclusions regarding trends in site location (refer **Appendix C** at **Appendix** J) were as follows:

- A greater number and/or richness of artefacts tend to coincide with major spurlines and low gradient basal slopes above, and set back from, the valley floor.
- The valley floors and in particular the alluvial flats, are generally characterised by intermittent and low incidences of artefacts.
- Micro-topographic features such as locally elevated terraces and creek banks, within the broader valley floor context, tend to contain a higher incidence of artefacts.
- The ridgeline crests and saddles tend to be characterised by intermittent and low incidences of artefacts, with higher incidences occurring in association with features such as low gradient knoll crests and break of slope interfaces.

Of the 23 sites, 11 sites were assessed as having low archaeological significance within a local context. This was based on the low diversity of artefacts and the relatively low and discontinuous number of artefacts found at these locations. These are sites G2B A15, G2B A17, G2B A19, G2B A20, G2B A21, G2B A23, G2B A25, G2B A27, G2B A34, G2B A35 and G2B A37.

Nine sites were assessed as having moderate archaeological significance within a local context. This was based on the sites having a greater number of artefacts present or a greater richness of artefacts. These are sites G2B A16, G2B A18, G2B A22, G2B A24, G2B A26, G2B A28, G2B A32, G2B A33 and G2B A36.

Three sites were assessed as having moderate to high archaeological significance within a local context based on their association with the Brookside encampment and Dicky Wood's Meadow battleground. These are sites labelled G2B A29, G2B A30 and G2B A31.

Discussion with Aboriginal stakeholders during fieldwork and AFG meetings indicate that all archaeological recordings within the project area are of Aboriginal cultural significance, however to date no detailed responses have been received with regard to individual sites.

Three archaeological recordings (apart from PASAs) were not subject to archaeological testing being G2B A3, G2B A38 and G2B PAD1.

Site G2B A3 is considered to be of low archaeological significance within a local context based on the diversity, low artefact incidence and the substantially disturbed nature of the area.

Based on the confirmed site content of G2B A38, the site has low archaeological significance within a local context. A significance assessment for the associated PAD cannot be completed without survey data. However, based on the predictive model, the potential of this PAD is considered to be moderate or high.

Similar to G2B A38, a significance assessment for G2B PAD1 cannot be completed. Based on test excavation results for the project and the predictive model, the potential for G2B PAD1to contain archaeological material is high. As such, the potential archaeological significance for G2B PAD1 may be low to high within a local context.

Places or landscapes of reported historical and cultural Aboriginal significance

Places and landscapes which have, or may potentially have, historical or cultural significance to the local Aboriginal community within the project area include:

- The historical encampments at Broughton Village,' Brookside' Aboriginal Encampment (G2B A14).
- The 'Little Mountain' or Dicky Wood's Meadow battle ground (G2B A13).
- Historical Aboriginal encampments at Berry, being the Boongaree Aboriginal encampment and the Berry Pickers encampments (collectively referred to as G2B A39).
- The Toolijooa Ridge Aboriginal cultural landscape (TRACL).
- 12 large and old/mature growth fig trees on Broughton Creek.

Other generalised landscape features considered to have cultural significance and values by Aboriginal stakeholders in the project area and its surrounds, include:

- Large and old/mature growth fig trees.
- Remnant and regenerating native vegetation.
- Plants and animals with significance in past and contemporary Aboriginal cultural practice.
- Landforms which remain unchanged by European land use or strongly manifest the pre-European landscape (examples include prominent ridgelines, escarpments, hills, former swamp basins and river and creek corridors).
- Natural ecological systems associated with features such as creeks and rivers, forests and swamps.

Places or landscapes of Aboriginal cultural heritage significance may be found to include related archaeological remains. However, the importance of these places is not dependent on the presence of such remains. The cultural significance of the Aboriginal landscapes and places in the project area are described below.

The ‘Brookside’ Aboriginal encampment

There is a local oral tradition that Aboriginal people were known to have camped along the banks of Broughton Creek in the vicinity of ‘Brookside’ at Broughton Village until at least the turn of the century.

This recording consists of a place only and to date no archaeological evidence has been found. This place has Aboriginal cultural significance due to its association with the actions and destinies of local community ancestors and their families in the late nineteenth century. This site relates in particular to the interaction between Aboriginal and European people, and camping adjacent to homesteads.

The general location of the Brookside Aboriginal encampment in relation to the project is shown in **Figure 7-41**.

The Dicky Wood’s Meadow battleground

An Aboriginal battlefield is located in the project area, in the vicinity of Broughton Village. The Dicky Wood’s Meadow battleground is based on an account provided by a local Aboriginal person. The place has high significance for Aboriginal people as it relates to traditional lore and practice, and is associated with the potential for burials. Despite the absence of specific archaeological evidence for a battle ground, such evidence may still be present. The test excavations conducted to date have been limited in scope and extent relative to the potential battle ground area. The current archaeological evidence remains compatible with the reported battle ground function and does not limit its Aboriginal cultural value.

The general location of the Dicky Wood’s Meadow battleground in relation to the project is shown in **Figure 7-41**.

Historical Aboriginal encampments at Berry

This recording comprises an area within which two phases of Aboriginal camping activity is known, or thought likely, to have occurred. It is surmised that nineteenth century camping may have occurred in this area, upstream of the Boongaree encampment, possibly as a response to the European ‘Broughton Creek’ village built on the adjacent spurline. Numerous oral accounts record that in the twentieth century, up to at least the 1960s, Aboriginal people regularly camped on the creek flats during seasonal employment as crop pickers.

The location of the Boongaree encampment, which was centred on the former meadow lands at the intersection of Broughton and Broughton Mill Creeks (outside of the project area), has high Aboriginal cultural significance within a regional context. This is due to multiple factors including:

- Its cultural, spiritual and historical importance as an Aboriginal encampment recorded at the time of European contact, and the home of important local identities Toodwick (known to Europeans as Broughton) and his brother Broger.
- Its cultural associations with the ancestors of contemporary Aboriginal people who identify with the lower Shoalhaven River district.
- The potential for burials to occur within the area.
- It’s potential to contain archaeological evidence of potentially continuous Aboriginal occupation from prior to European contact, into the mid and later nineteenth century.
- Its potential to contain archaeological evidence of the interaction between the European and Aboriginal communities and economies throughout the period of occupation.

It is not known if nineteenth century Aboriginal camping occurred, upstream of Boongaree, within the area of the project and of recording G2B A39. It is surmised that this was likely, given the presence of the 'Broughton Creek' European village on the adjacent spurline, and the discovery of a gorget bearing the legend 'Neddy Noora Shoal Haven 1834' in the bed of Broughton Mill Creek opposite the *Mananga* homestead in 1925 (refer **Section 4.4.3**). If archaeological evidence of this phase of camping was demonstrated within this area, then it could potentially have high archaeological significance, and the place have high Aboriginal cultural significance, both within a regional context.

The later twentieth century phase of Aboriginal camping on the creek flats, now associated with the Berry Bowling Club, is historically well established. These camps remain part of living memory for many local Aboriginal people and relate to both their own experiences and to the lives of community and family members now deceased. As such, the location and any physical traces of the camps have strong cultural significance to Aboriginal people. They are evidence of a past way of life, and constitute a place associated with their ancestors. The location and any physical traces also have historical and social significance to the local community in general, as evidence of the role of Aboriginal people in the Berry township and economy. Physical traces, if identifiable, could potentially have archaeological value.

The general location of the Historical encampments at Berry in relation to the project is shown in **Figure 7-41**.

Toolijooa Ridge Aboriginal cultural landscape

The TRACL has Aboriginal cultural significance due to its stated role as a traditional access route and pathway between the Illawarra Range and the coastal fringe. Archaeological test excavations conducted for this project and previous investigations confirm that discontinuous subsurface artefact distributions occur along the ridge crest and some of its prominent spurs. There are also unconfirmed reports of ceremonial grounds on the ridgeline.

A further significant aspect of the ridgeline is its dominant visual role in the landscape, and its presumed importance as a wildlife corridor. These values relate to a sense of belonging and custodianship to the land and the health of its plants and animals.

The general location of the TRACL in relation to the project is shown in **Figure 7-41**.

Large and old growth fig trees

Large and old growth fig trees within the Illawarra region are considered to be of high Aboriginal cultural value. All trees which are large and mature, or which can be classed as old-growth are of stated cultural significance to at least some of the Aboriginal stakeholders in the Southern Illawarra. However, the reasoning and justification behind these values varies. Some of the stated reasons for the cultural values of the trees include:

- The well developed buttresses of the mature fig trees were used by Aboriginal people as shelter and weather breaks and were often used as camp sites.
- Fig trees were a good source of food, including figs in season and the animals that lived on them, such as possums and fruit bats.
- The trees are associated with the spirit of Yaroma. The Yaroma is a creature resembling a man but of greater size and strength, with longer teeth and hair all over its body. The Yaroma is described as a strong and dangerous creature that may be concealed within a fig tree and which may ambush unsuspecting passersby.
- Mature fig trees are associated with birthing and women's lore. In some examples, notches were made along limbs of trees to signify births into a tribe or family group.

Around twelve fig trees were identified in the area surrounding the project. It is probable that high cultural significance would be unanimously accepted amongst the project Aboriginal stakeholders for the pre-European high canopy forest remnant fig tree (MFT22) identified on the banks of Bundewallah Creek. This would be based, not only on the traditional lore associated with large and mature fig trees, but also for the education, representative and rarity value of this tree. Its size, height and form are reminiscent of a forest structure now vanished from the Coastal Plain, and as a consequence, a traditional lifestyle which also disappeared with that forest.

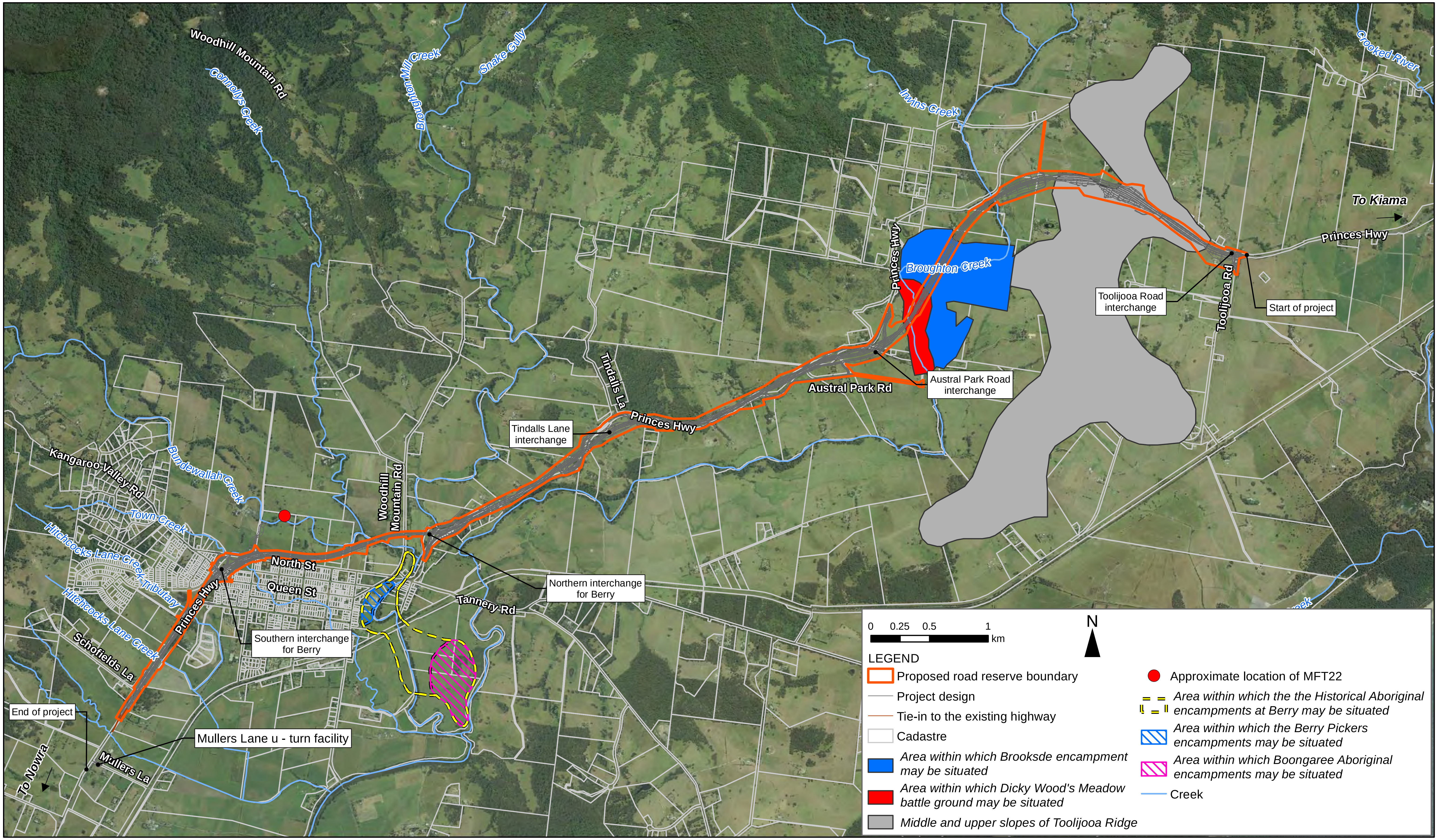

Figure 7-41 General location of Aboriginal culturally significant places and landscapes in relation to the project

Source: AECOM (2012)

7.7.3 Assessment of potential impacts

The potential impacts of the project on Aboriginal heritage recordings include:

- A direct impact and disturbance to the entire site or the majority of a site containing Aboriginal objects due to the construction of the project (that is, the footprint of the upgraded highway).
- A direct impact and disturbance to the entire site or the majority of a site containing Aboriginal objects within proposed areas for ancillary facilities situated outside of the project corridor.
- Complete or varying degrees of direct impact and/or disturbance to items with Aboriginal cultural significance which do not fall into the category of an Aboriginal object, such as mature fig trees.
- Indirect impact to Aboriginal objects, or non-Aboriginal objects with Aboriginal cultural value, such as from development related changes to the landscape or scenic context of a site or item.

The impacts of the project on 42 Aboriginal heritage recordings were assessed. This included:

- Two sites containing surface artefacts.
- The 23 sites determined to contain subsurface artefacts based on the test excavation of PASAs.
- One PAD.
- Four places or landscapes of reported historical and cultural Aboriginal significance. These include three ethno-historical recordings and one cultural landscape, being the 'Brookside' Aboriginal encampment, the Aboriginal encampments at Berry, Dicky Wood's Meadow battleground and TRACL. The assessment of impact on these sites also allows for the assessment of potential Aboriginal burials.
- Twelve fig trees.

Of the 42 recordings, sixteen would not be impacted by the project, eighteen would be partially impacted, and eight fully impacted. Of those fully impacted, all consist of archaeological deposits, with the exception of one fig tree. Partially and fully impacted sites, which include two ethno-historical recordings and one cultural landscape, are listed in **Table 7-60**. Direct impacts on the historical Aboriginal encampments at Berry have been avoided by limiting the construction of the Woodhill Mountain Road roundabout to within the corridor that has already been disturbed by road construction activities.

The potential avoidance of the above sites by the realignment of the preferred project route would be counterproductive, given that in most cases the identified archaeological deposits extend either side of the construction footprint. A shifted alignment would simply impact the same archaeological resource within an adjacent area. A re-alignment would also move the preferred project alignment away from the disturbance corridor associated with the existing highway, which is paralleled closely by the project works.

The approach taken to minimise impacts where possible is to locate the project disturbance as close as possible to the existing disturbance corridor rather than establish new corridors which would likely impact a more intact and less degraded archaeological resource.

At the AFG held on 21 November 2011, a resolution was made relating to minimising damage as much as possible to Toolijooa Ridge and Dicky Wood's Meadow, and that these places should be protected at all costs.

Table 7-60 Summary of anticipated construction related impacts to recorded archaeological deposits

Site ID	Recording type	Local significance	Direct impact	Degree of impact	Comments
G2B A13	Ethno-historic place (Dicky Wood's Meadow battleground)		Yes	Partial	The actual size and location of the battle ground remains unknown, however, the area of potential for this site has been estimated at around 136 hectares. Around 9.4 hectares (or 6.8 per cent) of this area would be impacted by the project. This includes a 200 metre buffer around the project. The impacts on this site would be primarily related to the potential to uncover burial sites. This would be heightened through any required excavation across the potential location of the site which would disturb the existing soil profile in the area. Disturbance to the natural soil profile would be minimised by constructing the proposed carriageway on an embankment. Where practicable, the removal of top soil would be avoided or minimised prior to the placement of fill.
G2B A14	Ethno-historic place ('Brookside' Aboriginal historic encampment)		Yes	Partial	The actual size and location of the encampment is unknown, however 0.4 kilometres of the construction footprint passes through an area within which the encampment is likely to have been situated. The encampment is associated with the potential for archaeological occupation deposits, which could be disturbed during construction of the project. Disturbance to the natural soil profile would be minimised by raising the elevation of the proposed carriageway on imported fill. Where practicable, the removal of top soil would be avoided or minimised prior to the placement of fill.
TRACL	Cultural Landscape (Toolijooa Ridge)		Yes	Partial	Approximately 1.4 kilometres of the project would traverse the higher slopes of the Toolijooa Ridge and its associated side spurs. Impacts would include the carriageway formation, deep cuttings, and visually obtrusive embankments.
MFT12	Fig tree		Yes	Full	The tree is situated within the construction footprint.
G2B A15	Archaeological deposit	Low	Yes	Full	The deposit exists within the construction footprint.
G2B A16	Archaeological deposit	Moderate	Yes	Partial	The deposit is likely to extend to either side of the construction footprint.

Site ID	Recording type	Local significance	Direct impact	Degree of impact	Comments
G2B A17	Archaeological deposit	Low	Yes	Partial	The deposit extends to either side of the construction footprint.
G2B A18	Archaeological deposit	Moderate	Yes	Partial	The deposit would be impacted by the trench for the Town Creek diversion but extends to either side of proposed trench.
G2B A19	Archaeological deposit	Low	Yes	Partial	The deposit is likely to extend to either side of the project.
G2B A21	Archaeological deposit	Low	Yes	Partial	The deposit is likely to extend to either side of the project.
G2B A22	Archaeological deposit	Moderate	Yes	Full	Most of the site focus is likely to be present within the construction footprint.
G2B A23	Archaeological deposit	Low	Yes	Full	Most of the site focus is likely to be present within the construction footprint.
G2B A24	Archaeological deposit	Moderate	Yes	Full	Most of the site focus is likely to be present within the construction footprint.
G2B A25	Archaeological deposit	Low	Yes	Partial	The deposit exists within the construction footprint and is likely to extend downslope and to the south of the construction footprint.
G2B A26	Archaeological deposit	Moderate	Yes	Full	The deposit exists within the construction footprint.
G2B PAD1	Potential archaeological deposit	Low to high*	Yes	Partial	The deposit is likely to extend to either side of the construction footprint.
G2B A27	Archaeological deposit	Low	Yes	Partial	The deposit is likely to extend to either side of the construction footprint.
G2B A28	Archaeological deposit	Moderate	Yes	Partial	The deposit is likely to extend to either side of the construction footprint.
G2B A29	Archaeological deposit	Moderate to high	Yes	Partial	The deposit is likely to extend to either side of the construction footprint.
G2B A30	Archaeological deposit	Moderate to high	Yes	Partial	The deposit is likely to extend to either side of the construction footprint.
G2B A31	Archaeological deposit	Moderate to high	Yes	Partial	The deposit is likely to extend to either side of the construction footprint.
G2B A32	Archaeological deposit	Moderate	Yes	Partial	The deposit is likely to extend to either side of the construction footprint.
G2B A33	Archaeological deposit	Moderate	Yes	Partial	The deposit is likely to extend to either side of the construction footprint.

Site ID	Recording type	Local significance	Direct impact	Degree of impact	Comments
G2B A34	Archaeological deposit	Low	Yes	Partial	The deposit is likely to extend to either side of the construction footprint.
G2B A35	Archaeological deposit	Low	Yes	Full	The deposit is likely to extend to either side of the construction footprint. However most of the focus of the site occurs within the construction footprint.
G2B A36	Archaeological deposit	Moderate	Yes	Full	Most of the likely archaeological deposit on this spurline shoulder would be impacted.

** In the absence of any surface or subsurface artefact data, it is not possible to provide a significance assessment for this recording. The significance listed in the table is based on test excavation results elsewhere along the project and the predictive model.*

Impacts on the cultural landscape

The project would have varying degrees of impact on the cultural landscape values, including:

- The cutting at Toolijooa Ridge.
- The loss of one large fig tree.
- The loss of some areas of native vegetation which may include plants known to have traditional uses.
- Substantial modification of natural landforms within the project area, through the construction of road platforms and cuttings.

Specifically, the project has the potential to impact the cultural values of the TRACL. The physical, visual and potential habitat changes across Toolijooa Ridge resulting from the project would amount to a substantial impact to the Aboriginal cultural values of the ridgeline. As stated earlier within this section, the stakeholders also resolved that little damage to the ridge should be incurred.

Approximately 1.4 kilometres of the project would traverse the higher slopes of the Toolijooa Ridge and its associated side spurs. Impacts would include the carriageway formation, deep cuttings, and visually obtrusive embankments. The cutting through Toolijooa Ridge would be about 900 metres in length, a maximum of 130 metres wide and a maximum of about 26 metres deep.

These impacts would affect the Aboriginal cultural values of the landscape. The cutting through the ridge would result in significant alteration to the profile from various viewing angles. The visual continuity of the crest of the ridge would also be impacted. The presence of the project corridor would prevent vehicles and pedestrians travelling along the ridge crest. This constraint is significant given the value of the ridge as a former pathway.

The vegetation clearance required for the project would reduce the current extent of vegetation cover. Aboriginal stakeholders have expressed concern that this may also impact habitat values.

Impacts resulting from ancillary construction facilities

The impact associated with ancillary construction facilities includes a range of works and actions that may result in a complete impact, a majority impact or a partial impact to any Aboriginal objects present. Works would include:

- Establishment of bunded fuel and chemical storage areas.
- Construction of offices and sheds.
- Installation of sewerage and other services, as required.
- Sediment and erosion control works.
- Clearing and levelling.
- Construction of hard stand areas for plant and equipment.
- Temporary storage of construction materials or material generated from within the construction site.
- Erection of fencing.

The exact location, configuration and scope of the impacts within the construction ancillary facility sites is unknown at the current stage of project planning. This is due to the number variables which would only be clarified at the detailed design stage of the project, and would also be dependent on the operational preferences and logistical constraints of the construction contractors. This uncertainty has implications for the effective management of potential impacts to heritage values. One option would be to conduct a full scale test excavation program to define archaeological sensitivity across all possible ancillary areas. This, however, would result in considerable unnecessary testing impact to sites given that not all of the proposed ancillary sites would be impacted.

Where possible, direct impact to areas of potential heritage significance would be avoided. This is would be achieved by fencing and excluding certain areas from use, or by temporarily covering deposits with hard stand gravels and rehabilitating the area upon completion. Where and if necessary, a delayed and focused pre-construction testing program would be conducted, once areas of planned and unavoidable impact have been defined. Further details on the testing and management of ancillary facilities have been provided in **Section 7.7.4**.

The following is an outline of the Aboriginal heritage items and areas which may be potentially impacted by the location of the ancillary facilities. Locations of the ancillary facilities are shown in **Figure 4.19**.

Site A (adjacent to the Toolijooa Road interchange)

One known Aboriginal archaeological site has been identified, together with an associated area of predicted archaeological potential (G2B A38). G2B A38 is an isolated surface artefact situated on basal slopes with archaeological potential.

A confirmed sub-surface Aboriginal archaeological deposit (G2B A12 (PASA 31), NOHC 2011a), is located outside of the ancillary facility site on the crest of the spurline extending to the east of the intersection of the Toolijooa Road and Princes Highway. Given the high degree of direct impact which has occurred in this area as the result of road and house construction, it is considered unlikely that the deposit now extends into the ancillary facility site.

The higher ground on the spurline in the north western portion of the area falls within the approximately defined boundary of the Aboriginal cultural landscape of the Toolijooa Ridge.

Sites B and C (Toolijooa Ridge)

This area occurs within the Aboriginal cultural landscape of the Toolijooa Ridge. There is one confirmed sub-surface Aboriginal archaeological deposit within the northern area, G2B A35. This deposit is likely to extend to the north of the limit of archaeological testing, along the crest of the ridge, including the proposed vehicle access to the northern area. A further area of predicted archaeological potential is situated on the crest of a ridgeline knoll in the southern area.

A large fig tree (MFT12) is situated at the eastern end of the northern area and may be subject to direct impact from construction, independent of any preparation or function of the ancillary facility.

Site D (East of Broughton Creek)

There are no known Aboriginal sites within this area. Based on the recovery of artefacts from archaeological test pits just to the north (G2B A33 and 34), it is probable that archaeological deposits are also present within the proposed ancillary facility site. The area of predicted archaeological potential covers approximately two thirds of the proposed ancillary facility.

Site E (West of Broughton Creek)

There are no confirmed Aboriginal sites or archaeological deposits within this area. However, the whole of the area is classed as having archaeological potential for the following reasons:

- A confirmed archaeological deposit (G2B A32) is situated just north of the proposed ancillary facility. This indicates that part of the archaeological deposit may be present in the northern portion of the proposed ancillary facility.
- A confirmed archaeological deposit (G2B A31) situated adjacent to the north bank of Broughton Creek, just west of the proposed ancillary facility. This indicates that archaeological deposit would likely be present along the southern margin of the proposed ancillary facility, where it occurs within at least 200 metres of the river bank.
- The southern two thirds of this area falls within the potential location of Dicky Wood's Meadow. If a margin of up to 200 metres from the meadow is allowed for the potential location of associated burials, the whole of the proposed ancillary facility falls within this outlined area of potential.

Site F (Greystanes lodge)

This area includes a mature fig tree (MFT16) which was probably planted in association with a former Berry Estate tenant farmhouse at this location. In addition, this area is situated on the edge of a potential location of Dicky Wood's Meadow. If a margin of up to 200 metres from the meadow is allowed for the potential location of associated burials, the whole of this proposed ancillary facility falls within this outlined area of potential.

Site G (South east of the intersection of Austral Park Road and the Princes Highway)

There are no known Aboriginal sites within this area. There is one area of predicted archaeological potential on a small spurline shoulder located immediately east and south east of the building located in this area.

Site H (South west of the intersection of Austral Park Road and the Princes Highway)

There are no known Aboriginal sites within this area. There are two areas of predicted archaeological potential within this area:

- A spurline shoulder on the western margin of the proposed ancillary facility.
- The banks of an unnamed tributary creek, flowing along the northern edge of the Broughton Creek valley. This area of potential occurs within the south eastern portion of the proposed ancillary facility.

Site I (West of the intersection of Tindalls Lane and Princes Highway)

A confirmed archaeological deposit (G2B A24) is situated immediately adjacent to the eastern boundary of this proposed ancillary facility. It is considered unlikely that this deposit extends further downslope and into the proposed ancillary facility. An area of predicted archaeological potential occurs along the northern portion of the proposed ancillary facility.

A large fig tree (MFT19) is situated in the base of a gully on the western boundary of this area. There are a number of mature native trees within the area which have not been inspected for the possible occurrence of Aboriginal scars.

Site J (Oakleigh farmhouse and area)

There are no known Aboriginal sites or areas of predicted archaeological potential within this area.

A large fig tree (MFT23) occurs in the middle of the proposed ancillary facility, and was probably planted in association with the early history of the present farmhouse, or a former homestead at this location.

Site K (Western end and south of North Street, Berry)

There are no known Aboriginal sites within this area. However a confirmed subsurface archaeological deposit (G2B A16) is situated immediately to the east, adjacent to flats bordering Town Creek. This indicates that an archaeological deposit may be present in the southern, upslope portion of the proposed ancillary facility.

Site L (southwest of Princes Highway, south of Graham Park)

The majority of this area has not been the subject of archaeological survey. Survey of the proposed Princes Highway upgrade, along the eastern margin of this area, resulted in the identification of a potential archaeologically sensitive area (PASA 11) in association with an unnamed creek. This PASA falls within the future assessment area of the proposed Berry to Bomaderry upgrade and has not been the subject of test excavation.
There are a number of mature native trees within the area which have not been inspected for the possible occurrence of Aboriginal scars.

Impacts from the realignment of services and utilities

Service and utility realignments required as part of the project have been presented in **Section 4.2.11**. Generally, the works involved would occur within the assessed footprint of the project and the associated easement. These impacts have been assessed as part of this environmental assessment. There remains some potential for the realignment of services outside of the proposed project easement, such as where major utilities would require realignment. In this case, an appropriate heritage assessment and impact mitigation process would be required to be completed prior to any disturbance.

Representative and worst case impact scenarios

For this assessment, representative impact is defined as that impact which has been anticipated in the impact analysis and to which the proposed management and impact mitigation strategies are directed. It is representative of the expected scenario, based on an analysis of the best information available and on a reasonable or normative level of prediction.

Worst case impact is defined as an extreme scenario where the highest conceivable degree of impact is anticipated due to unexpected occurrences which are extraordinary and outside of a reasonable level of prediction.

The worst case scenario with regard to Aboriginal heritage would consist of an unexpected encounter of an Aboriginal object or objects which, due to an exceptional level of assessed significance warrants *in situ* conservation and a consequential change in the project alignment. This would conceivably be due to the discovery of a previously undetected or unpredicted item.

Worst case scenario discoveries fall into two broad categories:

- An archaeological deposit or feature with exceptional Aboriginal cultural value.
- A previously unassessed place of exceptional Aboriginal cultural value which may, or may not be associated with archaeological material.

The following are potential examples which may constitute a worst case scenario, depending on the Aboriginal cultural and scientific values associated with the find and its' *in situ* conservation:

- Unique or rare site types.
- Evidence of mid to early Holocene and/or Pleistocene occupation (meaning it is older than 5,000 years before present).
- A burial ground (or grouping of burials), or a single burial with high significance grave goods.
- An archaeological deposit containing rare and well preserved organic items due to water logged and anaerobic conditions, such as may be found within a swamp or peat deposit.

It is considered that the potential for a worst case scenario has been minimised by the application in this assessment of a robust analysis which included:

- The participation of registered Aboriginal stakeholders and the exchange of information and discussion of issues at AFG meetings.
- A review of ethno-historical sources.
- Reference to oral tradition and information provided by local community sources.
- The use of predictive archaeological modelling.
- Archaeological survey and interpretation.
- Review of aerial photography.

An unexpected finds procedure has been developed by RMS which defines a protocol to be followed in the event that an unexpected find is made during the process of construction (refer **Appendix H** of the *Aboriginal Cultural Heritage Technical Paper* at **Appendix J**). The adoption of this procedure provides both a safeguard and management process in the event of a worst case scenario.

Cumulative impacts

The cumulative impacts of the project can best be understood by dividing the assessment area into broad landscape suites. This allows a comparison of similar known or predicted archaeological resources according to the premise that the distribution of, and variability in, Aboriginal sites tends to be related to landscape types and associations. The incidence of six broad landscape suites, or topographies, has been assessed across the project area and the two adjacent section of the Princes Highway upgrade – the Gerringong upgrade and the Berry to Bomaderry upgrade. Further details and associated mapping is provided in **Section 10.7** of the *Aboriginal Heritage Technical Paper* (**Appendix J**).

The six landscape suites are:

- *Low relief, locally elevated, undulating bedrock slopes adjacent to the Shoalhaven River gorge.* This topography occurs within the southern end of the Berry to Bomaderry upgrade, but is widespread on either side of the Shoalhaven river gorge upstream from Nowra.
- *Basal slopes, spurs and interfluves fringing the coastal flats (which were former estuary basins).* This topography dominates the Berry to Bomaderry upgrade and Gerringong upgrade. It forms a margin of descending spurlines and drainage lines around the edge of the coastal plain. The plain, now relatively well drained, was formerly dominated by swamp basins, and before that, by estuarine embayments. This topography consists of the terminal slopes of the south-eastern fall of the Illawarra Range.

- *Ridges, spurs and interfluves fringing major alluvial valley floors*. This topography dominates the (Foxground and Berry bypass) project area and is characterised by the spurlines, slopes and drainage gullies which border the major alluvial valleys that drain onto, and later merge with, the coastal plain. Those portions occurring within all three project areas form part of the Broughton Creek and Broughton Mill / Bundewallah Creek valleys.
- Major alluvial valley floors (excluding former estuary basins). Despite numerous drainage lines crossing the three project areas, only two major valley floors are traversed which are situated away from former estuarine basins of the coastal plain. These are the valleys of Broughton Creek and Broughton Mill / Bundewallah Creeks. Both are traversed in the (Foxground and Berry bypass) project area.
- *Higher ridges and spurs.* This topography consists of the higher ground within the three project areas and occurs across Toolijooa Ridge and Mount Pleasant. This topography dominates the lower-middle portion of the southeastern fall of the Illawarra Range.
- *Wetland basin (drained), former estuary basin.* This topography dominates the coastal plain of the Southern Illawarra, situated between the coastal sand bodies and the bedrock slopes. The three project alignments largely avoid this flood prone topography, except for Omega flat in the Gerringong upgrade project area.

All of these topographies extend to a majority degree, to either side of the project areas for the three sections of the Princes Highway upgrade between Gerringong and Bomaderry. None of these categories are rare across the Southern Illawarra and the proportion subject to impact from the upgrade projects is very small relative to their total distribution.

As shown in **Table 10-2** of **Appendix J**, the greatest net impact of all three sections of the Princes Highway upgrade between Gerringong and Bomaderry occurs across the alternating spurs and valleys of the coastal plain margin, with 55 per cent of the projects traversing this topography. Only seven per cent of this net impacted area however occurs within the Foxground and Berry bypass project.

The Foxground and Berry bypass project is dominated by the spurlines, slopes and gullies which fringe the valleys of the Broughton and Broughton / Bundewallah Creek valley floors. This topography accounts for 44 per cent of the project and 36 per cent of all confirmed Aboriginal recordings. The next largest landscape within the project is major alluvial valley floors, again belonging to the Broughton and Broughton / Bundewallah Creek valleys. These comprise 31 per cent of the project and account for 50 per cent of all confirmed Aboriginal recordings.

The remaining topography is of the higher ridges and spurs. This comprises 14 per cent of the project and accounts for four per cent of all confirmed Aboriginal recordings. Fifteen per cent of the Gerringong upgrade project area also includes higher ridges and spurs, and includes 22 per cent of the confirmed Gerringong upgrade Aboriginal recordings.

The topographies traversed by the three sections of the Princes Highway upgrade between Gerringong and Bomaderry have a relatively high site incidence, 1.14 sites per kilometre in the Gerringong upgrade project area and 2.48 sites per kilometre in the Foxground and Berry bypass project area. However, they do not in themselves provide a basis for broad concern about the cumulative impact of the project or the broader Princes Highway upgrade development context. In all cases, the topographies are not rare within the Southern Illawarra, and all extend up and downslope, and/or up and downstream of the highway easement. The archaeological resource encountered within the three sections of the Princes Highway upgrade between Gerringong and Bomaderry can be expected to similarly occur in adjacent areas. Given the linear nature of the highway project, the potential for substantial impact to a full suite of related landforms is low.

The location of the highway through the former location of Dicky Woods Meadow (G2B A13), and around the northern margin of Berry could be considered a cumulative impact. The high Aboriginal cultural significance of the former Meadow cannot be compared, or weighed against, an equivalent or expected archaeological resource elsewhere within the same topographic zone. This ethnographically recorded traditional battle ground is a rare site type and would be hard to predict elsewhere using archaeological and landscape criteria. The construction of the highway through the potential area of the former Meadow represents a substantial cumulative impact to the remaining area of that site.

The township of Berry is situated in the lower catchment of Broughton Mill Creek. Its continuing urban development has substantially impacted a suite of low spurs, basal slopes and creek flats at a point where the catchment merges with the coastal plain and the former estuary. Although this transitional zone, from bedrock basal slopes to the flat coastal plain, is extensive and continues southwest to Bomaderry, Berry remains the only section intersected by a major alluvial valley. As such, the impact of the Foxground and Berry bypass project along the northern margin of the town poses a further cumulative impact to this particular topographic nexus.

7.7.4 Environmental management measures

Mitigation and management measures would be implemented to avoid, minimise or manage Aboriginal heritage impacts. These mitigation and management measures have been identified in **Table 7-61** and incorporated in the draft statement of commitments in **Chapter 10**.

Throughout all phases of the project Aboriginal stakeholders would continue to have the opportunity to actively participate in an on-going consultation program regarding the management of Aboriginal cultural heritage within the project in accordance with the Procedure for Aboriginal Cultural Heritage Consultation (RMS, 2011).

Table 7-61 Mitigation and management measures

Potential impacts	Mitigation and management measures
Construction	
Stakeholder consultation	Continue ongoing consultation between RMS and Aboriginal stakeholders regarding the management of aboriginal cultural heritage within the project area.
General construction impacts	Develop a Heritage Management Plan prior to construction. The plan would include: • Registered archaeologists and representatives of registered Aboriginal parties to train construction teams prior to the commencement of construction. • Implement the Unexpected Finds Procedure (refer to **Appendix H** of the *Aboriginal Cultural Heritage Technical Paper* at **Appendix J**) for the unanticipated discovery of Aboriginal objects, burial sites and human remains. • Include appropriate training in site inductions for construction staff regarding the Unexpected Finds Procedure and the cultural significance of the Dicky Wood's Meadow, Brookside and Toolijooa Ridge. Where possible this training would be given by a project archaeologist and a representative of the registered Aboriginal parties. • Outline the assessment process for any works to be conducted outside of the currently defined project area. This would include activities such as realignment of utilities, land rehabilitation and revegetation programs.

Potential impacts	Mitigation and management measures
Impacts on cultural values and ethno historic sites	Minimise disturbance to the natural soil profile of G2B A13 and G2B A14 within the construction footprint. This would generally be achieved by constructing the proposed carriageway on embankment, reducing the need to cut into the natural soil profile. Where practicable, the removal of top soil would be avoided or minimised prior to the placement of fill. Further details on the suitability of this method are provided in **Section 11.1.2** in the *Aboriginal Heritage Technical Paper* (**Appendix J**). Reduce the visual impacts associated with the construction and finishing of the embankment and cutting faces along Toolijooa Ridge. This would be achieved in accordance with the mitigation measures in **Section 7.6** and would minimise impacts to the cultural values of the TRACL. Re-establish vegetation along the ridge as soon as practicable. Conduct archaeological salvage excavation prior to the commencement of construction works within G2B A13. Excavation would be conducted in all areas where it is anticipated that the natural soil profile would be impacted, such as from pier, abutment and swale construction. Consideration would be given to the use of remote sensing techniques as an initial stage of the salvage excavation program. This could assist in the selection of areas warranting detailed salvage methodologies. Design and construct the roundabout at the intersection of Woodhill Mountain Road and the current Princes Highway so that direct impacts are limited to the area of existing disturbance around the intersection (refer to **Appendix I** of the *Aboriginal Cultural Heritage Technical Paper* at **Appendix J**). Erect temporary fencing between the zone of construction activity and any adjacent areas of the historical Aboriginal encampments at Berry (G2B A39) to define a 'no–go' area for vehicles, material storage or other actions likely to result in ground disturbance. Avoid direct impacts to mature fig trees in the project area through the detailed design phase of the project. If direct impacts to fig trees are unavoidable, a management program would be established in consultation with the AFG. Where practicable, trees in poorer condition would be selected for removal in preference to those displaying signs of good health. Provide an opportunity for the Aboriginal stakeholders to conduct ceremonial activities, where required, within the project area of G2B A13 and TRACL prior to construction works.
Impacts to Aboriginal archaeological Impacts	Avoid unnecessary impact to site G2B A3. Conduct a program of salvage archaeological excavation at sites with research potential, including G2B A16, G2B A18, G2B A24, G2B A29, G2B A30, G2B A31, G2B A32, G2B A33, G2B A36 and G2B PAD1 prior to the start of construction related ground disturbance within the area of those sites. Erect temporary fencing between the zone of construction activity and any adjacent Aboriginal site, or portion of the site and/or archaeological deposit to define a 'no–go' area for vehicles, material storage or other actions likely to result in ground disturbance. This would apply to sites G2B A2, G2B A3, G2B A15, G2B A16, G2B A17, G2B A18, G2B A19, G2B A21, G2B A23, G2B A24, G2B A25, G2B A26, G2B A27, G2B A28, G2B A29, G2B A30, G2B A31, G2B A32, G2B A33, G2B A34, G2B A35, G2B A36 and G2B 38.

Potential impacts	Mitigation and management measures
Impacts from ancillary facilities	Adopt the following selection criteria for the location of ancillary facilities: • Locate ancillary facilities on sites that have a low likelihood of having Aboriginal heritage significance and/or potential. • Sites or areas of moderate to high Aboriginal heritage significance and/or potential, including known sites, potential archaeologically sensitive areas and areas of Aboriginal cultural significance, are not to be used for ancillary facilities except where the impact is authorised and managed by a relevant approval or an approved Heritage Management Plan. Fence Aboriginal sites adjacent to ancillary facilities and exclude these areas from ancillary functions and use. Avoid disturbance to the natural soil profile, by overlaying the area with a protective treatment barrier (such as geotextile), followed by a layer of hard stand gravels, all of which would be removed after construction during site rehabilitation. Conduct the required test excavation programs prior to construction as part of the detailed design phase of the project. Where direct impact to sites of Aboriginal heritage significance from the location and set up of ancillary construction facilities cannot be avoided: • Conduct a program of salvage excavation prior to impact on areas of potential that represent a continuation of landforms that are known to contain archaeological deposits. This would apply to the proposed ancillary sites D, E, F, I and K (refer to **Figure 4.20**). • Conduct a program of test excavation and management strategies for areas of greater than low predicted archaeological potential that are unrelated to adjacent confirmed archaeological deposits prior to direct impact. This applies to the proposed ancillary sites A, C, H and L (refer to **Figure 4.20**).
Operation	
Longer term impacts on Aboriginal cultural values and ethno-historic recordings	Develop a Heritage Interpretation Plan (HIP), with the aim of identifying options for the promotion of the cultural values of the project area for current and future generations. The HIP would be developed in consultation with Aboriginal stakeholders, landowners and local Councils. Options may include interpretive signage, educational materials, and supporting local museum displays. In particular, the HIP would acknowledge and promote the Aboriginal cultural values associated with TRACL and Dicky Wood's Meadow battleground (G2B A13).
Ongoing care of artefacts	Liaise with Aboriginal stakeholders regarding the management and curation of all Aboriginal artefacts (Aboriginal objects) recovered or salvaged from the project, following the completion of any required description and analysis. Submit an application for a Care Agreement to the OEH where artefacts are to be held in the care of an individual or organisation. Alternatively, recovered artefacts may be re-buried on-site or deposited with the Australian Museum (Sydney) pursuant to section 88 of the *National Parks and Wildlife Act 1974*.

Potential impacts	Mitigation and management measures
	Ensure all management and curation actions are consistent with OEH policy, comply with any necessary permit or agreement conditions and satisfy documentation standards. Record the location of all reburied Aboriginal objects on an OEH Aboriginal site recording form and submit to the OEH.
Impacts to cultural landscape values	Reduce the visual impact of the project through the planting and regeneration of vegetation. Minimise and mitigate the impact to ecological values. Re-establish native vegetation as a priority in areas requiring revegetation. Encourage the use of native plant species with Aboriginal cultural values in revegetation programs. Appropriate species would be identified through liaison with Aboriginal stakeholders. Incorporate or allow for the interpretation of cultural values, through the erection of signage, the adoption of Aboriginal nomenclature, or the inclusion of appropriately commissioned Aboriginal art or motifs.

7.8 Non-Aboriginal (historic) heritage

This chapter provides an assessment of non-Aboriginal (historic) heritage, which was nominated in the DGRs as a key environmental issue for the project. It represents a summary of the *Non-Aboriginal (Historic) Heritage Technical Paper* (NOHC, 2012), which was prepared for the project with consideration of the DGRs.

The technical paper is provided at **Appendix K**. The relevant extract from the DGRs is presented below.

Director-General's requirements	Where addressed
Historic heritage *– including but not limited to:*	
An assessment of the impact of the project on historic heritage values, in particular impacts on the historic township of Berry.	Section 7.8.3 Appendix K – Technical paper: Non-Aboriginal (historic) heritage assessment

7.8.1 Approach to assessment

The methodology used to identify heritage items within a study area, defined as the project area (including the highway and all ancillary facilities) plus a 200 metre buffer either side, included a search of relevant heritage registers and schedules together with a literature review, field survey and archaeological test excavation.

The significance of identified items was assessed following the NSW Heritage Branch (formerly DP&I and now OEH) guidelines 'Assessing Heritage Significance' (2001). This was followed by an impact assessment, the preparation of a Statement of Heritage Impact (SOHI) for each impacted item and the recommendation of mitigation measures. The SOHIs were prepared using NSW Heritage Branch guidelines 'Statement of Heritage Impact' (2002).

A distinction has been made between *field recordings* and *heritage items*. A *field recording* refers to any recorded item or site, regardless of its assessed heritage significance. A *heritage item* refers to an item or site which is assessed to have heritage significance which satisfies or exceeds the threshold for significance within a local context (as defined in the NSW *Heritage Act 1977,*

Literature and database review

A range of archaeological and historical data relevant to the project was reviewed. This literature and data review was used to determine if known historical sites were located within the study area. This was also used to create a predictive model of other historically significant sites that may be located in the study area and to place the project within an archaeological and heritage management context based on known regional and local site patterns. The review of documentary sources included heritage registers, databases and schedules, local histories and archaeological reports.

Sources of historical information included regional and local histories, heritage studies and theses, parish maps, newspaper articles, local museum displays, websites and, where available, other historical maps including Crown survey plans.

Searches were undertaken of the following statutory and non-statutory heritage registers and schedules (updated July 2012):

- Statutory listings:
  - World Heritage List (World Heritage Committee, UNESCO).
  - The National Heritage List (Australian Heritage Council).
  - The Commonwealth Heritage List (Australian Heritage Council).
  - The State Heritage Register (NSW Heritage Branch, OEH).
  - Section 170 Heritage and Conservation Register compiled by the RMS.
  - Section 170 Heritage and Conservation Register compiled by Rail Corp.
  - Schedule 7 (Heritage Conservation) *Shoalhaven LEP 1985* (with amendments as at 21 October 2011).
  - Schedule 5, Part 1 (Heritage Items, Environmental Heritage) *Kiama LEP 2011* (as at 16 December 2011).
  - Schedule 1 (Items of Environmental heritage) *Illawarra Regional Environmental Plan (REP) No.1*, gazetted 1986 and now deemed a State Environmental Planning Policy, (as at 7 January 2011).
- Draft statutory listings:
  - Schedule 5 (Environmental Heritage) *Draft Shoalhaven LEP 2009*.
  - Kiama Heritage Inventory, *Draft Kiama LEP 2010*.
- Non-statutory listings:
  - The Australian Heritage Database (Department of Sustainability, Environment, Water, Population and Communities (DSEWPC)).
  - The State Heritage Inventory (NSW Heritage Branch, OEH).
  - Australian National Shipwreck Database (DSEWPC).
  - The Register of the National Estate (Australian Heritage Council).
  - Shoalhaven Heritage Inventory (includes data sheets on LEP listed items together with non-listed items identified in previous Heritage studies and reports).
  - Register of the National Trust of Australia (NSW).
  - Australian Institute of Architects, Heritage Buildings List.
  - Engineers Australia (Engineering Heritage Recognition Program).
  - Royal Australian Institute of Architects Twentieth Century Register of Significant Buildings.

Since the original conduct of searches to inform this assessment, the Kiama LEP 1996 has been repealed and replaced by the Kiama LEP 2011. The Kiama LEP 2011 lists all dry stone walls in the Foxground area as a local heritage item. A dry stone wall remnant G2B H54 on Toolijooa Ridge is assumed to fall within this listed item, together with a similar listing in the Illawarra REP No.1.

Consultation with statutory authorities

Consultation with the Heritage Branch (OEH) undertaken to date includes:

- Formal notification of the project by RMS.
- A meeting with the heritage branch of OEH on 2 August 2012 to present the project and discuss the assessment and its outcomes.

Additionally, information has been accessed from the State Heritage Inventory, State Heritage Register and Minutes of the State Heritage Register Committee.

The majority of consultation with government authorities has occurred with the staff of Shoalhaven City and Kiama Municipal Councils.

Archaeological field survey

An archaeological field survey and inspection was conducted over a period of three months (February to April) in 2009 in multiple survey events according to property access availability and local weather conditions. This program was conducted as part of a wider survey extending between Mount Pleasant (Gerringong) and Bomaderry. Isolated and supplementary inspections, specific to the project, also occurred in 2010 and 2011.

The archaeological survey within the study area involved both on foot and vehicle inspection, depending on property access and ground visibility constraints. The intensity of the survey varied according to an appreciation of ground surface visibility, archaeological potential, historical research, and the interpretation of historical mapping and aerial photography.

The field assessment involved the inspection of standing structures, surface and above ground archaeological remains, and an assessment of the potential for subsurface archaeological material.

Recordings were numbered following an inventory compiled for an archaeological survey of the preferred Princes Highway upgrade alignment between Mount Pleasant (Gerringong) and Bomaderry. As a consequence, the start and finish numbers are variable.

Archaeological test excavation

Test excavations were conducted at recording G2B H14 and consisted of a series of one metre by one metre test pits excavated at 10 metre intervals within an area of identified potential. These pits were then expanded, or abandoned, on the basis of the stratigraphy and artefacts contained within them. Further explanation of the test excavation methodology is provided in **Section 2.5** of the *Non-Aboriginal (Historic) Heritage Technical Paper* at **Appendix K**.

7.8.2 Existing environment

Historical context

On 10 March 1805, Lieutenant Kent of HMS Buffalo returned to Sydney after examining the district overland 18 miles north from Jervis Bay. Information from that expedition confirmed that the area was originally covered with rainforest, brush cedar, soft and hardwoods and a variety of bushes, palms, vines and ferns.

Independent cedar getters were in the Shoalhaven from at least 1811 and the Speedwell ship managed to bring the first recorded cargo of cedar from the Shoalhaven River to Sydney in December 1812. The timber industry then grew in scale, exploiting the patches of cedar on the rivers and creeks, but the main concentration was in the Long Brush, which stretched from Kiama to Jamberoo (Peter Freeman Pty Ltd 1998:11).

A route from Sydney to the Southern Highlands was established in 1821. It was pioneered by Hamilton Hume and Charles Throsby through Tallaganda Shire, with Hume reporting that the route could be made along a line of trees he had marked.

After Hume returned from that expedition he left Sydney with Lieutenant Johnston and Alexander Berry in January 1822 to explore the coastal rivers. They sailed up the Clyde and trudged inland to the Pigeon House. Although it was a government sponsored voyage, it appears that Berry’s purpose was to seek out land on which he could make a settlement (Bayley 1975:20).

Alexander Berry and his business partner Edward Wollstonecraft were given grants in the area from 1822 onwards. The land grants were used to pasture stock that were given to them in lieu of debts. Unlike other Sydney merchants who took up land but seem to have kept their mercantile and pastoral activities separate, Berry and Wollstonecraft set out to integrate the two. During its early years the Shoalhaven estate was the source of much produce sold in their Sydney George Street store. To that end they developed the land and acquired more. By 1843 historical maps indicate that Wollstonecraft, Berry and his brother David, owned the majority of the study area.

The partners' effort to enlarge their estate at every opportunity was probably to secure the cedar getting in the district, for by the 1820s the supply of cedar from the Illawarra and the Hunter River valley was nearing exhaustion. Maize, tobacco, wheat, barley and potatoes were planted and marketed in Sydney; pigs were also reared and cattle were brought to the Shoalhaven from the Illawarra over a road made for the purpose. The partners bought a ship to provide transport between Sydney and Shoalhaven and also began to drain the extensive swamps included in their grants. On Wollstonecraft's death in 1832, the property was passed to Berry.

Following Alexander's death, the estate passed to David Berry, who died unmarried at Coolangatta in 1889. Following his death, enormous bequests by David Berry to the University of St. Andrews (Scotland) and to the endowment of a hospital at Berry, amounting to a quarter of a million pounds, necessitated sale of the estates by the Trustees. They immediately set about a comprehensive plan of improvements before selling including reclamation of the swamp areas.

On 29 March 1892 the sale of the Berry (Shoalhaven) Estates began and continued for three days. The entity was divided into three for the purpose of the sale. First, the Gerringong farms which included four estates and totalled 175 acres; second the whole township of Bomaderry; and third the Numbaa estates, which totalled between 5,000 and 6,000 acres respectively.

Broughton Creek (Berry)

Until 1899, the town of Berry was known as Broughton's Creek, Broughton Creek, or simply 'The Crick'. It was named after Broughton (c.1798-c.1850) an Aboriginal guide, tracker and constable. In 1822, Broughton started work for Alexander Berry, setting up Berry's farm, Coolangatta, recruiting Aboriginal labour, keeping the peace, capturing bushrangers and droving cattle. He became a favourite of Berry, who presented him with a rectangular breastplate inscribed 'Broughton Native Constable of Shoalhaven 1822'.

Broughton Creek was strategically sited on the northern part of Alexander Berry's Coolangatta Estate with a double wharf on the junction of Broughton Creek and Broughton Mill Creek, a water powered sawmill and a tannery. By 1860, the town was a focal point for the farming hinterland.

James Wilson, a ferryman at Back Forest was appointed manager of the tannery and ran a general store. After the tannery buildings were badly damaged in the severe floods of the 1860s and 1870s, Wilson opened a new store on higher ground on the corner of Pulman Street in nearby Broughton Creek Village (Mabbutt n.d 9).

The village had a schoolhouse provided by Alexander Berry in 1861 and a postmaster from the same date. By 1866, there were 300 people in the immediate vicinity. Although the sawmill had closed, the tannery flourished. There were also two stores, a blacksmith, a saddlery and a hotel (Bayley 1975).

As the land was opened up first by Berry estate tenant farmers, and in the 1860s, by settlers under the Robertson Land Act, Broughton Creek became the port servicing a large area of dairy farm. Farmers from Broughton Vale, Broughton Village, Jaspers Brush, Brothers Creek, Woodhill and even Kangaroo Valley, took their butter and other produce to the wharf at Broughton Creek. From the wharf it was taken to the ocean steamer at Greenwell Point or drogher, until 1871, when Alexander Berry provided a flat bottomed steamer, the *Coolangatta*.

Despite the Berry estate's insistence on yearly tenancies in the area, stores and shops were built in the 1870s and in 1879, Broughton Creek was surveyed and a plan for a town was made on the higher land on the west bank of the creek.

After David Berry's death in 1889, the name of the township was changed from Broughton Creek to Berry in his honour.

The Illawarra rail line (now the South Coast line) was opened as an isolated line as far as Bombo in 1887. The Bombo to Bomaderry section was opened in 1893 (www.nswrail.net).

The town of Berry continued to flourish as a service centre for a predominantly saw milling and dairying district. The population was 1300 in 1884, with additional town blocks enlarging the town site from that laid out in 1883. Today, Berry continues to provide the basic service needs of the community, but the 1980s saw it transformed into a tourist town, with tea rooms, antique and gift shops (Clark 1993:5, Cousins 1994:260-263, Peter Freeman Pty Ltd 1998:20, Lidbetter 1993:4).

Literature and database review

The review of archaeological and historical data and literature found that there are eight heritage items within the study area. These items are listed on existing statutory registers and include (followed by the site ID number assigned for this project):

- The existing Princes Highway Broughton Creek bridge which is listed on the RMS section 170 Heritage and Conservation Register (G2B H29).
- Six items on the Heritage Conservation Schedule (Schedule 7) of the Shoalhaven LEP 1985 (with amendments as at 21 October 2011). These include (followed by the site ID number assigned for this project):
  - Mananga Homestead and property, Berry (G2B H16).
  - Glenvale Homestead and property, Broughton (G2B H45).
  - St Patrick's Church, Convent and grounds, Berry (G2B H47).
  - Uniting Church Hall, Berry (G2B H58).
  - Avenue of Nine Poplar trees on Woodhill Mountain Road, Berry (G2B H62).
  - Mark Radium Park, Berry (G2B H63).
- A dry stone wall on Toolijooa Ridge (G2B H54) may fall into a listed category of dry stone walls in the Foxground area, included both within the heritage schedule items in the *Kiama LEP 2011* (Schedule 5, Part 1, Environmental heritage) and the *Illawarra REP No.1* (Schedule 1, Items of environmental heritage). The Kiama Municipal Council assumes these listings are inclusive of all dry stone walls within the Kiama LGA.

The Berry District Landscape Conservation Area is a broad scale, landscape based recording, originally defined by the National Trust of Australia (New South Wales). It is listed on the Trust's register and was also placed on the Register of the National Estate as an Indicative Place.

The *Mananga* homestead is included on the Royal Australian Institute of Architects 20th Century Register of Significant Buildings (no. 47022656). It is identified simply as a residence on the Princes Highway, with an approximate date of 1910. The presence of elaborate gable treatment on the southern verandah is noted. This site is also on the Shoalhaven LEP 1985 Heritage Schedule.

Archaeological field survey

Forty non-Aboriginal field recordings have been identified within the study area (G2B H10-G2B H30, G2B H45, G2B H47-G2B H63 and the Southern Illawarra Coastal Plain and Hinterland Cultural Landscape (SICPH CL)). The locations of the recorded items are shown in **Figure 7-42** at a small scale (excluding SICPH CL, and on large scale aerial photography in the *Non-Aboriginal (Historic) Heritage Technical Paper* at **Appendix K**.

Six of these recordings were not found to have heritage significance against the assessment criteria. These recordings consist of two cottages (G2B H10 and G2B H50), and four twentieth century highway remnants (G2B H12, G2B H18, G2B H24 and G2B H57).

The remaining 34 recordings were found to have heritage significance and are classed as heritage items. These consist of (followed by the site ID number assigned for this project):

- Ten road sections or remnants (G2B H15, G2B H19, G2B H20, G2B H21, G2B H22, G2B H23, G2B H26, G2B H27, G2B H30 and G2B H55).
- One highway bridge (G2B H29).
- Twelve standing buildings or building groups (G2B H11, G2B H13, G2B H16, G2B H17, G2B H25, G2B H28, G2B H45, G2B H47, G2B H49, G2B H51, G2B H56 and G2B H58).
- Five confirmed or potential archaeological deposits (PADs) comprising former building sites (G2B H14, G2B H48 G2B H52-G2B H53, and G2B H59).
- One quarried rock outcrop (G2B H61).
- One remnant dry stone wall (G2B H54).
- One tree avenue (G2B 62).
- One public park (G2B H63).
- One item of movable heritage, a skid mounted work-site shed (G2B H60).
- One cultural landscape, the SICPH CL.

Of these heritage items, eight are included on existing statutory heritage listings (G2B H16, G2B H29, G2B H45, G2B H47, G2B H54, G2B H58, G2B H62, and G2B H63). These are:

- Mananga Homestead and property, Berry (G2B H16).
- 20th century concrete bridge (Princes Highway, Broughton Creek) (G2B H29).
- Glenvale Homestead and property, Broughton (G2B H45).
- St Patrick's Church, Convent and grounds, Berry (G2B H47).
- Dry Stone Wall, Toolijooa Ridge (G2B H54).
- Uniting Church Hall, Berry (G2B H58).
- Avenue of Nine Poplar trees on Woodhill Mountain Road, Berry (G2B H62).
- Mark Radium Park, Berry (G2B H63).

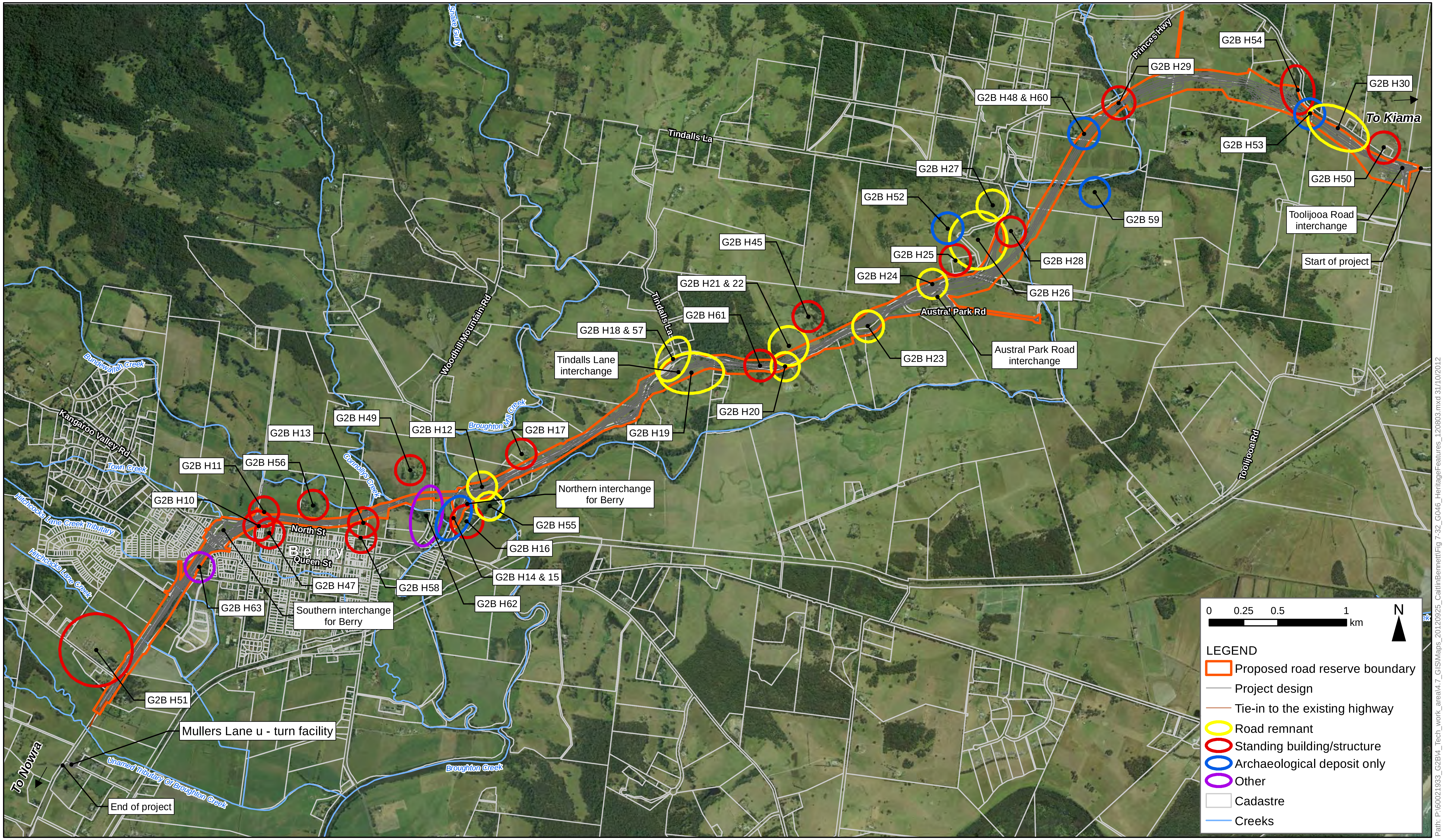

Figure 7-42 General location of non-Aboriginal heritage recordings

Source: AECOM (2009), LPMA (2011)

Archaeological test excavation

Five PADs were identified as a result of the archaeological survey (G2B H14, G2B H48, G2B H52, G2B H53 and G2B H59). It was determined that only one of these locations required further archaeological investigation in order to draft appropriate management strategies relative to its assessed significance. This site G2B H14 is the location of former buildings at the northern end of the Broughton Creek village (now Berry). Of the remaining four PADs, three would not be subject to direct impact. The remaining PAD (G2B H53) would be subject to a program of archival recording (and salvage, if required) to assist in confirming its heritage significance.

Archaeological test excavations were undertaken at G2B H14 to determine the nature, extent and significance of the archaeological deposits in the area.

The site extends for about 130 metres north-south by 15 metres east-west (at its widest point). It borders the eastern margin of the current Princes Highway alignment, where it diverges from the former pre-1955 alignment, on the northern approach into Berry. The site comprises PADs from former nineteenth and twentieth century Broughton Creek town buildings that were located along the western side of the former highway alignment (G2B H15). Based on historical research compiled by members of the Berry and District Historical Society, the following structures of local heritage significance are known, or reliably predicted, to have occurred in this area:

- The Berry Butter Factory (1889).
- Court House (1870s).
- Roman Catholic Church (1866).
- The Council Chambers (1868).
- Overseers Cottage (1858).
- A Carpenter’s Cottage.

The artefact assemblage from the test pitting program at G2B H14 comprises glass, ceramic, metal and miscellaneous (brick, shell, wood, plastic) items. Two hundred and ninety-four pieces were recovered from the excavation. The assemblage is broadly characterised by late nineteenth-century or early twentieth-century material culture and some more recent roadside debris; the latter being most prominent in the upper levels of the site.

On the basis of historical research, including analysis of aerial photographs and available maps, it appears that the archaeological deposits at G2B H14 relate primarily to an area of street frontage, as opposed to the above mentioned structures themselves. There is however potential for traces of the buildings to occur along the western margins of the site.

In summary, archaeological deposits at G2B H14 were assessed as having potential to provide information on the following aspects of the site’s history:

- The width of the street frontage and the activities that took place in this area.
- The location of individual buildings or portions of their eastern limits.
- The location of individual lot boundaries that extend east to west across the site.
- Differing site functions across these lots.
- Overall site chronology from the mid nineteenth to mid twentieth century.

Cultural landscape values

The SICPH CL extends southwards from the southern Illawarra Range, from Mount Pleasant in the east, to Browns Mountain in the west, and southwards to Greenwell Point. The predominantly pastoral landscape character of the coastal plain and adjacent escarpment slopes has been previously recognised as a landscape with significant heritage and conservation values (such as by the National Trust). The identification of the SICPH cultural landscape for this assessment, seeks to recognise the cultural heritage values of this are as a consequence of the interplay between cultural practice and the physical environment.

Recent trends in the region have seen the decline of many smaller villages and communities, changes in population density, the diminishing viability of small farms and the growth of rural subdivision. However, the region retains a fundamentally nineteenth century pastoral structure. This is evident as a patchwork of cleared and drained floodplains, cleared estates, vegetated boundaries, forested upper slopes, and a network of townscapes and valley settlements. All of these elements are aesthetically held together by the backdrop of the Illawarra Range, its top escarpment, and prominent ridgelines extending across the plain to the coast.

The vegetation of the region is also a critical component of the cultural landscape. Landscape elements include the continuous pastoral grasslands, remnant patches of sclerophyll and regenerating rainforest, ribbons of riparian vegetation and the widespread iconic incidence of often isolated cabbage tree palms, large spreading fig trees and boundary plantings of Coral trees.

The town of Berry is an integral component of the cultural landscape and its values are identified in the SICPH CL recording. The importance of the town can be summarised by the following points:

- It is the only town within the SICPH CL, and north of the Shoalhaven, which was founded as a private town, and as a part of the Berry Estate.
- It is the only non-coastal, nineteenth century town within the SICPH CL which has developed a viable urban presence, identity and civic centre.
- It demonstrates the historical progression from a private village, initiated and supported by the Berry Estate, to a public town governed by a local government authority.
- It has always been an important part of local district networking and in particular, infrastructure for communication, transport, industry, trade and administration.
- Its road and rail corridors endure as active elements, its maritime corridor (Broughton Creek) remains as an inactive component.
- Its institutions, industry and organisations have variously dominated and influenced the development, extent and structure of the surrounding region.
- It is centrally located within the SICPH CL and provides an aesthetic and cultural focus.
- Many of the nineteenth century traits of the town have not been replaced or overwhelmed by subsequent latter twentieth century urban or industrial development.
- The context of the town remains pastoral.

Many of these characteristics and values form the basis for the recent recognition, by the National Trust of Australia (NSW) of the *Berry Township Urban Conservation Area* (BTUCA). This area was listed on the Trust's Register in 2011. The listing recognises the historic development of the town, and its distinctive urban character set within a rolling agricultural landscape. The following are identified as key components of the town:

- The range of nineteenth and first half of the twentieth century (mostly single storey) pitched roofed public, commercial and residential buildings.
- The arrangement of buildings within a strict nineteenth century urban grid.
- The residential gardens and street tree plantings.
- The containment of town development within the grid and the abrupt boundary (and resulting contrast) with the adjacent rural lands.
- The views out from the townscape to the rural lands and the Illawarra escarpment.
- The views into the town.

The BTUCA listing incorporates three levels (refer to **Figure 7-43**):

- A broad scale visual boundary which adopts the regional boundary of the Berry District Landscape Conservation Area previously defined by the National Trust (New South Wales). This area is roughly equivalent to the SICPH CL.
- A subdivision boundary which relates to the closer urban settlement of the nineteenth century Berry town grid.
- A buffer zone which seeks to protect the immediate rural setting of the urban grid (Clark and Duyker 2010).

The Berry-Bolong Pastoral Landscapes also shown in **Figure 7-43** is another previously defined landscape conservation area which includes the project.

Figure 7-43 Previously defined landscape conservation areas which include the project

7.8.3 Assessment of potential impacts

Significance assessment

Environmental heritage means those places, buildings, works, relics, moveable objects, and precincts, of state or local heritage significance (Section 4, *Heritage Act 1977*). An item would be considered to be of State (or local) heritage significance if, in the opinion of the Heritage Council of NSW, it meets one or more of the following criteria:

Criterion (a)	An item is important in the course, or pattern, of NSW's cultural or natural history (or the cultural or natural history of the local area).
Criterion (b)	An item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the cultural or natural history of the local area).
Criterion (c)	An item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area).
Criterion (d)	An item has strong or special association with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons.
Criterion (e)	An item has potential to yield information that would contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area).
Criterion (f)	An item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area).
Criterion (g)	An item is important in demonstrating the principal characteristics of a class of NSW's: • cultural or natural places; or • cultural or natural environments. (or a class of the local area's: • cultural or natural places; or • cultural or natural environments.)

Of the forty non-Aboriginal (European) field recordings:

- Six have been found to fall below the significance thresholds defined within the assessment criteria. These are G2B H10, G2B H12, G2B H18, G2B H24, G2B H50 and G2B H57. These recordings will not be considered further with regard to potential impact and impact mitigation.
- Three cannot be given definitive assessments until the nature of predicted archaeological deposits are confirmed through test excavation. These items have been given indicative assessments of local context significance, subject to confirmation (G2B H48, G2B H52 and G2B H53). It should be noted that these sites would not be impacted by the project.
- One is assessed as having State significance (Graham Park – former agricultural research institution, G2B H51).
- The remaining thirty items are assessed as having heritage significance within a local context, according to one or more of the specified significance criteria.

The significance assessment of each site or item against the assessment criteria is provided in **Table 7-62**. A more detailed assessment is presented in **Appendix H** of the *Non-Aboriginal (Historic) Heritage Technical Paper* at **Appendix K**.

Table 7.62: Summary of Non-Aboriginal significance assessments

ID	Recording	Description	Context of significance	Significance criteria a	b	c	d	e	f	g	Summary statement of significance
G2B H10	Early C20th Cottage (72 North St. Berry)	Early twentieth century cottage, impacted by modern renovation.	Below threshold								The cottage at G2B H10 does not meet any of the significance criteria. This item falls below the threshold for heritage listing.
G2B H11	Federation Cottage c.1894 (77 North St. Berry)	Federation house with a number of additions.	Local							✓	The *GlenDevan* house (G2B H11) is of local significance as a representative example of Federation period housing on the Berry Estate.
G2B H12	Remnant portion of C20th highway (N. Berry wayside stop)	Ceased use as part of the highway in 1955. It was used as a Council stockpile area until it was reconfigured as a landscaped wayside stop (170 metres)	Below threshold								**Twentieth century highway remnants** The twentieth century road remnants comprised by the recordings G2B H15, G2B 20, G2B 21 and G2B 26 form an important example of elements of early twentieth century highway design, construction and modification. In particular, G2B H26 is important in the course of local highway upgrades. It is also directly associated with the Binks, an early tenant farming family that is of importance due to its involvement with the development of the local dairy industry. Items G2B H20, G2B 21 and G2B 26 all have the potential to yield information regarding standards in early twentieth century road design and construction, and G2B H15 and 26 are notable in terms of their rarity and representativeness. Remnant recordings G2B H12, G2B 18, G2B 24 and G2B 57 all fall below the threshold of significance defined in the assessment criteria.
G2B H15	Remnant portion of C20th highway (Adj to *Mananga* homestead)	Ceased use as part of the highway in 1955 and is now used as an access road for adjacent residential lots (195 metres).	Local						✓	✓	
G2B H18	Remnant portion of C20th highway (near and opposite Tindalls Lane intersection)	Now resumed within an adjacent dairy farm (150 metres).	Below threshold								
G2B H20	Remnant portion of C20th highway (Broughton)	Now resumed within adjacent dairy farm (195 metres).	Local					✓			
G2B H21	Remnant portion of C20th highway (Broughton)	Remnant includes a 90 degree bend and upslope embankment, and is revegetated (120 metres).	Local					✓			

ID	Recording	Description	Context of significance	Significance criteria							Summary statement of significance
				a	b	c	d	e	f	g	
G2B H24	Remnant portion of C20th highway	Poorly preserved and has been used extensively as a fill, gravel and materials dump (180 metres).	Below threshold								
G2B H26	Remnant portion of C20th highway	This portion of highway formerly known as “Binks’ Corner”, consists of an angled descent and ascent across a small valley, and was bypassed when the ‘Big Dipper’ was constructed in 1936. It follows an 1870s-80s alignment of the highway (total length around 612 metres).	Local	✓	✓			✓	✓	✓	
G2B H57	Remnant portion of C20th highway (intersection of Highway and Tindalls Lane)	Small remnant, substantially impacted by more recent road works and the Eastern Gas Pipeline (30 metres).	Below threshold								
G2B H13	Burnett Estate Workers Cottage c.1917 (143 North St. Berry)	Simple weatherboard cottage (c. 1917), former residence for an agricultural estate worker.	Local							✓	The Burnett Estate Overseer’s Cottage at G2B H13 is a well preserved and locally representative example of an early twentieth century weatherboard overseer’s cottage.

ID	Recording	Description	Context of significance	Significance criteria a	b	c	d	e	f	g	Summary statement of significance
G2B H14	Archaeological deposit (former C19th *Broughton Creek* town buildings)	A number of former town structures were located on the eastern side of the former highway alignment (G2B H15), roughly opposite *Mananga*. These include the Berry Butter Factory 1889, Overseers Cottage 1858, Court House 1870s, and the Council Chambers 1868, and a Carpenters Cottage.	Local	✓				✓	✓	✓	The site G2B H14 is of importance in terms of the local history, particularly the development of nineteenth-century commercial and government premises and the road network. Excavations at the site have demonstrated that the G2B H14 archaeological deposits have the potential to yield information that will contribute to an understanding of site function(s), the spatial organisation of the urban landscape at Broughton Creek, and site chronology and formation processes. The remaining deposits at G2B H14 are rare within the local Berry context as the only remnants of this northernmost portion of the urban landscape and as a representative example of a relatively undisturbed portion of a nineteenth century street frontage.
G2B H16	*Mananga,* 1894, Queen Anne style homestead, former Berry Estate Manager's Residence (A40 Princes Highway. Berry)	Federation (1894) Queen Anne style homestead, possibly designed by Sydney architect Howard Joseland. Property includes portion of Berry Estate water mill race.	Local	✓	✓	✓		✓		✓	The Mananga Homestead and the broader site complex are of local historical importance due to their role in the course of the history and development of the Berry Estate and Broughton Creek Village. Mananga Cottage and Mananga Homestead are both directly linked to important members of the Stewart Family, and as such have a strong and special historical association. The complex as a whole, and the Mananga Homestead in particular, display landmark qualities and are important in demonstrating aesthetic characteristics of a Federation period homestead. The site also has the potential to yield information that would contribute significantly to an understanding of the history of and development of the site, the Berry Estate and Broughton Creek Village. Of particular note is the existence of traces of the water race from the 1830 Broughton Creek saw mill. This item is also locally representative of a complex with multiple phases of occupation and a Federation Queen Anne style farm house with Art Nouveau character.

ID	Recording	Description	Context of significance	Significance criteria							Summary statement of significance
				a	b	c	d	e	f	g	
G2B H17	*Hillview* homestead (2nd half C19th) former Berry Estate tenant farm) (A111 Princes Highway Berry)	Former 19th century Berry Estate tenant homestead.	Local					✓	✓	✓	The *Hillview* homestead is a locally rare and representative example of a mid-nineteenth century slab house from a Berry Estate tenant farm. It is characteristic of a Scottish style of house layout and it has the potential to contribute, through archaeological survey/excavation to an understanding of organisation and operation of the Berry Estate as well as the living conditions and social status of tenant farmers.
G2B H19	Remnant portion of C19th road (West of Gembrook Lane)	Poorly preserved remnant of the original Berry Estate Road (430 metres).	Local	✓	✓			✓	✓		**Remnants of the Berry Estate Road (c.1856-1870s)** The remnant sections of the nineteenth century Berry Estate road are representative and relatively rare examples of a transport corridor that was locally important as a private road and as the first inland route that bypassed Seven Mile Beach. These road remnants have a strong association with Messrs Alexander and David Berry, who were of local importance due to their prominent role in European settlement. They also display the potential to yield information, through archaeological excavation and survey, that would contribute to an understanding of nineteenth century road construction and use.
G2B H22	Remnant portion of C19th road	Remnant of original Berry Estate Road, and includes shallow cutting (460 metres).	Local	✓	✓			✓	✓		
G2B H23	Remnant portion of C19th road	Remnant of the original Berry Estate Road (320 metres). The road is evident as a shallow relief and through differences in grass cover.	Local	✓	✓			✓	✓		

ID	Recording	Description	Context of significance	Significance criteria a	b	c	d	e	f	g	Summary statement of significance
G2B H27	Remnant portion of C19th road	This is a portion of the original Berry Estate Road which was superseded by the adjacent, more gradient sensitive 1870s-80s alignment (G2B H26). It includes three straight sections with two corners, including a well preserved cut and benched section of 260 metres (total length is 550 metres).	Local	✓	✓			✓	✓	✓	
G2B H30	Remnant portion of C19th road	A relatively well preserved section of road, situated within a pasture field, along the crest and shoulder of a prominent spurline. This remnant is a portion of the original Berry Estate Road. The road platform is evidenced by side ditches and variably shallow ground relief. Includes bordering gum trees at the eastern end and descent to Toolijooa Road saddle (530 metres).	Local	✓	✓			✓	✓	✓	

ID	Recording	Description	Context of significance	Significance criteria a	b	c	d	e	f	g	Summary statement of significance
G2B H55	Remnant portion of C19th road (north/upslope of *Mananga* homestead)	Remnant of original Berry Estate Road (100 metres), evident as a cut and benched platform, impacted by modern cross drains.	Local	✓	✓			✓	✓	✓	
G2B H25	*Sedgeford* homestead, 1902, (A495 Princes Highway, Broughton Village)	Federation weatherboard homestead (1902) and gardens.	Local		✓					✓	The *Sedgeford* homestead and gardens have a strong and special association with the Binks Family, a well known local family who have, since the beginning of the twentieth century, made a lasting contribution to the local and wider community through the dairy industry. G2B H25 is representative of an early twentieth century dairy farm in association with a disused highway alignment; it retains well preserved examples of the Federation period homestead and the associated gardens.
G2B H28	*Brookside* homestead (A540 Princes Highway. Broughton Village)	Late 19th century to early twentieth century homestead. Buildings have been transported from other locations and there are also archaeological traces of former outbuildings. This recording includes a memorial tree and plot with the cremated remains of Mr William Chittick (died 2005), located 220 metres upstream of the homestead on the western side of the Broughton Creek.	Local					✓		✓	The Brookside homestead comprises two salvaged structures, one of which appears to be from portion 181, a 100 acre block associated initially with Anthony Finn and later with Dicky Woods. Investigation and analysis of the Brookside homestead's constituent elements, in particular the section from portion 181, may yield information that will help in interpretation of deposits at G2B H59. The archaeological traces of former structures, including a dairy, at G2B H28 have the potential to yield information that will contribute to an understanding of the history of the local dairy industry. They also have the potential to be representative of such a site.

ID	Recording	Description	Context of significance	Significance criteria							Summary statement of significance
				a	b	c	d	e	f	g	
G2B H29	C20th concrete bridge, 1935, (Princes Highway. Broughton Creek)	RMS Bridge number 704, Southern Region. Constructed in 1935, using standard concrete beam design, and widened in 1994.	Local	✓		✓			✓	✓	The Broughton Creek Bridge's construction is associated with the grand scheme of highway improvement undertaken by the Main Roads Board cum Department of Main Roads in an attempt to bring the State's main roads up to the standard required by the modern motoring age emerging in the inter-war period. As a widened bridge, it represents the continual process of upgrading required in response to the increased volume, weight and speed of traffic on this busy highway
G2B H45	*Glenvale* homestead, former Berry Estate tenant farm (A371 Princes Highway. Broughton)	Former Berry Estate tenant farm, homestead includes vertical slab construction.	Local					✓	✓	✓	The *Glenvale* homestead is a locally rare and representative example of a mid-nineteenth century slab house from a Berry Estate tenant farm. It is characteristic of a Scottish style of house layout and it has the potential to contribute, through archaeological survey/excavation to an understanding of organisation and operation of the Berry Estate as well as the living conditions and social status of tenant farmers.
G2B H47	Former St Patrick's Convent, and St Patrick's Church and grounds (80 North St. Berry)	Two story brick convent building, brick church and grounds	Local				✓		✓	✓	St Patrick's Church and grounds, including the former St Patrick's Convent, are strongly associated with the local Catholic community; the site has been associated with the Catholic Church since the late nineteenth century. The former convent is a locally rare site type and the complex as a whole is representative of inter-war religious architecture and a Catholic site complex.
G2B H48	Potential archaeological deposit, former Berry Estate tenant farm (now Greystanes Lodge)	Location of a former Berry Estate tenant farm, homestead, now redeveloped with modern farm buildings (*Greystanes Lodge*). Any remaining archaeological items are likely to be substantially disturbed.	Local (subject to confirmation through test excavation)					✓			The potential archaeological deposits at G2B H48 are locally significant as a site that may contribute to an understanding of life on Berry Estate tenant farms.

ID	Recording	Description	Context of significance	Significance criteria							Summary statement of significance
				a	b	c	d	e	f	g	
G2B H49	*Oakleigh* homestead (59 Woodhill Mountain Rd. Berry)	Inter War Bungalow style Farmhouse.	Local					✓		✓	The homestead at G2B H49 is locally representative of 1930s farm house construction. It is a well preserved example of its type.
G2B H50	*Clare Moy* Cottage (342 Princes Highway. Toolijooa)	Early 20th century weatherboard farm cottage.	Below threshold								The *Clare May* Cottage does not meet any of the significance criteria. This item falls below the threshold for heritage listing.
G2B H51	*Graham Park* former agricultural research institution (8, 9 and 13 Schofields Lane, Berry)	Former agricultural research station. The first Artificial Insemination Breeding Station in New South Wales was established at Berry in the 1950s and was subsequently moved to Graham Park in 1958. The facility closed in the 1990s.	State	✓	✓	✓		✓	✓	✓	Graham Park Research Station is of local and State importance in terms of its role in the development of agricultural research, in particular artificial insemination and stock breeding. It is also historically linked to pioneering research sponsored by the Berry Estate under Alexander Hay, and directly linked to the life and works of Edward Graham, an individual of State importance in the context of government policy on agriculture and agricultural development. Graham Park also derives significance at local and State levels due to its contributions to agricultural research. The complex of buildings, laboratories, sheds and enclosures has the potential to yield information, through archaeological investigation, that would contribute to an understanding of the development and operation twentieth century agricultural research stations. It is a locally rare site that is also representative of its type at local and State levels.
G2B H52	Potential archaeological deposit, former Berry Estate tenant farm (A441 Princes Highway. Broughton Village)	PAD, situated on the angle in the 'Binks Corner' remnant highway section (G2B H26). The only such PAD where the original relationship between the structures and the 1870s-80s highway may survive.	Local (subject to confirmation through test excavation)					✓	✓	✓	The potential archaeological deposits at G2B H52 relate to a nineteenth century Berry Estate tenant farm. This site is of local significance as a place that has the potential to yield information about tenant farms and the interrelationship between such sites and sequences of transport corridor modifications through the nineteenth and early twentieth centuries. It is also locally important as an example of a former tenant farm that maintains its original configuration with the 1856 and 1870s highway alignment and as a representative example of such a site.

ID	Recording	Description	Context of significance	Significance criteria							Summary statement of significance
				a	b	c	d	e	f	g	
G2B H53	Potential archaeological deposit, former Berry Estate tenant farm structure and indeterminate rock rubble alignment (Toolijooa Ridge)	PAD. The PAD site includes an indeterminate rock rubble alignment parallel to a former 19th century road alignment (Berry Estate Road).	Local (subject to confirmation through test excavation)					✓			The potential archaeological deposits at G2B H53 are locally significant as a site that may contribute to an understanding of life on Berry Estate tenant farms.
G2B H54	Remnant C19th dry stone wall (former highway boundary, Toolijooa Ridge)	Remnant dry stone wall, situated along former western boundary of highway easement, at least 100 metres in length, and possibly extending for a further 150 metres north (obscured by lantana growth).	Local			✓		✓	✓	✓	The dry stone wall at G2B H54 is of local significance in terms of its aesthetic values, research potential, and its rarity as a fence type and regional outlier.
G2B H56	Farmhouse and Dairy (disused), early to mid C20th, (117 North St., Berry)	Standing ruins of early twentieth century farmhouse, outbuildings, disused dairy and yards.	Local					✓		✓	The Broughton Mill homestead and dairy is a good and locally representative example, albeit somewhat dilapidated, of an early twentieth century dairy farm.
G2B H58	Uniting Church Hall (formerly Wesleyan Chapel), 1884, Victorian Carpenter Gothic style, (69 Albert St, adj. to North St)	Timber frame and weatherboard church hall/chapel.	Local	✓			✓		✓	✓	The Uniting Church Hall is of local historical importance as the first building to be erected on land legally acquired in the new township of Berry; it is also important in the course of the development of the township and its places of religious worship. This item is also of local social significance due to its ongoing connection with the Uniting Church community. The church hall is also a locally rare and representative item in terms of a Victorian Carpenter Gothic building.

ID	Recording	Description	Context of significance	Significance criteria							Summary statement of significance
				a	b	c	d	e	f	g	
G2B H59	Archaeological deposit and remnant plantings, former early C19th homestead (Broughton Village)	Remnant tree plantings, garden plants and surface foundation stones are indicative of an archaeological deposit of a former early 19th century farm residence.	Local	✓	✓			✓	✓	✓	The potential archaeological deposits at G2B H59 are of local significance as a site associated with early land alienation, in particular an unusually small land grant amongst a series of larger estates. The site also appears to be directly associated with Anthony Finn, an individual of local importance. The potential deposits at G2B H59 have the potential to contribute to an understanding of the nature and phases of nineteenth century occupation. This site is also important as a relatively intact, rare and representative example of archaeological deposits relating to a local, small nineteenth century farm.
G2B H60	Skid mounted work-site shed	Portable (towable) timber frame and corrugated iron shed, currently located at *Greystanes Lodge,* Broughton Village.	Local					✓	✓	✓	The G2B H60 work-site shed on skids is a relatively well preserved and representative example of its type and demonstrates the design and functional requirements of such a structure. It is likely to be a rare example of this shed type, which is unlikely to be well documented, or represented in collections, museums or reserves.
G2B H61	Quarried rock outcrop, Broughton	A small area of rock quarrying (evidenced by drill roles and fracture surfaces) on a small natural sandstone outcrop forming the bed of a tributary streamline. A nearby concrete highway culvert is situated immediately upslope. Quarrying may be related to an earlier phase of highway construction.	Local							✓	Quarried rock at Broughton (G2B H61) is a locally representative example of a small sandstone quarry for rock, probably used in early road construction.

ID	Recording	Description	Context of significance	Significance criteria a	b	c	d	e	f	g	Summary statement of significance
G2B H62	Avenue of Poplar trees	Nine Lombardy Poplars, situated along the eastern side of Woodhill Mountain Road, between the existing highway and just past the Bundewallah Creek bridge. Numerous younger Poplar plantings continue the avenue to the north, on both sides of the road, but do not form part of the Shoalhaven LEP listed item.	Local			✓					The Poplar trees planted at G2B H62 are a locally significant landmark and aesthetic landscape component.
G2B H63	Mark Radium Park	Recreational and ornamental park and gardens (developed by Berry Apex Club), which commemorates a local Australian champion pony which held high jump records between 1938 and 1955.	Local		✓	✓					Mark Radium Park is listed on the Shoalhaven LEP heritage schedule as a place of local importance due to its aesthetic qualities and historical association with Jack McGee and his pony Mark Radium.

ID	Recording	Description	Context of significance	Significance criteria a	b	c	d	e	f	g	Summary statement of significance
SICPH CL	Southern Illawarra Coastal Plain and Hinterland Cultural Landscape	The cultural landscape of the Southern and eastern falls of the Southern Illawarra Range, and adjacent coastal plain.	Local	✓	✓	✓	✓	✓	✓	✓	The Southern SICPH CL is of local significance in terms of its historical associations and importance in the pattern of local history. It is also locally significant in terms of its strong and special association with the local Aboriginal community. More notably, it is of local and State significance in terms of its aesthetic qualities, which relate in part to the unique natural character of the junction of the coastal plain with the Illawarra escarpment, and in part from the striking contrast between the culturally modified elements of the landscape and the more natural elements. The clearly identifiable nineteenth century structure of the landscape also contributes to the aesthetic value of the SICPH CL. The SICPH CL is a rare landscape type, both in terms of its natural features and also the retention of such clear examples of the late nineteenth and early twentieth century pastoral landscape and associated private towns. It is the only remaining such portion of the broader Illawarra cultural landscape that has not been substantially impacted by urban infill. As such it is also representative of its type and displays considerable research potential in terms of historical themes at local and State levels.

Impacts on items of non-Aboriginal heritage significance

The classification of development impact falls into two broad categories: direct or indirect impact. This classification is made relative to the identified heritage place or item. Where a development would result in physical loss or change to a place or item, this is a direct impact. Direct impact may affect a place or item in part or as a whole.

Where a development would avoid direct impact to a place or item, but would change its context or surroundings, this is termed an indirect impact. This is mostly caused by a development being situated in relative proximity to the place or item and consequently the setting of the place/item is changed. Indirect impacts may reduce the historical integrity of a place/item and compromise the interpretation or visual appreciation of the place/item.

The potential impacts of the project on non-Aboriginal heritage have been categorised in **Table 7-63** as follows:

Impact category A.	A whole or complete degree of direct impact to a heritage item resulting in the physical loss of the item. This can be expected to occur in up to 100 per cent of the planned highway easement, although there may be some limited potential for site remnants to survive in undeveloped areas or in some ancillary areas.
Impact category B.	Partial or minor direct impact to heritage item(s). The resulting loss or reduction in heritage significance will depend on the nature of the item and the extent and scope of the physical impact. Included in this category are: instances where a proportion of the item will remain, impact to the defined curtilage of an item, and impact to a minor or small proportion of an item, such as the root stock of a heritage tree.
Impact category C.	Indirect impacts, such as to the contextual and landscape values associated with an item. Typically this occurs when a development is now adjacent to, or closer to the item.
Impact category D.	Indirect impact to items of movable heritage which could be moved to avoid direct impact and as a consequence lose contextual integrity.
Impact category E.	No significant impact. This category involves instances where the development would either: not pose an impact to a heritage item (direct or indirect), or any measurable impact was insignificant and did not reduce the heritage value or significance of the item. An example would be where a development occurs within the viewshed from an item, but does not obscure, remove or reduce the role of contextual or landscape components that contribute to the significance of the item. A further example would be where a development, close to an item, does not increase the level of impact that has already occurred from existing elements or actions.

Concept design development

The concept design upon which the current assessment is based, was developed and refined with consistent reference to known and potential cultural heritage constraints. As a consequence, the design now avoids many items which would have been impacted in earlier versions. The following is a summary of these design revisions:

- The proposed location of the bridge over Broughton Mill Creek at Berry has been moved upstream to avoid direct impact to the Mananga homestead property (G2B H16), and to avoid close proximity and visual impact to buildings belonging to the Pulman Street Conservation Area, notably 'Constables Cottage' or "Wyndree" situated at the northern boundary of the conservation area.
- A proposed roundabout at the intersection of the (current) Princes Highway with Tannery Road has been replaced with a roundabout at the intersection with Woodhill Mountain Road. The Tannery Road option was situated within the Pulman Street conservation area and would have impacted upon the contextual landscape values of this area.
- The intersection of Schofields Lane and the upgraded highway has been revised to avoid impact to the entrance feature and remaining driveway at Graham Park, a former agricultural research institution with State significance (G2B H51).
- The proposed alignment of the bypass of the Foxground bends in the area of Broughton Village was moved to the east to avoid direct impact to the Sedgeford homestead (G2B H25), and a PAD at (former) 'Greystanes Lodge' (G2B H48), and to minimise impact to the outbuildings and property at Brookside (G2B H28).
- The concept design allows the retention of the current highway bridge over Broughton Creek (G2B H29) as part of a future service road. This bridge is listed on the RMS Section 170 Heritage and Conservation Register.

Of the 34 heritage items, 19 would not be directly impacted, six would be partially impacted, and nine wholly impacted. Of those not directly impacted (19), 13 occur within 50 metres of the construction footprint (CF) and 11 would be subject to indirect impacts relating to their landscape contexts. A summary of items that would be impacted by the project is provided in **Table 7-63**.

SOHI have been prepared for the impacted items (refer to **Appendix I** of the *Non-Aboriginal (Historic) Heritage Technical Paper* at **Appendix K**). Overall, the impacts were found to be acceptable, subject to the implementation of management recommendations described in **Section 7.8.4**.

Graham Park (G2B H51) is a former agricultural institution and is located southwest of Berry on the Princes Highway. It is the only site of State significance located within the study area. Heritage features at the site relate to the entrance structures and include gates, pillars and a sculpture of a bull. While this site is located within 50 metres of the construction footprint, it is not expected to be directly impacted by the project.

Table 7-63 Summary of identified heritage items and potential impacts

ID	Name/Location	Description	Significance	Direct impact	Impact category*	Comments
G2B H11	*Glen Devan* Federation House (77 North Street, Berry).	Federation house with a number of additions.	Local	Yes	A	Whole of the site would be impacted.
G2B H13	Burnett Estate Overseer's Cottage (143 North Street, Berry).	Simple weatherboard cottage (c. 1917), former residence for an agricultural estate worker.	Local	No	C	Located within 50 metres of the construction footprint.
G2B H14	Archaeological deposit (former 19th century *Broughton Creek* town buildings).	A number of former town structures were located on the eastern side of the former highway alignment (G2B H15), roughly opposite *Mananga*. These include the Berry Butter Factory 1889, Overseers Cottage 1858, Court House 1870s, and the Council Chambers 1868, and a Carpenters Cottage.	Local	Yes	B	Partial impact – due to construction of on-ramps and off-ramps and a realigned service road intersection
G2B H15	Remnant portion of 20th century highway (mid 1950s).	Ceased use as part of the highway in 1955 and is now used as an access road for adjacent residential lots (195 metres).	Local	Yes	B	Partial impact – due to upgrade as extended service road and new intersection
G2B H16	*Mananga,* homestead complex and grounds, former Berry Estate Manager's residence (A40 Princes Highway, Berry).	Federation (1894) Queen Anne style homestead, possibly designed by Sydney architect Howard Joseland. Property includes portion of Berry Estate water mill race.	Local	No	C	Located within 50 metres of the construction footprint.
G2B H17	*Hillview* homestead (A111 Princes Highway, Berry).	Former 19th century Berry Estate tenant homestead.	Local	No	C	Located within 50 metres of the construction footprint

ID	Name/Location	Description	Significance	Direct impact	Impact category*	Comments
G2B H19	Remnant portion of 19th century road.	Poorly preserved remnant of the original Berry Estate Road (430 metres).	Local	Yes	A	Whole of the site would be impacted.
G2B H20	Remnant portion of 20th century highway.	Now resumed within adjacent dairy farm (195 metres).	Local	No	E	Located within 50 metres of the construction footprint.
G2B H21	Remnant portion of 20th century highway.	Remnant includes a 90 degree bend and upslope embankment, and is revegetated (120 metres).	Local	Yes	A	Whole of the site would be impacted.
G2B H22	Remnant portion of 19th century road.	Remnant of original Berry Estate Road, and includes shallow cutting (460 metres).	Local	Yes	A	Whole of the site would be impacted.
G2B H23	Remnant portion of 19th century road.	Remnant of the original Berry Estate Road (320 metres). The road is evident as a shallow relief and through differences in grass cover.	Local	Yes	A	Whole of the site would be impacted.
G2B H25	*Sedgeford* homestead and grounds (A495 Princes Highway, Broughton Village).	Federation weatherboard homestead (1902) and gardens.	Local	No	C	Grounds located within 50 metres of the construction footprint.
G2B H26	Remnant portion of 20th century highway ("Binks' Corner").	This portion of highway formerly known as "Binks' Corner", consists of an angled descent and ascent across a small valley, and was bypassed when the 'Big Dipper' was constructed in 1936. It follows an 1870s-80s alignment of the highway (total length around 612 metres).	Local	No	E	Southern end of remnant would occur within 50 metres of the construction footprint.

ID	Name/Location	Description	Significance	Direct impact	Impact category*	Comments
G2B H27	Remnant portion of 19th century road.	This is a portion of the original Berry Estate Road which was superseded by the adjacent, more gradient sensitive 1870s-80s alignment (G2B H26). It includes three straight sections with two corners, including a well preserved cut and benched section of 260 metres (total length is 550 metres).	Local	No	E	Located more than 150 metres away from the construction footprint.
G2B H28	*Brookside* homestead (A540 Princes Highway, Broughton Village).	Late 19th century to early twentieth century homestead. Buildings have been transported from other locations and there are also archaeological traces of former outbuildings. This recording includes a memorial tree and plot with the cremated remains of Mr William Chittick (died 2005), located 220 metres upstream of the homestead on the western side of the Broughton Creek.	Local	Yes	B and C	Partial impact – acquisition of land for the project would include a southern outbuilding and associated platforms. Main residential buildings occur outside of the construction footprint but are in close proximity (within 50 to 100 metres of an elevated bridge over Broughton Creek). A memorial planting is 200 metres away from the construction footprint.
G2B H29	20th century concrete bridge (Princes Highway, Broughton Creek).	RMS Bridge number 704, Southern Region. Constructed in 1935, using standard concrete beam design, and widened in 1994.	Local	No	C	Bridge would be retained for use on service road and would be located immediately adjacent to the construction footprint (within 50 metres).
G2B H30	Remnant portion of 19th century road.	A relatively well preserved section of road, situated within a pasture field, along the crest and shoulder of a prominent spurline. This remnant is a portion of the original Berry Estate Road. The road platform is evidenced by side ditches and variably shallow ground relief. Includes bordering gum trees at the eastern end and descent to Toolijooa Road saddle (530 metres).	Local	Yes	A	Whole of the site would be impacted.

ID	Name/Location	Description	Significance	Direct impact	Impact category*	Comments
G2B H45	*Glenvale* homestead, (A371 Princes Highway, Broughton).	Former Berry Estate tenant farm, homestead includes vertical slab construction.	Local	No	E	Homestead buildings occur 120 metres from the project. Note that the whole of the property is listed on the Shoalhaven LEP 1985 and portions of the property would be directly impacted.
G2B H47	Former St Patrick's Convent (1921), St Patricks Church (1936), and grounds (80 North Street, Berry)	Two story brick convent building, brick church and grounds.	Local	No	C	Located within 50 metres of the construction footprint.
G2B H48	PAD, former Berry Estate tenant farm (now location of Greystanes Lodge).	Location of a former Berry Estate tenant farm, homestead, now redeveloped with modern farm buildings (*Greystanes Lodge*). Any remaining archaeological items are likely to be substantially disturbed.	Local (subject to confirmation through test excavation)	No	C	Located within 50 metres of the construction footprint.
G2B H49	*Oakleigh* farmhouse (59 Woodhill Mountain Road, Berry).	Inter War Bungalow style Farmhouse.	Local	No	C	Located 100 metres away the project.
G2B H51	*Graham Park* former agricultural research institution (8, 9 and 13 Schofields Lane, Berry).	Former agricultural research station. The first Artificial Insemination Breeding Station in New South Wales was established at Berry in the 1950s and was subsequently moved to Graham Park in 1958. The facility closed in the 1990s.	State	No	E	Located within 50 metres of the construction footprint.

ID	Name/Location	Description	Significance	Direct impact	Impact category*	Comments
G2B H52	PAD, former Berry Estate tenant farm (A441 Princes Highway, Broughton Village).	PAD, situated on the angle in the 'Binks Corner' remnant highway section (G2B H26). The only such PAD where the original relationship between the structures and the 1870s-80s highway may survive.	Local (subject to confirmation through test excavation)	No	E	Located 300 metres away from the construction footprint.
G2B H53	PAD, site of a former Berry Estate tenant farm structure (just east of the Toolijooa Ridge).	PAD. The PAD site includes an indeterminate rock rubble alignment parallel to a former 19^{th} century road alignment (Berry Estate Road).	Local (subject to confirmation through test excavation)	Yes	A	Whole of the site would be impacted.
G2B H54	Remnant portion of 19^{th} century dry stone wall, (west side of current highway, just east of Toolijooa Ridge saddle).	Remnant dry stone wall, situated along former western boundary of highway easement, at least 100 metres in length, and possibly extending for a further 150 metres north (obscured by lantana growth).	Local	Yes	B and C	Partial – at least the southern half of the known extent of the wall would be directly impacted.
G2B H55	Remnant portion of 19^{th} century road.	Remnant of original Berry Estate Road (100 metres), evident as a cut and benched platform, impacted by modern cross drains.	Local	Yes	A	Whole of the site would be impacted.
G2B H56	*Broughton Mill* homestead and Dairy (disused) (former Berry Estate tenant farm, 117 North Street, Berry).	Standing ruins of early twentieth century farmhouse, outbuildings, disused dairy and yards.	Local	No	C	Located within 50 metres of the construction footprint.
G2B H58	Uniting Church Hall (formerly Wesleyan Chapel 1884).	Timber frame and weatherboard church hall/chapel.	Local	No	E	Located 200 metres away from the construction footprint.

ID	Name/Location	Description	Significance	Direct impact	Impact category*	Comments
G2B H59	Archaeological Deposit and remnant plantings of former homestead (outside of Berry Estate – Finn/Wood/Grant/ Stewart/Dinning families).	Remnant tree plantings, garden plants and surface foundation stones are indicative of an archaeological deposit of a former early 19th century farm residence.	Local	No	C	Located 180 metres away from the construction footprint.
G2B H60	Skid mounted work-site shed (movable item).	Portable (towable) timber frame and corrugated iron shed, currently located at *Greystanes Lodge,* Broughton Village.	Local	No	E	Current location is within 50 metres of the construction footprint, but the location is not intrinsic to the heritage value of the item.
G2B H61	Quarried rock outcrop, Broughton.	A small area of rock quarrying (evidenced by drill roles and fracture surfaces) on a small natural sandstone outcrop forming the bed of a tributary streamline. A nearby concrete highway culvert is situated immediately upslope. Quarrying may be related to an earlier phase of highway construction.	Local	Yes	A	Whole of the site would be impacted.
G2B H62	Avenue of Poplar trees (Woodhill Mountain Road, Berry).	Nine Lombardy Poplars, situated along the eastern side of Woodhill Mountain Road, between the existing highway and just past the Bundewallah Creek bridge. Numerous younger Poplar plantings continue the avenue to the north, on both sides of the road, but do not form part of the Shoalhaven LEP listed item.	Local	No	C	Located within 50 metres of the construction footprint – the northern most Poplar tree is located 10 metres from a proposed water quality pond.

ID	Name/Location	Description	Significance	Direct impact	Impact category*	Comments
G2B H63	Mark Radium Park.	Recreational and ornamental park and gardens (developed by Berry Apex Club), which commemorates a local Australian champion pony which held high jump records between 1938 and 1955.	Local	Yes	B	Partial – a narrow portion of land along the western margin of the park would be impacted.
Southern Illawarra Coastal Plain and Hinterland	Cultural Landscape	The cultural landscape of the Southern and eastern falls of the Southern Illawarra Range, and adjacent coastal plain.	Local	Yes	B and C	Partial – impacts would include the visual and structural impact of the carriageway formation, deep cuttings, and visually obtrusive embankments.

Impact categories are described in* ***Section 7.8.3*

Impacts to cultural landscape values and the Berry township

The following section provides an overview of the development impact to cultural landscape values. A detailed statement of heritage impact is provided in Appendix I of the *Non-Aboriginal (historic) Heritage Assessment Technical Paper* provided at **Appendix K** of the environmental assessment.

The nature and extent of anticipated development impact

The project would impose a modern structural component onto the landscape. The formal traits of the project would contrast with those of the existing landscape in the following ways:

- The horizontal alignment of the project would be curvilinear within the constraints of standardised and even radius curves. This would contrast with most of the existing broad scale man made landscape features which are based on grids, right angles, or straight intervals joined by relatively tight curves.
- The vertical alignment of the project would be gradual and incremental, and would include ramps, embankments and cuttings to maintain standard rates of climb or descent. This is in contract to most of the existing broad scale man made landscape features which are more reflective of natural gradients and elevations.
- The width of the project corridor (including the carriageways, ramps and associated easement) would vary from around 50 metres to up to 200 metres. This is in major contrast to existing man made corridors which are nearly all less than 50 metres in width.
- Unlike the alignment of existing roads which, through their curves, and opportunistic alignments, manifest the natural topography they are traversing, the bypass alignment would create its own topography of cuttings and embankments as required by limited tolerances in vertical and horizontal alignment. As a consequence the bypass may run contrary to the natural flow of ridges, valley orientation, and slope contours.
- Whereas the overwhelming character of property boundaries, field delineation, artificial lowland drainage, and secondary and minor roads is one of a grid and rectangular divisions, the bypass would superimpose this patchwork with a visually dominant and curvilinear corridor, following its own independent directional agenda.

In the general proximity of Berry, the project would:

- Impact upon the short and mid-distance view-sheds from the town’s northern streetscapes.
- Impose a contrasting and modern (curvilinear) road form upon, the grid dominated nineteenth century character of the existing rural town fringe.
- Impact upon some remnant pastoral open space along the northern margin of the town grid. This margin provides a visually appealing contrast between the urban and rural, and contributes a pastoral character and setting for the town.

These impacts, without mitigation, would amount to a significant deterioration in the cultural landscape values of the SICPH CL and specifically to the Berry landscape setting. The construction of the project would intersect, interrupt, or truncate previous landform elements which contribute to those values such as roads, field systems, natural landforms and vegetation belts. On the northern margin of Berry, the existing pastoral setting of valley-floor fields, farm buildings, and converging tree lined streamlines, would be divided by the project, and blocked from near and middle distance views from the town. This combination of interruption and obscuration could, without mitigation, amount to a significant impact to the northern landscape setting of the town, and thus the heritage values of that setting.

The project, due to its size and engineered character would also have the potential to significantly change the character of its surroundings. The necessary vertical alignment of the project would, in places, result in substantial cuttings, embankments and ramps. These, and their continuous nature, ensure the potential of the project to be a dominant landform in its own right. Across the northern margin of Berry, from east to west, the project would descend to the valley floor via the bridge at Berry over Broughton Mill Creek. It would then traverse the valley floor before passing under Kangaroo Valley Road via a cutting at the Berry interchange. Each of these sections, the bridge, valley traverse, and underpass/interchange, have the potential to impose significant visual impacts onto the town setting. This potential includes both disruption to existing elements, and the introduction of new and inappropriate elements, such as modern and incompatible design and engineering elements.

Project aspects which respect or enhance the cultural landscape values

The SIPCH CL has an assessed local level of significance under all criteria: a, b, c, d, e, f and g.

Apart from substantial deviations across the Broughton Creek valley and around Berry, the project would generally follow the original corridor of the first European road constructed for vehicles between Berry and Gerringong – the 1856 Berry Estate Road. This would provide a degree of historical and functional integrity to the project. It would remain a modern manifestation of an original mid nineteenth century access and transport corridor.

The construction of a bypass of Berry avoids the need to widen and transform one of the town grid streets to accommodate the highway traffic. If the latter option was adopted it would irrevocably change the amenity and heritage character of the town, and require the full or partial demolition of many properties with heritage value.

Potential impacts within ancillary construction facilities

There are no known or predicted sites of heritage significance that would be affected by ancillary construction facilities in addition to the sites and features addressed in this report.

There are six recordings located within ancillary construction sites. Two of these, (G2B H24 and G2B H30) would be directly impacted by the project.

Direct impacts can be avoided at the remaining four recordings, which are:

- G2B H54 (dry stone wall on Toolijooa Ridge).
- Significant fabric within G2B H49 (*Oakleigh* farmhouse).
- The mature tree plantings and potential archaeological deposits at G2B H48 (current location of Greystanes farmhouse).
- The skid mounted work-site shed at Greystanes farmhouse, G2B H60.

Representative and worst case impacts

For this assessment, representative impact is defined as that impact which has been anticipated in this analysis and to which the proposed management and impact mitigation strategies are directed. It is representative of the expected scenario, based on an analysis of the best information available and on a reasonable or normative level of prediction.

Worst case impact is defined as an extreme scenario where the highest conceivable degree of impact is anticipated due to unexpected occurrences which are extraordinary and outside a reasonable level of prediction.

The worst case scenario with regard to non-Aboriginal cultural heritage values consists of the unexpected encounter of a heritage item or items which, due to a high level of assessed significance (such as at a State or National level) warrants in situ conservation and a consequential change in the project alignment. This would conceivably be due to the discovery of a previously undetected and unpredicted item or the discovery of a new feature associated with a known heritage item. Conceivable examples of worst case scenario discoveries include the following:

- A unique, well preserved and substantial remnant or archaeological deposit of the early industry and occupation of the Berry Estate (such as a cemetery, convict stockade, road bridge or mill).
- An archaeological deposit containing rare and well preserved organic items due to water logged and anaerobic conditions, such as may be found within a swamp or peat deposit.

The worst case scenario would be ameliorated by the implementation of appropriate mitigation measures, as outlined at **section 7.8.4**. The potential for a worst case scenario is has been further minimised by the conduct of a robust analysis which included:

- The use of predictive modelling and a review of historical documentary and pictorial sources.
- Archaeological survey and interpretation.
- Reference to oral tradition and information provided by local community sources.
- Review of aerial photography.

The RMS draft unexpected finds procedure defines a protocol to be followed in the event that there is an unexpected find during construction (refer **Appendix C** of the *Non-Aboriginal (Historic) Heritage Technical Paper* at **Appendix K**). The adoption of this procedure provides both a safeguard and management process in the event of a worst case scenario.

7.8.4 Environmental management measures

Mitigation and management measures would be implemented to avoid, minimise or manage non-Aboriginal heritage impacts. These mitigation and management measures are identified in **Table 7-64** and incorporated into the draft statement of commitments in **Chapter 10**.

Table 7-64 Mitigation and management measures

Potential impacts	Mitigation and management measures
Construction	
General construction impacts	Enter all heritage items which would remain in whole, or in part, within the project easement following the end of project construction, on the RMS' Section 170 Heritage and Conservation Register(s). Adopt and follow the draft RMS Standard Management Procedure – Unexpected Archaeological Finds (RMS, 2011), or an RMS approved revised version, in the event that unexpected cultural heritage finds are encountered during project construction. Include heritage awareness in site induction training for project staff.
Indirect or accidental impacts on known sites	Install temporary fencing or other measures as appropriate to the location for items G2B H13, G2B H16, G2B H17, G2B H25, G2B H29, G2B H45, G2B H47, G2B H49, G2B H51, G2B H56, G2B H59 and G2B H62 (no impacts anticipated) and items G2B H14, G2B H15, G2B H28, G2B H54, G2B H62 and G2B H63 (partial impacts anticipated). These would be used to delineate “no go” heritage areas.

Potential impacts	Mitigation and management measures
Impacts on nineteenth century road remnants	Implement a co-ordinated archival recording program for all nineteenth century road remnants that would be directly impacted by construction prior to any impact (G2B H19, G2B H22, G2B H23, G2B H30 and G2B H55). This program would include archaeological excavation and recording at appropriate and selected locations (G2B H19, G2B H23, G2B H30, and G2B H50), to record any ditch profiles, subsurface foundations or former surface treatments Permanently conserve road remnants and related elements as appropriate (G2B H26, G2B H27 and G2B H52), to compensate for the loss of a significant proportion of the remaining remnants of the former Berry Estate Road. This conservation would occur in the vicinity of 'Bink's Corner' at Broughton Village and may potentially involve: • Managing and interpreting the elements as a publically accessible site. • Illustrating the history or local road construction, function and economics. The optimal format(s), location(s) and strategies for the public interpretation of this complex of roads and road remnants would be defined in a Heritage Interpretation Plan (HIP) to be developed as part of the project
Impacts on twentieth century road remnants	Conduct a co-ordinated archival recording program of twentieth century road remnants (G2B H15 and G2B H21) prior to any impact. Limit work in the vicinity of G2B H15 (adjacent to Mananga homestead) to essential works.
Potential archaeological deposits	Implement an archaeological program of monitoring and/or salvage in the event of construction impacts, such as demolition of the modern farmhouse, at G2B H48. The aim of this program would be to record and recover any artefacts or other information which relates to the former Berry Estate tenant farm. Conserve and avoid damage to the remnant tree plantings at G2B H48, which predate the modern farmhouse. Conserve and manage the potential archaeological site G2B H52. Conduct a program of archival recording and archaeological salvage excavation, at G2B H53, as appropriate, and as required by the nature and significance of the relics encountered. Assess the potential for impact to PADs within the G2B H14 area below the current road platform. Conduct salvage excavation according to the determination of that assessment where the vertical alignment of the existing highway carriageway is to be lowered.
Archaeological deposits	Conduct a program of salvage excavation within the construction footprint at G2B H14, south of test pit C110. Avoid direct impact to site G2B H59 (archaeological deposits and remnants plantings).

Potential impacts	Mitigation and management measures
Standing buildings and structures	*Broughton Creek bridge (G2B H29):* Erect fencing, where possible, to conserve and protect the concrete Broughton Creek bridge (G2B H29) from construction impacts. Allow the bridge to continue to function as a road-bridge for the highway-converted service road following construction. Interpretive information would be made available to the public on the concrete Broughton Creek bridge (G2B H29). The format and location of this information would be determined by and defined in a Heritage Interpretation Plan *Brookside homestead (G2B H28):* Conduct an archival recording at the Brookside homestead (G2B H28) prior to construction. This would include those features subject to direct impact and the homestead building which incorporates structures previously moved from site G2B H59. Maintain and enhance the natural character of Broughton Creek and its banks in the vicinity of the bridge immediately south of the *Brookside* homestead (G2B H28) as much as feasible to ameliorate impact to the landscape context by maintaining and reinforcing the visual quality of the creek corridor. This would be achieved by maintaining and augmenting native bank side vegetation, and maximising the distance between the banks and bridge abutments. *Glen Devan (G2B H11):* Conduct an archival recording of Glen Devan (G2B H11) and its grounds prior to the commencement of construction. This recording would include documentation of construction methods and materials exposed during any demolition works. Using a suitably qualified archaeologist, monitor ground disturbance in the area of G2B H11 with the aim of recording any features relevant to the archival recording, and recovering any significant relics. In the event of demolition, recover and reuse (with commemorative identification) suitable demolition material in appropriate local, infrastructure such as interpretive or entrance features, way-side stop facilities, landscaping or artwork. The RMS should remain open to the possibility of a third party or agent proposing to conserve all or part of the G2B H11 structure by moving it to a new location within or near Berry, at that party's expense. RMS to seek third parties who may be interested in conserving all or part of the G2B H11 structure(s)*. *Graham Park (G2B H15):* Construct temporary fencing to identify a 'no–go' area around the existing Graham Park (G2B H51) entrance structures (gates, pillars and sculpture of a bull) during construction. Any roadworks in the vicinity of the Graham Park entrance, would not exclude the capacity for visitors to pull over and safely inspect the entrance feature. If necessary, allowance would be made for the potential future installation of interpretive signage.

Potential impacts	Mitigation and management measures
Impacts on miscellaneous site types	Avoid direct impacts (where feasible), and actively conserve and manage the remnant dry stone wall G2B H54. In the event that direct impact to all or part of this site is unavoidable, an archival recording of the wall would be conducted prior to construction. Any rock material displaced from the wall as a result of construction works would be retained for use in the repair and conservation management of the original wall. Compile an archival record of the quarried rock outcrop, G2B H61, prior to impact. Conserve in situ the most northern Poplar tree in the tree avenue G2B H62. Erect temporary protective fencing around the root zone of the tree prior to construction to define a no-go area. Reinforce and replicate the existing landscape character created by the existing planted avenues of poplar trees in the project easement in the area of Woodhill Mountain Road. Retain the existing front yard plantings at G2B H17 (Hillview homestead) which would fall within the bypass easement (particularly the Oak tree). This may require a minor deviation of the proposed service road. Ensure construction works do not occur outside the project footprint wherever feasible in the vicinity of Mark Radium Park (G2B H63). Avoid impacts to the skid mounted worksite shed at Greystanes, G2B H60. This structure would be moved to avoid impact. The structure would be donated to an appropriate museum, provided that the institution has the capability to conserve and store the structure.
The Southern Illawarra Coastal Plain and Hinterland	Construct and finish the project embankments and cutting faces, where possible, to minimise adverse visual impacts, and to facilitate the re-establishment of vegetation. Locate vegetation along the project and adjacent areas to maintain vistas from the road corridor and conform to the rectangular patchwork of the surrounding landscape. Incorporate artistic elements in structures adjacent to the carriageway (such as bridgework, and retaining and noise abatement walls). Where possible, these would be derived from local cultural heritage themes, especially at locations in close association to places of significance. Minimise and mitigate visual impact of the bypass on the northern margins of Berry. One strategy to achieve this would be the construction of a landscaped noise barrier between the bypass and the town (refer to **Section 7.6** for further details regarding the design of the noise barrier).

**If no interested third party or agent is identified, G2B H11 would be recorded and demolished.*

7.8.5 Residual impacts

Following the establishment of mitigation, the residual impacts of the project on the landscape setting of Berry would consist of:

- Views of the project, away from the northern town margin, such as from Woodhill Mountain Road, of the southern and northern interchanges, and the southern bypass approach to the town.
- The disturbance to, and loss of, landscape elements due to the physical placement of the project. These include fencelines, field systems, riparian vegetation, and road alignments. None of these features had heritage significance as individual items however. Their value is as constituent parts of the much larger SICPH CL.
- The visual impact of the project looking south, from the north side of the project. This however, is not a significant heritage viewshed as it does not include the framing upper register of the Illawarra Range, nor serve as part of a visitor's experience of the Berry town.

Many of these residual visual impacts occur in settings already impacted by the existing highway town entrances or by later twentieth century urban development. The visual amenity of the key vistas and settings with remaining heritage value, namely those looking northwards from the northern margin of the town, would be substantially maintained through the conduct of the proposed mitigation strategies. On this basis, it can be concluded that the residual impacts to the Berry landscape setting would be acceptable when weighed against the benefits and objectives of the project.

In general, and away from the Berry setting, the project would present a similar set of residual impacts to the SICPH CL:

- The addition of a major engineered landscape component in the form of a consistently graded and angled curvilinear road platform associated with extensive bridges, cuttings and embankments.
- Visual intrusion of the project into views of, and across, the landscape.
- Disturbance to, and loss of, landscape elements due to the physical placement of the project. These include ridge and creeklines; cadastral boundaries defined by fencelines, field systems, and road alignments; and patterns of both native and introduced vegetation.

The primary means of mitigating the landscape impacts of the project would be through the re-establishment of vegetation, the appropriate use of landscaping and barriers, and the use of complimentary visual components and compatible design elements. With the effective use of these strategies, it can be concluded that the residual impacts to the SICPHL would be acceptable when weighed against the benefits and objectives of the project.

7.9 Land use and property

This chapter assesses land use and property impacts, which is a key environmental issue for the project. The relevant extract from the DGRs is presented below. Environmental management measures are identified to minimise impacts.

The environmental assessment requirements that relate to socio-economic impacts are addressed in **Section 7.10**.

Director-General's requirements	Where addressed
Directly-affected properties and land uses adjacent to the project, including: impacts to land use viability and future development potential, property allotment, land sterilisation and severance impacts.	Section 7.9.2 Section 7.10
The agricultural sector taking into account the fragmentation and potential loss of agricultural and farm viability including internal and external farm access arrangements both during construction and operation of the project.	Section 7.9.2 Section 7.10

7.9.1 Existing environment

Regional context

The Princes Highway is the main transport corridor for the South Coast, and provides linkages between rural communities, Berry and other urban and employment centres in the region. This includes Shellharbour, Kiama and Gerringong to the north, and the regional centre of Nowra-Bomaderry to the south. Gerringong, located immediately to the north of the project, is a small to medium sized urban area consisting mostly of low density housing and retail services.

Nowra-Bomaderry is the closest major regional centre to the project with a current population of 27,477 (Australian Bureau of Statistics, 2006). This centre provides a mix of residential, commercial, retail, industry, and special uses, such as the Royal Australian Navy Air Force base. Nowra lies in the Shoalhaven LGA which is projected to grow by an additional 34,000 people by 2031, with the majority of growth concentrated in Nowra-Bomaderry (DoP, 2007b). This is expected to strengthen its role as the major residential, employment and administrative centre for the northern part of the South Coast region.

The Illawarra Regional Strategy (DoP, 2007a) and the South Coast Regional Strategy (DoP, 2007b) apply to the Kiama and Shoalhaven LGAs respectively. The aim of these strategies is to ensure that adequate land is available and appropriately located to sustainably accommodate the projected housing and employment needs of the region over the next 25 years.

Berry, the only urban settlement located along the project, is not identified as an emerging centre and does not contain any major future growth areas. Rather, both regional strategies identify future population and employment growth in centres outside of the areas immediately surrounding the project. This includes infill development and major new release areas in Nowra-Bomaderry. Both strategies identify the importance of and the need to protect the rural (agricultural) and environmental assets (such as biodiversity corridors) of the regions.

Local context

The project and its surrounds (the project area) is subject to the provisions of the *Kiama Local Environmental Plan 2011* (Kiama LEP) the *Shoalhaven Local Environmental Plan 1985* (Shoalhaven LEP), and the draft *Shoalhaven Local Environmental Plan 2009* (draft Shoalhaven LEP).

The project would pass through three zones of the Kiama LEP and nine zones of the Shoalhaven LEP (refer to **Table 7-65**). Under the Kiama LEP, the majority of the project is zoned SP2 Infrastructure (Classified Road). Under the Shoalhaven LEP, the majority of the project is zoned 1(b) Rural (Arterial and Main Road Protection) or 5(d) Special Uses (Proposed Arterial Roads Preservation and Widening of Existing Arterial Roads Preservation). The land use zones are shown in **Figure 7-44**.

Shoalhaven City Council has exhibited the draft Shoalhaven LEP. Under the draft Shoalhaven LEP, the project would pass through six zones. The majority of the project area is zoned RU1 Primary Production or SP2 Infrastructure. The remainder is zoned as RE1 Public Recreation, R2 Low Density Residential, R5 Large Lot Residential or E3 Environmental Management (Town Creek). Roads are listed as a permissible land use under all zones.

The minimum lot size for each zone within the project area is listed in **Table 7-65**. For land zoned rural within the project area, the minimum lot size required under the Kiama LEP and the Shoalhaven LEP is 40 hectares. However, the majority of rural lots within the project area fall below 40 hectares. The LEPs provide exemptions to the minimum lot size subject to satisfying listed objectives and criteria within the relevant LEP. In most cases, this would remove the dwelling entitlement for the created lot.

Land uses within the project area largely reflect the land use zones, and consist of rural/agricultural, residential, commercial and light industrial uses. Rural/agricultural land uses are the dominant land use within the project area, with residential, commercial and light industry located in the urban area of Berry (see **Figure 7-45**). The primary industrial, commercial and recreation areas within Berry are shown in **Figure 7-46**.

Table 7-65 Kiama LEP and Shoalhaven LEP – minimum lot sizes.

Zone	Minimum lot size
Kiama Local Environmental Plan 2011	
SP2 Infrastructure (Classified Road)	40 hectares
RU2 Rural Landscape	40 hectares
E3 Environmental Management	40 hectares
Shoalhaven Local Environmental Plan 1985	
1(b) Rural (Arterial and Main Road Protection)	40 hectares
1(g) Rural (Flood Liable Zone)	40 hectares
2(a1) Residential (A1)	$500m^2$ – $650m^{2*}$
2(a2) Residential (A2)	$2000m^2$
2(c) Residential (Living Areas)	$500m^2$ – $650m^{2*}$
5(d) Special Uses (Proposed Arterial Roads Preservation and Widening of Existing Arterial Roads Preservation)	Not specified in LEP or Development Control Plan (DCP)
6(a) Open Space (Existing)	Not specified in LEP or DCP
6(c) Open Space (Proposed)	Not specified in LEP or DCP
9(a) Natural Hazards (Urban Flooding)	Not specified in LEP or DCP

** The minimum lot size for residential development, other than zone 2(a2), is established in DCP No.100 (Subdivision Code).Minimum lot sizes set within the DCP are subject to performance criteria.*

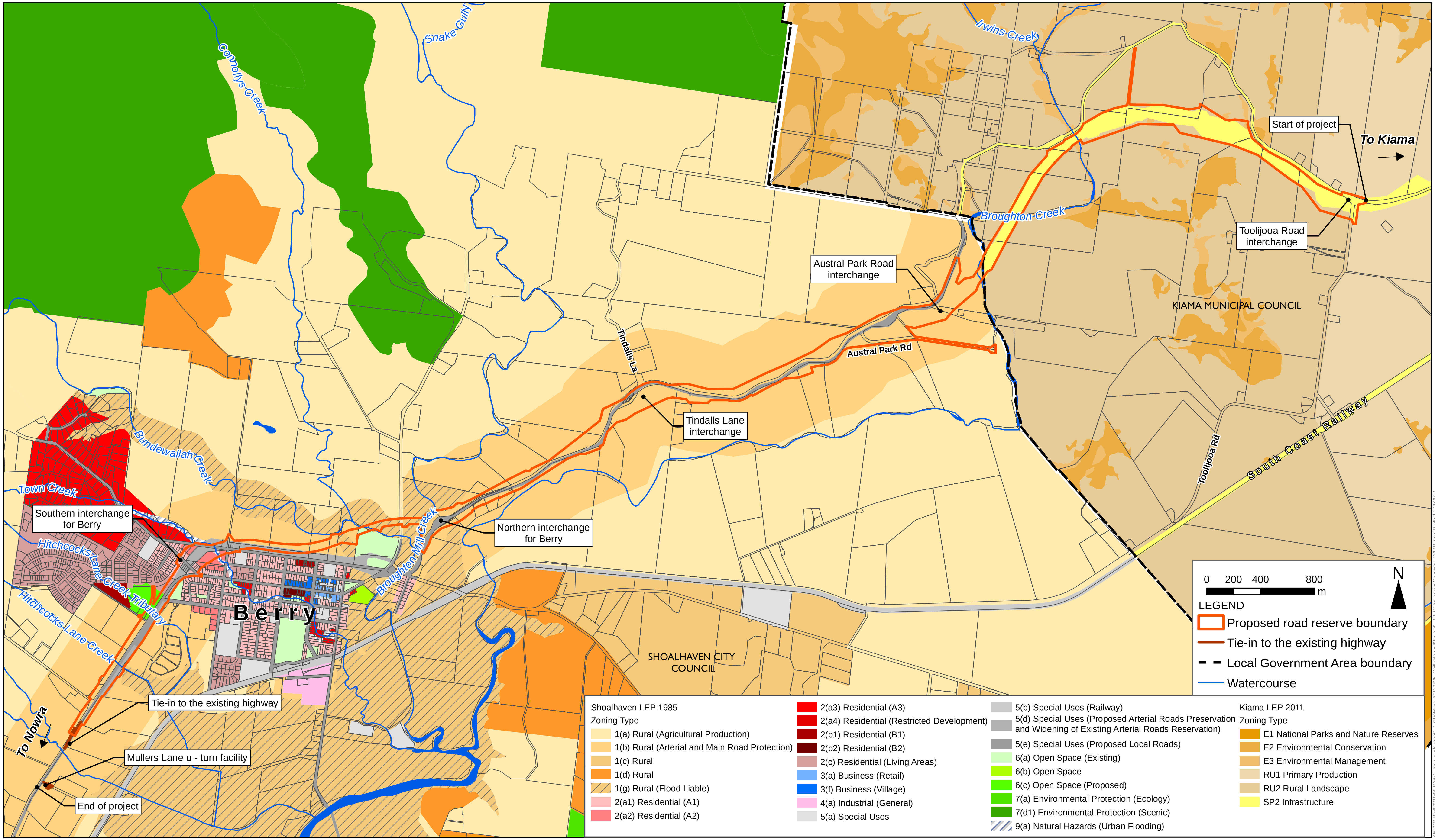

Figure 7-44 Overview of land use zones as shown in the Shoalhaven LEP 1985 and Kiama LEP 2011

Source: Dept. of Lands (2011), RTA (2011), Kiama Municipal Council (2007), Shoalhaven Council (2007)

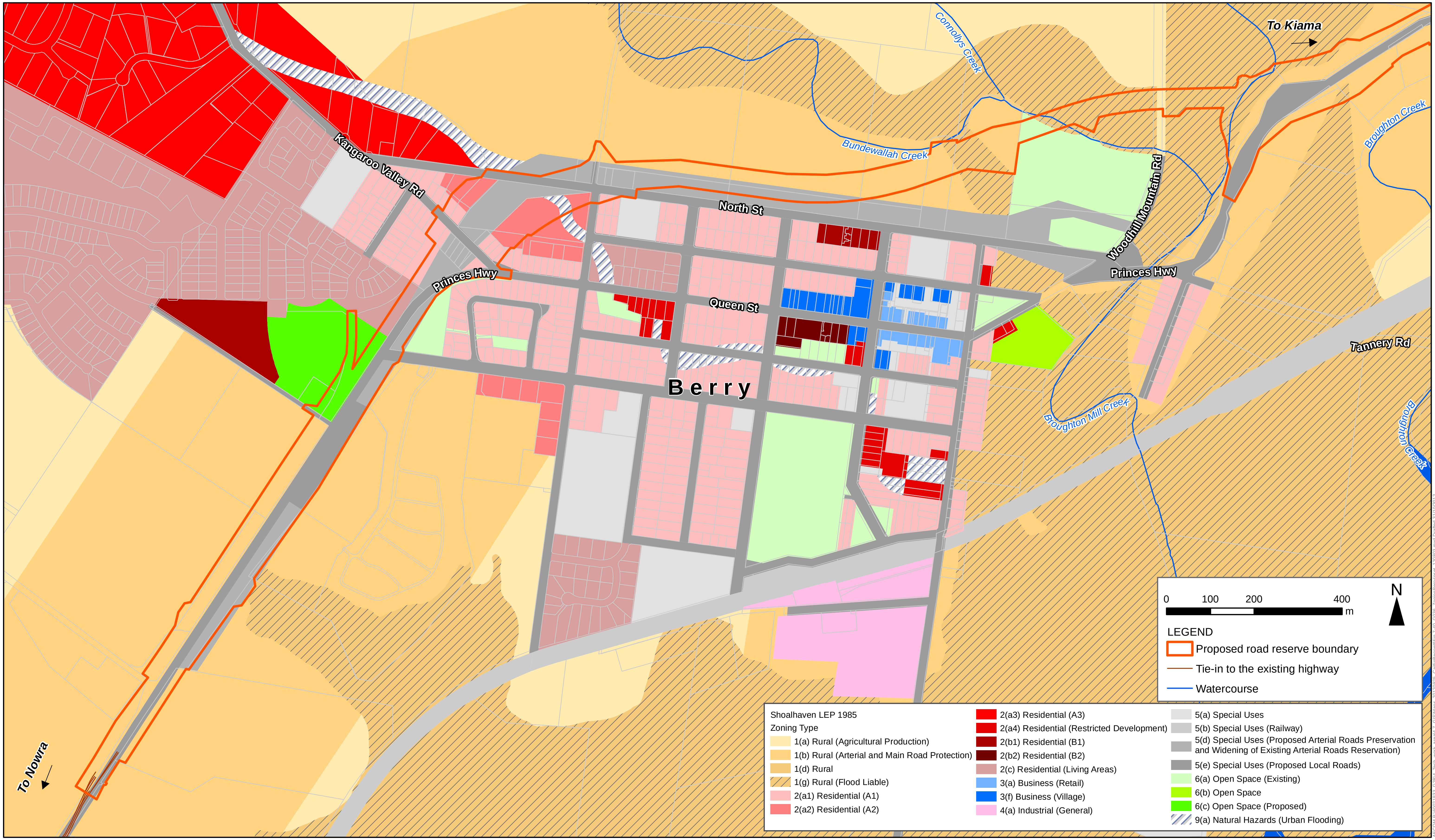

Figure 7-45 Overview of land use zones as shown in the Shoalhaven LEP 1985 (Berry detail)

Source: Dept. of Lands (2011), RTA (2011), Kiama Municipal Council (2007), Shoalhaven Council (2007)

Figure 7-46 Industrial, commercial and recreational land uses within Berry

Source: AECOM (2012)

Figure 7-47 and Figure 7-48 display land uses for properties directly impacted by the project, property by property. The area consists of residential and rural residential properties as well as agricultural properties. The area also contains open space, vacant lots, farm dams and areas set aside for future road corridors.

Most of the agricultural land in the project area is used for grazing associated with dairy operations or beef production. A number of agricultural businesses operating in the area are associated with dairy farming cooperatives, such as the Berry Dairy Co-operative and Gerringong Dairy Co-operative. Other agricultural activities include turf farming, cultivation (such as livestock feed), agistment, vineyards, organic farms and hobby farms.

Rural land use

The former NSW Agriculture's classification scheme divides agricultural land into six classes, with Class 1 being the land of the highest value in terms of suitability for intensive cultivation and a wide range of agricultural activities. The following classes of agricultural land are found in the project area:

- Class 2 – arable land that is suitable for regular cultivation for crops but not suited to continuous cultivation. It has moderate to high sustainability for agriculture, but soil factors or environmental constraints reduce the overall level of production and may limit the cropping phase to a rotation with sown pastures.
- Class 3 – grazing land or land well suited to pasture improvement. It may be cultivated or cropped in rotation with pasture. The overall production level is moderate. Erosion hazards, soil structure and other factors (such as climate) may limit the capacity for cultivation. Soil conservation and drainage works may be required.
- Class 4 - land that is suitable for grazing but not for cultivation. Agriculture is based on native pastures or improved pastures using minimum tillage techniques. Production may be seasonally high but the overall production level is low as a result of major environmental constraints.
- Class 5 – land unsuitable for agriculture or at best suited to only light grazing. Agricultural production is very low to zero due to severe constraints including economic factors, which preclude land improvement.

Figures 4 and **5** in the *Socio-economic Technical Paper* (AECOM, 2012) at **Appendix L** show the classification of agricultural land within the study area.

The key agricultural land use in the project area is grazing associated with dairying and beef production. The majority of agricultural land in the project area is classified as Class 2 and Class 3 land, which largely correspond to areas of floodplain. The remaining agricultural land is classified as Class 4 and 5. As identified earlier within this section, rural lots in the project area are typically less than 40 hectares with some lots consolidated into larger land holdings. The smallest lots are typically rural-residential land holdings, which are scattered throughout the project area. However, clusters of rural-residential lots also occur at Broughton Village, Foxground, near Tindalls Lane and west of Berry along Agars Lane (near the David Berry hospital). Bed and breakfast accommodation businesses are also scattered within the rural section of the project area. A disused quarry is located just north of Berry, outside and directly adjacent to the project area.

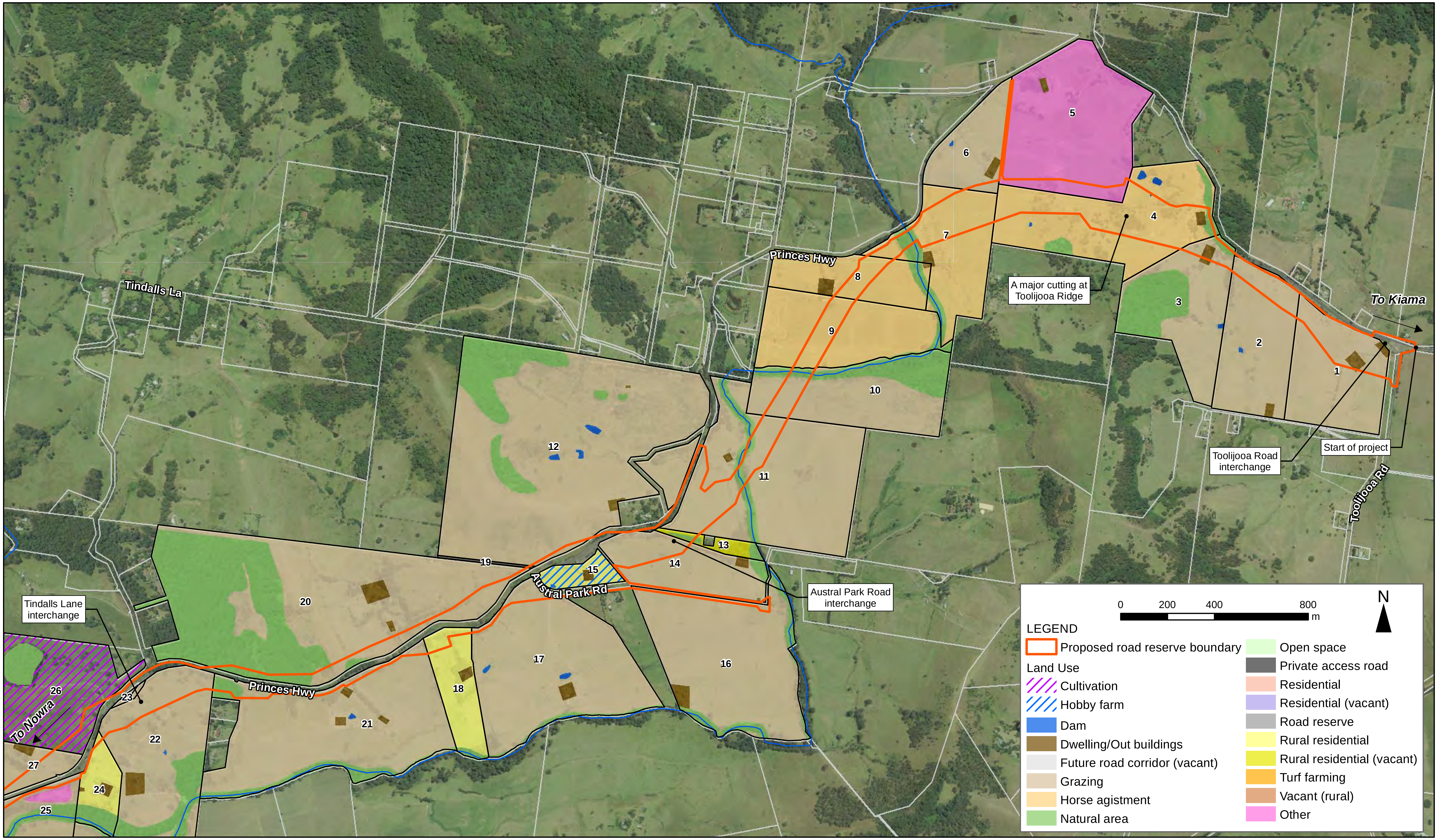

Figure 7-47 Overview of land uses (Toolijooa Road interchange to Tindalls Lane interchange)

Note: Lot numbers refer to Table 7 - 64

Source: AECOM (2012)

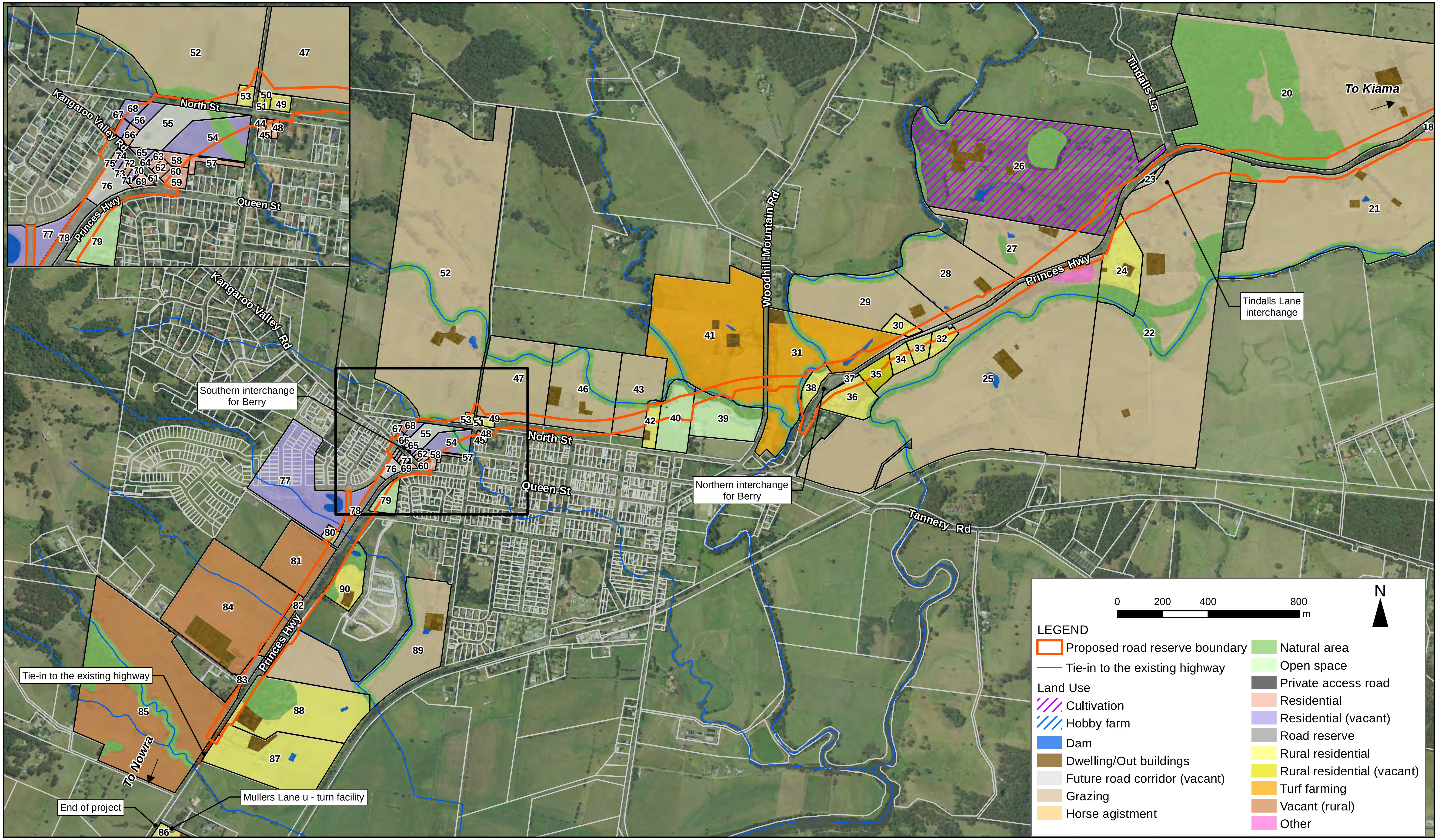

Figure 7-48 Overview of land uses (Tindalls Lane interchange to Schofields Lane junction)

Note: Lot numbers refer to Table 7 - 67

Source: AECOM (2012)

Urban land use

Berry is largely contained within a historic street grid with the historic area of Berry, at Pulman Street to the east and the more recent residential expansions occurring to the west along Kangaroo Valley Road. Recreational and open space areas are provided at Mark Radium Park, Hazelberry Park (Berry Showground), David Berry Memorial Park, Apex Park, the sportsground at the eastern end of North Street and the Camp Quality Memorial Park. The Berry Riding Club and a number of other equestrian clubs including the Woodhill Mountain Pony Club and the Shoalhaven Show jumping Club operate from a property owned by Shoalhaven City Council on North Street, adjacent to the sportsground (refer to **Figure 7-46**).

Due to its proximity to Nowra and Bomaderry, Berry serves as a commuter town to these larger towns. Berry also provides a range of retail services and serves as a popular rest and refreshment stop for highway traffic and as a tourist destination. The retail and commercial areas of Berry are largely concentrated along Queen Street (Princes Highway) between Prince Alfred Street and Albany Street.

A light industrial area is located south of the railway line around Old Creamery Lane. Businesses within this light industrial area include automotive repair operations, self-storage facilities and agricultural suppliers as well as commercial/retail businesses, such as the Treat Factory (a wholesale food supplier). The Berry sewerage treatment plant is located on Wharf Road, south of the light industrial area.

Areas immediately north of North Street, other than the recreational uses described earlier within this section, are used for grazing (dairy), horse agistment, and rural-residential purposes. Two churches are located on North Street, and are listed as local heritage items under the Shoalhaven LEP.

Recent or planned residential development within Berry is largely located along Kangaroo Valley Road, such as Huntingdale Park Estate, Graham Park, and the Gables. Two retirement villages are also under development near Victoria Street namely the Arbour and the Grange. The Arbour is accessed from Victoria Street and is expected to be completed mid 2013 (Michael Sullivan, The Arbour, pers. comm. 5 October 2011). The Grange accessed from Victoria Street has been operational for a few years, with a remaining 14 villas still to be constructed (www.thegrangeatberry.com.au).

Huntingdale Park Estate and Graham Park are located directly adjacent to the project. The Huntingdale Park Estate development has approval for 243 lots and is still under development with completed residences located along Huntingdale Park Road, Lincoln Close and Boran Place. An equestrian centre, a manger’s residence and four cabin tourist development was approved by Shoalhaven City Council in 2010 for the Graham Park property. This development has not commenced.

Public utilities

Public utilities within the project area comprise:

- The Eastern Gas Pipeline (Jemena) that traverses most of the project area and crosses the existing highway in the vicinity of Tindalls Lane.
- Endeavour Energy 132 kV electrical transmission lines that traverse the western side of Berry and the South Coast railway line.
- An Optus fibre optic cable that traverses the project area on a similar alignment to the Eastern Gas Pipeline and Endeavour Energy 132 kV transmission line.
- Shoalhaven Water sewer and water pipelines that run from Pulman Street to Wharf Road, Berry.
- A Telstra fibre optic cable that follows the southern side of the South Coast Railway Line through the project area.
- The South Coast Railway Line runs largely adjacent to the highway to the north and south of Berry.

Public utilities are discussed in further detail in **Chapter 4**.

7.9.2 Assessment of potential impacts

Construction

Long term impacts on property and land use would occur from the commencement of construction. These would include the severance, fragmentation and reductions in the size of available agricultural and residential land, and changes to property accesses. The immediate but long term impacts of the project have been considered as impacts associated with the operation stage of the project and are discussed below.

During construction, temporary impacts to property and land use would occur as a result of:

- Ancillary construction facilities, such as stockpile sites and site compounds.
- Construction sediment basins.
- Disruptions or changes to local roads and property accesses.

Temporary ancillary construction facilities sites, if located outside the road reserve for the project, would result in a temporary change in land use during construction. The majority of identified potential ancillary sites are located on agricultural land currently owned by RMS and are primarily located outside the final road reserve. In the event that land would be required that is not owned by RMS, discussions would be held with the affected property owners about purchasing or leasing the required land in the short-term during the construction phase of the project.

The proposed sedimentation basins are located within the road reserve. It is not expected that additional land use and property impacts would arise from the installation of basins at these sites over and above what would occur as a result of the operational impacts of the project. However, should sites be required that are not located within either the road reserve or within RMS owned land, then additional land would need to be leased over the short term during the construction phase of the project.

The project would also require the alteration and/or temporary disruption to property accesses to accommodate the construction of the project. This may also disrupt internal farm movements where the project would permanently sever a property into two or more parcels. In most cases, RMS has already acquired these properties. However, temporary internal access arrangements would need to be negotiated with impacted landowners or with RMS tenants, to enable internal access to continue with disruption minimised as much as reasonably possible during construction. The permanent impact of these alterations is discussed further in this section (as an operational impact).

The adjustment and realignment of major service utilities would also be undertaken during construction. This has been discussed in **Section 4.2.12**.

Operation

Potential impacts on property and land use by the project would include:

- Property acquisition.
- Severance and sterilisation of land.
- Changes in property access.
- Impacts on future development potential of land within the project and adjoining areas.
- Impacts on dwelling entitlement.
- Impacts on urban settlement patterns and future development potential of adjoining land.

Property acquisition

The project would require adjustments to the boundary of the existing highway corridor. Consequently, around 112 hectares of land currently outside the existing corridor would be included in the road reserve. This land, referred to as directly affected land, would be required permanently for the project and would no longer be available to be used for its original purpose.

RMS has acquired a large portion of the directly affected land and would acquire the remainder of directly affected land prior to commencement of construction. This may involve:

- Partial acquisitions where only part of a property would fall within the road reserve.
- Full acquisitions, where the majority of a lot would be impacted.

For allotments that are subject to partial acquisitions, there would be residual portions of land remaining (referred herein as residual land). In some cases, RMS may also acquire the entire property where the partial acquisition of a property may make a property unviable for its original use (for example, where agricultural uses are no longer viable due to the fragmentation of a lot). However, land acquired in excess of the project needs, ie outside the road reserve, would be sold following completion of the project.

Examples where full acquisition may be required for properties that have areas of residual land remaining include in the area of the Toolijooa cutting where an allotment is severed or where the project severs an allotment across the Broughton Creek floodplain.

A total of 90 lots would be directly impacted by the road reserve. The majority of land that would be impacted is rural land used for grazing purposes associated with dairying or beef production and horse agistment (refer to **Table 7-66**).

As of August 2012, of the 90 properties, 39 properties had already been acquired in full by RMS, totalling around 308 hectares (being the combined total of directly affected land and the residual land). The majority of these properties have been acquired under the hardship provisions of the RMS *Land Acquisition Information Guide* (RTA, 2011).

Table 7-66 Directly affected and residual land, classified by land use

Land use	Directly impacted* (hectares)	Residual land** (hectares)	Total (hectares)
Rural			
Grazing (for dairy or beef production)	49	522	571
Horse agistment	23.5	50.7	74.2
Turf farming	3	32	35
Cultivation (hay, lucerne or silage)	1.6	35.8	37.4
Vacant (rural)	3	52	55
Dwelling and outbuildings on rural properties	1.3	16.5	17.8
Dams	0.14	2.71	2.85
Rural residential with hobby farming	3	0	3
Rural residential	10.5	39.6	50.1
Vacant (rural residential)	1	2	3
Natural area, including native or dense vegetation and watercourses	6.6	114.5	121.1
Private access road for rural properties	0.02	0.4	0.42
Other rural uses (tourism and disused quarry)	3.1	29.4	32.5
Urban			
Residential***	1	0.6	1.6
Vacant (residential)	1.8	11.6	13.4
Open space, including areas for stormwater detention.	1.9	7.5	9.4
Future road corridor vacant	1.2	0.5	1.7
Other			
Road reserve	0.6	1.4	2
Total	**112**	**919.5**	**1031.5**

** Directly impacted refers to land that would be contained within the road reserve and subject to land acquisition.*
*** Residual land refers to remaining portions of allotments following partial or full acquisition that would not be ultimately contained within the road reserve*
**** One residential property also currently operates a bed and breakfast accommodation from the property.*

The remaining 51 properties (of the total 90 properties impacted by the project) remain in private ownership or within the ownership of Shoalhaven City Council (six properties). A further 63.8 hectares of directly impacted land would be acquired as part of the project. In most cases, acquisition would be limited to partial or strip acquisition. Any additional acquisitions (such as full acquisitions for hardship) would be determined during detailed design and in consultation with the affected landowners. All acquisitions would be in accordance with the *Land Acquisition (Just Terms) Act 1991* and the RMS Land Acquisition Information Guide (March 2011) and would occur prior to construction.

Figure 7-47, **Figure 7-48** and **Table 7.67** provide a property-by-property review of the acquisitions required by the project and land use impacts. The determination of these boundaries has been derived from a combination of ground survey, the proposed road reserve boundary and cadastral overlay. This would be subject to further refinement during detailed design, which may alter the final acquisition requirements and estimates.

Land use viability, severance and sterilisation of land

Impacts on the viability of current or future uses of directly impacted properties may occur depending on the amount of land acquired, the area of residual land remaining, and the degree of severance and sterilisation.

Of the 90 allotments (lots) directly impacted by the project:

- 25 lots would be fully contained within the road reserve.
- 53 lots would be impacted with one parcel remaining.
- 12 lots would be impacted with two or more unjoined parcels remaining.

Land use sterilisation refers to where the project severs a property into fragments of a size or shape that makes the ongoing use of that land unviable. In these cases, the land use can no longer be used for its current purpose and has no development potential.

Areas of land that would be sterilised as a result of the project are located at the Austral Park Road interchange, around the western end of the Austral Park Road extension, Tindalls Lane interchange, the northern interchange for Berry, the southern interchange for Berry and areas where the project closely follows the existing highway alignment. These areas have been incorporated into the road reserve, and would primarily be used for landscaping. Sections of redundant highway would be rehabilitated and landscaped.

For the majority of lots that would not be fully contained within the road reserve, the acquisition of land at these lots would result in:

- Land use severance, being the creation of a physical barrier between a property and an existing road access to that property.
- Impacts on the viability or development potential for residual land due to the size of the residual lot. This includes the loss of dwelling entitlements.

The project has been designed to minimise the land use severance of land by following, where possible, property boundaries or the existing alignment of the highway. However, a number of properties would be subject to land use severance to varying degrees by property acquisition.

The land use severance, land use viability and future development potential impacts on agricultural land, rural residential land, urban land, open space and other land uses is discussed separately in this section.

Table 7-67 Property impacts and percentage of directly affected property as at September 2012

Lot number	Predominant land use	Total lot size (hectares)	Area of direct impact (hectares)	Area of residual land (hectares)	Percentage of lot directly impacted	Ownership
1	Grazing	18.34	5.89	12.45	32	Private
2	Grazing	18.74	2.86	15.89	15	Private
3	Grazing	20.59	1.62	18.97	8	Private
4	Horse agistment	28.99	13.02	15.97	45	RMS
5	Other (tourism)	31.71	3.13	28.58	10	Private
6	Grazing	10.27	0.47	9.80	5	Private
7	Horse agistment	18.41	6.52	11.88	35	RMS
8	Horse agistment	12.30	1.94	10.36	16	RMS
9	Horse agistment	20.72	3.06	17.66	15	RMS
10	Grazing	22.59	2.16	20.43	10	Private
11	Grazing	43.66	7.95	35.71	18	Private
12	Grazing	77.64	0.44	77.20	1	Private
13	Rural residential	2.08	0.50	1.59	24	Private
14	Grazing	13.52	4.13	9.39	31	Private
15	Hobby farm/Rural residential	6.48	6.48	-	100	RMS
16	Grazing	34.29	0.77	33.52	2	Private
17	Grazing	35.90	1.58	34.32	4	RMS
18	Rural residential	8.88	1.12	7.76	13	Private
19	Private access road	0.42	0.02	0.39	5	Private
20	Grazing	69.62	6.66	62.96	10	Private
21	Grazing	41.44	3.19	38.25	8	RMS
22	Grazing	60.92	5.84	55.08	10	Private
23	Grazing	0.32	0.32	-	100	Private

Lot number	Predominant land use	Total lot size (hectares)	Area of direct impact (hectares)	Area of residual land (hectares)	Percentage of lot directly impacted	Ownership
24	Rural residential	5.70	0.16	5.55	3	RMS
25	Grazing	67.78	1.85	65.93	3	Private
26	Cultivation	42.31	1.57	40.73	4	RMS
27	Grazing	10.94	2.48	8.46	23	Private
28	Grazing	11.84	1.09	10.74	9	Private
29	Grazing	12.87	0.52	12.35	4	Private
30	Rural residential	0.96	0.16	0.80	17	Private
31	Turf farm	16.62	2.36	14.26	14	Private
32	Rural residential	1.00	0.37	0.63	37	Private
33	Rural residential	1.00	0.46	0.54	46	RMS
34	Rural residential	1.00	0.35	0.65	35	Private
35	Rural residential	1.42	0.69	0.73	48	RMS
36	Rural residential	3.10	0.58	2.51	19	RMS
37	Road reserve	0.09	0.09	-	100	RMS
38	Rural residential	1.22	1.22	-	100	RMS
39	Open space	5.29	0.33	4.95	6	SCC
40	Open space	4.16	1.33	2.83	32	SCC
41	Turf farm	24.97	1.19	23.78	5	RMS
42	Rural residential	1.23	0.50	0.73	41	Private
43	Grazing	6.25	0.98	5.27	16	Private
44	Residential	0.08	0.03	0.05	38	Private
45	Residential	0.07	0.02	0.06	21	Private
46	Grazing	10.81	1.31	9.50	12	Private
47	Grazing	10.65	0.90	9.75	8	Private

Lot number	Predominant land use	Total lot size (hectares)	Area of direct impact (hectares)	Area of residual land (hectares)	Percentage of lot directly impacted	Ownership
48	Residential	0.07	0.004	0.07	5	Private
49	Rural residential	0.20	0.20	-	100	RMS
50	Rural residential (Vacant)	0.06	0.06	-	100	RMS
51	Rural residential (Vacant)	0.07	0.07	-	100	RMS
52	Grazing	56.95	0.15	56.79	0.3	RMS
53	Rural residential	0.20	0.17	0.03	86	RMS
54	Residential (vacant)	1.69	1.12	0.57	66	RMS
55	Future road corridor (vacant)	1.27	1.27	-	100	RMS
56	Residential (vacant)	0.25	0.25	-	100	RMS
57	Residential	0.2	0.002	0.198	1	Private
58	Residential	0.22	0.20	0.02	91	Private
59	Residential & Bed and breakfast	0.21	0.01	0.20	5	Private
60	Residential	0.06	0.06	0.01	88	RMS
61	Residential	0.06	0.06	-	100	RMS
62	Residential	0.06	0.06	-	100	RMS
63	Residential	0.07	0.07	-	100	RMS
64	Residential (vacant)	0.05	0.05	-	100	RMS
65	Residential (vacant)	0.11	0.11	-	100	RMS
66	Residential	0.14	0.14	-	100	Private
67	Residential (vacant)	0.12	0.10	0.03	78	RMS
68	Residential (vacant)	0.26	0.12	0.14	47	RMS
69	Residential	0.13	0.13	-	100	Private
70	Residential (vacant)	0.01	0.01	-	100	RMS
71	Residential (vacant)	0.07	0.07	-	100	RMS

Lot number	Predominant land use	Total lot size (hectares)	Area of direct impact (hectares)	Area of residual land (hectares)	Percentage of lot directly impacted	Ownership
72	Residential	0.07	0.07	-	100	RMS
73	Residential	0.06	0.06	-	100	RMS
74	Residential (vacant)	0.07	0.07	-	100	RMS
75	Residential	0.07	0.07	-	100	RMS
76	Future road corridor (vacant)	0.54	0.54	-	100	RMS
77	Residential (vacant)	11.71	0.06	11.65	1	Private
78	Road reserve	1.32	1.32	0.00	100	RMS
79	Open space	1.24	0.35	0.89	28	SCC
80	Open space	0.40	0.12	0.28	30	SCC
81	Vacant (rural)	6.07	0.99	5.08	16	Private
82	Vacant (rural)	0.97	0.97	-	100	Private
83	Road reserve	0.58	0.45	0.13	77	SCC
84	Vacant (rural)	19.57	0.23	19.34	1	Private
85	Vacant (rural)	37.51	0.64	36.87	2	SCC
86	Rural residential	5.32	0.06	5.26	1	Private
87	Rural residential	11.69	0.11	11.58	1	Private
88	Rural residential	12.69	0.59	12.10	5	Private
89	Grazing	16.60	0.24	16.36	1	Private
90	Rural residential	3.09	0.05	3.04	2	Private
	Total	**1031.5**	**112**	**919.5**		

Changes in property accesses

External property access

External property access refers to the connection of a property to the external road network. This may be a direct driveway connection at the property boundary, via a private road or by a right of way access through a neighbouring property.

Access to adjoining properties would be affected by the project, and in most cases, accesses would require permanent relocation to cater for the new or widened road reserve. A total of 47 properties across the project would have some physical change to external access arrangements.

Agricultural and rural residential properties located along the off-line section of the project between Toolijooa Road and the Austral Park Road interchange would not have property accesses altered by the project, except where:

- The access would be impacted by minor realignment works of the existing highway near the Toolijooa Road and Austral Park Road interchanges.
- The access to the existing highway for two properties would be lost as the project would physically separate the property from the existing highway. In these instances, underpasses have been provided to maintain direct access to the existing highway.

Agricultural and rural residential properties located along the on-line upgrade sections of the project would have their direct access to the highway maintained but restricted to left-in left-out movements (as discussed in **Section 7.1.3**). The potential impacts of this change on travel times are discussed in **Section 7.9** and **Section 7.10**.

For some agricultural and rural residential properties located along the on-line upgrade sections of the project, where road safety standards (such as sight distances) cannot be met at the current access point, the access would need to be relocated and the driveway extended accordingly. Opportunities to consolidate multiple property accesses to one access point to the project would also be explored by RMS with the affected landowners as part of detailed design. The exception to this would be at the following locations:

- For properties located south of the Austral Park Road interchange, the current direct access to the highway would be removed as the design could not safely maintain this access. Instead, access to these properties would be provided via the extended and upgraded Austral Park Road, which would connect to the Austral Park Road interchange.
- For properties located north-west and south-east of the northern interchange for Berry, a consolidated access driveway would be provided to connect these properties to the retained section of the highway south of the interchange.

For properties within Berry, changes to accesses would be required at properties that would be impacted by the project due to road closures at North Street, Victoria Street and Hitchcocks Lane. These include:

- An agricultural property that currently has direct access to North Street near Albany Street. A new access is currently being designed to provide access via Rawlings Lane.
- Any properties located on North Street located west of the cul-de-sac would have a driveway connection to the cul-de-sac.
- A property located adjacent to the south bound on-ramp at the southern interchange for Berry. A new access would be provided to the cul-de-sac at the western end of Victoria Street.
- Properties that currently have direct access to the highway via Hitchcocks Lane. Hitchcocks Lane would be modified to connect to Huntingdale Park Road.

One of the properties located on North Street would lose its current access via North Street and the George Street road reserve (lot number 44). It would not be replaced as part of the project and would be fully acquired by RMS. This would impact on the future land use options for this property, which is discussed later within section 7.9.2.

The RMS has already met with individual property owners to discuss functional and safe access arrangements, and consultation with affected property owners would continue during the detailed design phase of the project. A complete list of access changes to properties in the vicinity of the project is provided in **Appendix L**.

Internal farm access arrangements

The project would sever or isolate some parcels of agricultural land that may prohibit or limit internal movements including:

- Properties near the Toolijooa cutting and Broughton Creek bridges, where the project would sever and isolate properties to varying degrees.
- A property, located near Austral Park Road interchange, where the project would result in an additional barrier to farm movements given the property is already severed by the existing highway and Broughton Creek.
- Properties near the bridge at Berry, where the bridge would cross over two agricultural properties (turf farms).
- An agricultural property (grazing associated with a dairy), located directly north of the project at Berry, which would have an isolated parcel that would no longer be viable for its current land use .
- A property in west Berry, located west of the project, would have an isolated parcel of land as a result of the connection of Hitchcocks Lane to Huntingdale Park Road. The area of land that would be used for this connection is currently used as a private access road.

Where an agricultural property would be severed into two or more parcels, a suitable means of restoring internal access by connecting the fragmented portions of land would be provided, if this can be reasonably reinstated. Discussions to date with impacted property owners have identified the need to provide property underpasses near Toolijooa Ridge, access under Broughton Creek bridges and extensions to an existing cattle underpass. For properties adjacent to the bridge at Berry, restricted access would be provided to enable property owners to pass and gain access to fragmented parcels. These discussions would continue during the detailed design of the project. Where the access cannot be maintained, the isolated residual parcel would be acquired. The impacts on the viability of these agricultural properties are considered in **Section 7.10**. A complete list of internal access impacts is provided in **Appendix L**.

Impact on land use viability and development potential of land

Agricultural land

As shown in **Table 7-66**, the majority of the agricultural land directly impacted by the project is presently used for the livestock grazing associated with dairy or beef production, or for horse agistment. The majority of the lots are classified as Class 2 and 3 agricultural land by the former NSW Agriculture, but are below the minimum lot size for rural areas.

The greatest impact on agricultural land uses would occur where the project involves new sections of highway (an off-line upgrade) at Toolijooa Ridge, Broughton Creek floodplain and in areas north of Berry. Details of agricultural land impacted by the project are provided in **Table 7-8**.

Table 7-68 Agricultural land impacted by the project, by class classification

Agricultural land classification	Directly Impacted (hectares)	Residual land (hectares)	Total (hectares)
Class 2	32	287	319
Class 3	58	487	545
Class 4	10	87	97
Class 5	8	56	64
Total*	108	917	1025

** The total area differs to the total area of directly impacted land (by land use) due to the removal of urban land and watercourses, which are excluded from the agricultural classes*

Along Toolijooa Ridge and the Broughton Creek floodplain, six lots that are currently used for grazing or horse agistment purposes would be severed into one or more parcels. A further three properties would be severed from the highway, and two would be impacted by strip acquisition at the rear of the lots as discussed below:

- It is not expected that the strip acquisition at the rear of two properties would result in land uses changes or impact the development potential given the amount of residual land, current land use activity (tourism and grazing) and the land use zoning.
- It is not expected that the strip acquisition along the frontage of two properties would impact on the grazing land uses. However, at one of these properties, the dwelling would be directly impacted by the project.. Consequently, the dwelling entitlement for this property would require relocation within the lot.
- Lot numbers 3, 4, 7, 8 and 9 would be severed from the existing highway. Land use viability and future development potential for agricultural activities would be impacted owing to the size of the residual lots and access issues (refer to **Figure 7-47** and **Table 7-70**). These lots have been acquired by RMS. Amalgamation of these lots or with adjoining properties would be necessary to create holdings which would be viable for grazing or agistment land uses.
- The project would increase the fragmentation of lot number 10 and lot number 11, and parts of the residual land located to the east of the road reserve would be severed from the existing highway (refer to **Figure 7-47** and **Table 7-67**). This has the potential to impact on current and future agricultural land uses. Internal access arrangements for these lots have been identified and incorporated into the project, such as an extension of a cattle pass, access under Broughton Creek bridges and flood stock refuges. These would be negotiated with the landowner during detailed design.

Impacts to the agricultural properties within the rural sections of the project between the Austral Park Road interchange and Schofields Lane intersection would mostly be restricted to strip acquisition along highway frontages resulting in land use severance. Alternative access arrangements have been proposed as part of the project as discussed above.

As the acquisition of agricultural land for around half the properties located along this section of the project represents a small percentage of overall lot size, the impacts to current and future land use would be minimal. However, potential impacts to land use viability and future development potential have been identified for:

- The two lots currently used for turf farming, which would be severed by the bridge at Berry into two parcels. Impacts on a farm dam/billabong at one of the properties would also occur due to the construction of the northern interchange. Alternative access arrangements would be necessary to maintain the viability of the residual parcels. This may include controlled access under the bridge.
- A residual parcel of agricultural land used for grazing (dairy) which would be isolated from the majority of lot number 43. As access cannot be maintained to the small fragmented residual parcel located between North Street and the bypass, acquisition of the land would be required. This lot would have limited development potential as the land is zoned for road preservation purposes under the Shoalhaven LEP. As identified in **Chapter 4** this area would be retained as a buffer in conjunction with excess land acquired by RMS along North Street and options for community uses would be explored during detailed design.

Rural residential properties

With the exception of three properties (lot numbers 15, 49 and 53), dwellings on rural residential properties would not be directly impacted by the project. However, the project would sever access to the highway for the majority of the properties. Alternative access arrangements to maintain highway access have been proposed as part of this project (refer to Appendix L). The residual lots are unlikely to compromise the ongoing use of these properties for rural-residential purposes. As such, no change in land use is expected for these properties. Where rural-residential properties have been acquired in full, such as those located to the east of the northern interchange to Berry, the residual land that is not needed for the project, would be sold as rural residential properties following the completion of construction with the dwellings retained.

The dwelling at lot number 42 would not be directly impacted by the project. However, a portion of the lot would be acquired for the project, severing a small northern portion. As access would not be maintained to this portion, amalgamation with adjoining land would be required to maintain this land for agricultural purposes. Future development potential is limited given this is part of the riparian corridor for Bundewallah Creek. Should the lot be fully acquired, it would form part of the buffer between North Street and the edge of the project. As such, the land use would change to an open space or recreational use (as an option for the riding club re-configuration). Should this occur, the ultimate land use would be determined in consultation with Shoalhaven City Council.

Where dwellings on rural residential properties would be directly impacted at lot number 49 and lot number 53, the residual parcels would no longer be viable as rural residential purposes and would be sterilised for that use. These lots would either be amalgamated with an adjoining land (lot number 49) or would be utilised for the Town Creek diversion (lot number 53). Subject to detailed design, a residual lot may be created at Lot 15 with the dwelling retained. However, it would unlikely remain viable as a hobby farm and would continue for rural-residential purposes.

Urban land

At the southern interchange, 14 lots would be fully contained within the road reserve and subject to full acquisition. Eleven lots would be partially acquired, which would result in varying sizes of residual land. For the properties that are partially acquired, the impact would occur as a result of:

- Direct impact to a small percentage of the lot numbers 46, 48, 57, 59 and 77, although, the retention of property access would enable the existing land use to continue. One of these properties operates as a bed and breakfast. There may be amenity impacts on these residential properties.
- Due to the size of the residual land parcels, flooding restrictions or loss of road access, six lots would no longer be viable for residential uses (lot numbers 44, 54, 58, 60, 67 and 68). Most of these properties already have restricted development potential due to flooding and are vacant. The residual land ranges from around 100 square metres to 5700 square metres. The six urban lots have or would be acquired in full by the RMS. The future land uses for this land would be determined during detailed design, and most would require consolidation to enable future residential development to satisfy the minimum lot size requirements of the Shoalhaven LEP. Alternatively, options to use the residual land for community uses may be identified as part of the urban design solution for this area.
- At lot number 68, there would also be a temporary change in land use of the currently vacant residential property during construction as it would serve as an ancillary site. The land use of this property, following the completion of construction, would be determined during detailed design (as stated earlier).

Open space and other land uses

Land owned by Shoalhaven City Council would be impacted by strip acquisition (refer to **Table 7-7**). Most of these lots are used for recreational purposes or zoned for open space. The impacts on these lots are discussed below:

- Around 0.3 hectares of land or around six per cent of the Berry sportsground and Camp Quality Memorial Park would be acquired along the northern boundary, which would result in the severance of a small portion of residual land at the northern boundary. The project at this location would comprise a bridge, and would not directly impact any sportsground infrastructure. The loss of around 0.3 hectares of land would not sever the lot from North Street and would not sterilise the use of the remaining area. However, there would be road traffic noise and visual impacts as discussed in **Section 7.2** and **Section 7.6**. The residual land would require amalgamation with adjoining land however it has limited use given it is located within the riparian corridor for Bundewallah Creek.
- Around 1.3 hectares or around 32 per cent of the riding club would be acquired for the project. This would result in the isolation of a small portion of land between the project and Bundewallah Creek, and the demolition of two small buildings. The acquisition of land and the isolation of the northern portion of the lot would have a substantial impact on the club given the loss of training and performance areas. RMS would continue to consult with the club and Shoalhaven City Council during detailed design to identify an appropriate option for the club, which includes the use the adjoining land to re-configure the training and performance areas once safe access can be provided following the construction of the project at this location. The potential uses for the isolated northern portion of the site are limited due to the size of the residual lot and access. This residual lot would require amalgamation with adjoining land to retain some land use activity.
- At Mark Radium Park, around 0.35 hectares or 28 per cent of the park would be acquired along the western boundary of the park. This acquisition would not sever the park from its current road access via Victoria Street. The design of the southern interchange has incorporated retaining walls to minimise the extent of acquisition and potential impacts on the pond. While amenity impacts would occur due to increased road traffic noise and a reduced park area, there would be no impact on the use of the park as discussed in **Section 7.2**.

- An area at Huntingdale Park Estate zoned for open space, which is vacant and nominated for stormwater detention purposes for the Estate, in the order of 0.12 hectares would be acquired and would not impact on the future operation of the basin (located on the adjoining lot). While acquisition represents around 30 per cent of the total lot, a change in land use is not expected as it forms part of a much larger area that has been nominated for open space and landscaping.
- The majority of the lot, owned by Shoalhaven City Council (around 77 per cent) that forms part of Schofields Lane would be impacted (lot number 83). Amalgamation of the entire lot into the road reserve would be considered in consultation with Council as part of detailed design.
- A vacant rural property (lot number 85) would be used during construction. Around 0.64 hectares or two per cent of the total lot would be acquired along the highway frontage with no impact on access.

Impacts on dwelling entitlements

Land acquisition for the project would result in changes to the configuration of impacted property lots or the demolition of existing dwellings.

For properties zoned rural under the Kiama LEP and Shoalhaven LEP, dwellings cannot be constructed on properties that are below 40 hectares, except under certain circumstances and subject to the approval of the relevant council. However, both LEPs provide for the consideration of the potential to relocate dwellings, where they would replace the lost dwelling or entitlement (should a suitable site remain within the lot). This would be the subject of a separate development application and assessment process by the relevant council.

Of the 90 lots impacted by the project, it is estimated that:

- Five rural lots would each be severed into two large parcels of residual land, which would all be below the minimum lot size of 40 hectares. It is noted that these lots are already currently below the minimum lot size. At two of these lots, there would be no provision made to maintain access to a public road for severed portions.
- Two rural lots would have dwellings directly impacted, which may be eligible for relocation within the residual land (subject to a separate approval).
- One rural lot would have the dwelling directly impacted and would be severed into two portions of land that are below the minimum lot size. There would be no external access provided to the severed portion. The dwelling may be eligible for relocation within the residual land (subject to a separate approval).
- Four rural lots would be severed into two portions of land, with the smaller severed lot below the minimum lot size. Internal access would be maintained for two lots only. The remaining two lots would not have development potential due to the remaining size of the severed lot, flooding and lack of access (lot 42 and lot 43).
- The residual land for one rural lot would no longer have development potential due to the size of the created lot (lot 53).
- Two urban lots would be at or above the minimum lot size. However, one lot would no longer have access to a public road (lot 44). The other has limited development potential due to flooding (lot 54).
- Four urban lots are below the minimum lot size, ranging from around $100m^2$ to $1400m^2$ (lot 58, 60, 67 and 68).

The majority of the lots that would be below the minimum lot size or require amalgamation to retain development potential have been acquired by RMS (for example, Lots 4, 7, 8, 9, 53 and 54). This has been discussed earlier in **Section 7.9.2**.

The remaining 71 lots are either fully impacted by the project (that is, impacted 100 per cent), do not currently have a dwelling, or the dwelling is not directly impacted by the project.

Impacts on the urban settlement patterns and future development potential of adjoining land

As discussed earlier, Berry is the main urban settlement within the project area. The project would not significantly alter the settlement pattern of Berry, with the project generally following the future road corridor identified in the Shoalhaven LEP and the draft Shoalhaven LEP.

The project would remove highway traffic from Queen Street. This would have positive impacts for land uses and internal movements within Berry due to improvements in amenity and local network efficiencies. The design of the two interchanges to the north and south of Berry would maintain the predominant east-west movement along Queen Street, minimising any potential for alterations to the street hierarchy and land use patterns within the centre of Berry.

Loss of highway generated trade as a result of the bypass could have an impact on commercial land uses. However, improvements to the amenity of Queen Street may also create different commercial opportunities, which may change the development potential of the commercial centre of Berry. The potential impacts on the viability of businesses within Berry are discussed in **Section 7.10**.

The project would be unlikely to impact land uses for the adjoining established residential areas along North Street, and it would not separate the majority of the community from the recreational spaces at the sportsground and Camp Quality Memorial Park. However, in areas where the project is at its closest to North Street, increased road traffic noise would be experienced and the project would obstruct the visual connection between Berry and its rural setting generating visual impacts. Noise and visual impacts would affect the amenity of North Street. These issues are discussed in **Section 7.2, Section 7.6 and Section 7.10**.

The project would not alter land uses north of Berry, with development remaining limited due to the land use zoning and flooding constraints. The Berry Riding Club would require reconfiguration or relocation from its current location due to its partial acquisition, as discussed earlier in this section.

Huntingdale Park Estate is still being developed, and the existing highway lies immediately adjacent to the eastern boundary of the Estate. The original planning for this Estate included provision for the highway northbound off-ramp to connect to Huntingdale Park Road. This has not been considered as part of the current design of the southern interchange in favour of the proposal which would separate highway traffic from local traffic, and would enable Huntingdale Park Road to be maintained as a local access road. Hitchcocks Lane would be realigned to connect to Huntingdale Park Road, as the lane would no longer have a junction with the highway. This corridor is similar to what was originally provided for the northbound off-ramp and therefore would not impact on development potential of this Estate.

The traffic and transport assessment for the project demonstrates that the intersections at these locations would have sufficient capacity to cater for highway traffic and the Huntingdale Park Estate development when fully realised (as approved). As such, the project would be unlikely to impact on the future development of the remaining parts of the Estate due to access or traffic. However, it would impact on the amenity of adjoining land uses due to increases in road traffic noise. A four metre noise barrier has been proposed along the northbound off-ramp of the southern interchange to reduce road traffic noise levels as a result of the project. The final height and design of the noise barrier would be determined in consultation with the affected community, which would take into account the visual amenity of the area. Landscaping would also be proposed to minimise the visual impacts on the Estate. Any further development for residential or community purposes within the Estate would need to have consideration to road traffic noise by the relevant consent authority. This is discussed further in **Section 7.2**.

Construction of the approved equestrian centre and associated tourist development has not yet commenced. However, the impacts on this land are limited to a requirement for altered access (that is sympathetic to the heritage of this property access) and strip acquisition along the highway frontage. As such, impacts are likely to be limited to the amenity of the property due to increases in road traffic noise.

The completion of the Arbour is also unlikely to be impacted by the project. The project at this location follows the existing alignment of the highway and the property would not be subject to land acquisition. However, the project would have impacts on the amenity of residences and private open spaces located closest to the project. This is discussed further in **Section 7.2**.

Implications for regional land use planning

The South Coast Regional Strategy and the Illawarra Regional Strategy identify the important role of the Princes Highway in connecting communities, supporting economic development and linking neighbouring regions. The project would assist implementation of both strategies, as discussed in **Chapter 2**, by improving both road safety and efficiency of this main road corridor.

Both strategies recognise the need to protect the rural and agricultural land assets located in the South Coast and Illawarra regions. The project has been designed to minimise impacts on rural and agricultural land by following property boundaries or the existing alignment of the highway wherever possible, to minimise fragmentation of properties. The consideration of the potential impact on agricultural viability is discussed in **Section 7.10**.

Both strategies also recognise the need to protect the environmental and biodiversity assets located in the South Coast and Illawarra regions. The project would impact on the biodiversity corridors and environmental assets identified in the strategies, through native vegetation removal or by creating an additional barrier to fauna movement. The design of the project has minimised, where possible, the extent of vegetation clearance. However, additional mitigation would be required to further minimise and offset the impact on biodiversity values and corridors in the project area (refer to **Section 7.3.4**).

7.9.3 Environmental management measures

Mitigation and management measures would be implemented to avoid, minimise or manage impacts to land use and property. These mitigation and management measures are listed in in **Table 7-69** and incorporated in the draft statement of commitments in **Chapter 10**.

Table 7-69 Mitigation and management measures

Potential impacts	Mitigation and management measures
Construction	
Impacts on traffic and property access	Consult with the affected landowners where temporary property access would be required to maintain property access and internal farm access during construction. Provide property owners with advanced notification of project schedules, construction works and changes to access arrangements. Provide community updates on changes to the local road network within the project area during construction.

Potential impacts	Mitigation and management measures
Loss of agricultural land for use as ancillary sites	Strip and stockpile topsoil during the preparation of these ancillary sites. Reinstate top soils, with any necessary soil improvements, as part of the rehabilitation of these areas for ongoing agricultural use.
Operation	
Loss of property required for the project	Acquire land for the project in accordance with the RMS ‘Land Acquisition Information Guide’ (RTA, 2011) and the *Land Acquisition (Just Terms Compensation) Act 1991*. During negotiations with landowners, consider acquiring any severed or isolated sections of land where access cannot be reasonably reinstated. Residual land not required for the project would normally be disposed of by public auction or public tender.
Loss of use of land and property access	Complete property adjustments for fencing, access tracks, cattle underpasses and other farm infrastructure in consultation with the affected landowner. Reinstate property accesses that are lost as a result of the project in consultation with affected landowners including any relocated accesses as may be determined further during the detailed design phase of the project. Identify and implement internal access arrangements in consultation with landowners as required to maintain the long term viability of their property.
Permanent loss of agricultural land	Rehabilitate surplus residual land for sale (or transfer of ownership) to offset loss of similar agricultural land. Minimise sterilisation and severance of land uses and lots by amalgamating severed parcels of land together, where possible, with provision for road access. Minimise the creation of lots without dwelling entitlements by amalgamating severed parcels with lots with retained dwellings or selling to adjoining landowners. Consult with the community and Shoalhaven City Council to identify appropriate community uses for residual land located adjacent to North Street and the southern interchange for Berry during detailed design and construction.

7.10 Socio-economic

This chapter provides an assessment of social and economic impacts that were nominated in the DGRs as key environmental issues for the project. It represents a summary of the *Socio-economic Technical Paper* (AECOM and RM Planning, 2012) that was prepared for the project with consideration of the DGRs.

The technical paper is provided at **Appendix M.** The relevant extract from the DGRs is presented below.

Director-General's requirements	Where addressed
Directly affected properties and land uses adjacent to the project, including: impacts to land use viability and future development potential, property allotment, land sterilisation and severance impacts.	Section 7.9.2 Section 7.10.3
The agricultural sector taking into account the fragmentation and potential loss of agricultural and farm viability including internal and external farm access arrangements both during construction and operation of the project.	Section 7.9.2 Section 7.10.3
Local community socio-economic impacts associated with access, land use, property and amenity related changes.	Section 7.10.3
Business impacts including the overall viability, profitability, productivity and sustainability of businesses in the township of Berry associated with changes to route alignment.	Section 7.10.3
Impacts on recreational fishing access and opportunities in Broughton Creek, Broughton Mill Creek and Bundewallah Creek.	Section 7.10.3

7.10.1 Approach to assessment

Study area

In the context of the socio-economic assessment, the study area includes the project, as well as Berry, the lands immediately adjacent to the project, and the wider catchment as it relates to current usage of the Princes Highway.

Most of the study area lies within the Shoalhaven local government area (LGA). Around a third of the study area between Toolijooa Road and the third Broughton Creek bridge lies within the Kiama LGA.

Methodology

The approach to this assessment used quantitative as well as qualitative data. Key stakeholder issues and community values were identified during project consultation and interviews with property owners and a survey of local businesses were conducted.

The study area was profiled by examining the data from the Census Collection Districts (CCDs) of Broughton Vale, Broughton Village, Jaspers Brush and Rose Valley. Data for socio-demographic indicators were generally from the 2006 Census. A complete set of Census 2011 data was not available at the time the assessment was prepared.

Economic data was collated from surveys of local businesses conducted by AECOM in 2008 and 2011. Information was also sourced from a report, *Princes Highway Upgrade – Economic appraisal of Gerringong and Berry Town Access Arrangements* by SGS Economics and Planning (November 2008). The purpose of this report was to appraise the various town access arrangements for Berry and Gerringong from an 'economic impact' point of view. In so doing, it estimated the likely change in business turnover in the two towns resulting from the progressive Princes Highway upgrade.

The socio-economic impact assessment also drew upon evidence of reported socio-economic impacts experienced by other bypassed towns. This involved analysis of the potential project impacts with reference to the following documents:

- Bureau of Transport and Communications Economics 1994, Working Paper 11. *The Effects on Small Towns of Being Bypassed by a Highway: A Case Study of Berrima and Mittagong*.
- Urban Regional Planning Program, University of Sydney 2005, *The Karuah Highway Bypass, Economic and Social Impacts: The 1 Year Report*.
- Urban Regional Planning Program, University of Sydney 2009, *The Karuah Highway Bypass, Economic and Social Impacts: The 5 Year Report*.
- NSW RTA and University of Sydney, 1996, *Evaluation of the Economic Impacts of Bypass Roads on Country Towns: Final Report*.
- NSW RTA and University of NSW 2011, *Economic Evaluation of Town Bypasses: Review of Literature*.

7.10.2 Existing environment

The study area is strongly defined by physical, economic and social characteristics. The physical qualities of the rural environment derive from their agricultural capability as well as their scenic qualities. The region has high value agricultural capability and has become a draw for tourists. The lifestyle forged by the physical characteristics and community facilities have made the region an attractive place to live and this lifestyle is highly valued by the local community.

The assessment of the existing social and economic environment in the study area considered:

- The demographic profile.
- The economic environment, including a profile of the following industries and businesses:
  - Agricultural businesses.
  - Tourism businesses.
  - Businesses within Berry.
- The character of the community.
- The values of the community.
- Travel patterns.
- Recreation and community facilities.

Demographic profile

The study area has a homogenous and ageing population. A large proportion of the population is within the over 65 age group: 29.2 per cent compared with 13.8 per cent across NSW. The study area enjoys a lower than average unemployment rate, with the most common industries of employment being the retail and health care sectors. The bulk of jobs are located in Berry. The study area population is heavily dependent on motor vehicles for transport.

Some key social and demographic characteristics of the study area are as follows:

- The population of the study area, as well as that of Berry, declined between 2001 and 2006, whereas there was a marginal increase in the Shoalhaven LGA. Population forecasts for the Shoalhaven LGA show modest growth between 2011 and 2036 (NSW DP&I, 2010).
- The median age of Berry's population was 49 in 2006, whereas it ranged between 45 and 51 in the rest of the study area. The median age was 37 in NSW. Median age increased in the study area, Berry and Shoalhaven between 2001 and 2006 with a comparatively high proportion of the population aged 65 and over.
- Indigenous population in the study area was comparatively low in 2006 (0.7 per cent) and has been declining since 2001.
- The study area, including Berry and the Shoalhaven region, was largely homogeneous with more than 90 per cent of the population speaking English at home.
- Almost half (49 per cent) of the study area's workforce was employed in full time occupations in 2006, compared to 53 per cent of the Berry workforce, 51 per cent in Shoalhaven LGA and 61 per cent in NSW. Over a third (35 per cent) of the study area's workforce was employed in part time occupations, compared to 38 per cent in Berry. These proportions are higher compared to Shoalhaven LGA (34 per cent) and NSW (27 per cent). The study area's unemployment rate was four per cent compared to five per cent in Berry. This is low when compared to the rate of nine per cent in the Shoalhaven LGA and six per cent in NSW.
- About 40 per cent of jobs in Berry were concentrated in the retail, health care, accommodation and food services sectors. Comparable figures for the study area, Shoalhaven LGA and NSW are 32 per cent, 35 per cent and 28 per cent respectively. Much of this employment was related to servicing the tourist sector, while the prominence of the healthcare and social assistance services sector, coupled with an ageing population, suggests a link to the retiree market.
- Median weekly household income in Berry was $789 compared to $659 in Shoalhaven LGA and $1036 in NSW. The study area range is $700 to $1266.
- The vast majority of the study area's population used a car to go to work, as is the case with residents of Shoalhaven LGA.

Economic environment

The economic profile of the study area is generally dominated by agricultural and tourism industries. Businesses within Berry are also an important component of the economy of the study area.

Agricultural businesses

Agricultural land within the study area is used for dairy and beef production, viticulture, goat rearing, livestock feed (grasses), turf farming and horse agistment, with the largest economic contributions being from the dairy and beef industries. Dairy farms within the study area supply the Berry Rural Cooperative, which employs a total of 28 people across the organisation.

The different types of agricultural land uses and the classifications of the agricultural land within the study area have been discussed in **Section 7.9**. Agricultural land within the study area is generally suitable for a wide variety of agricultural uses, including regular cultivation. However, certain areas within the study area, especially the area around Broughton Village, are only suitable for grazing.

Agriculture businesses within the study area generally involve dairy, including Berry Rural Cooperative suppliers, and beef cattle farming, as well as horse agistment, goat rearing, turf production and silage.

Tourism

Tourism is an important driver of the economy of the South Coast Region. Almost a quarter (about 24 per cent) of all businesses in the region are in the tourism sector. This is greater than the national average which was 20.2 per cent in June 2009. Employing businesses, which employ staff as opposed to sole traders, comprise 54.8 per cent of all tourism businesses in the region, compared to the national average of 39.7 per cent.

In the year ending June 2011, the Shoalhaven LGA received 1.2 million domestic visitors and 421,700 visitor nights, an increase of 11 per cent over the previous year. By comparison, the South Coast Region (from Helensburgh to the Victorian border) recorded 2.9 million visitors while NSW recorded 24.1 million visitors during this period.

In the year ending 30 September 2011, international visitation to the area increased by 13 per cent, with expenditure in excess of $190 million by foreign visitors. Domestic overnight and day visitors to the area injected $617 million into the local economy, supporting 6000 jobs.

The tourism sector is therefore important to the study area both in terms of economic activity and job creation.

Businesses within Berry

Berry has a number of businesses that cater both to the tourist and local markets. There are 105 businesses in Berry of which 34 were likely to cater to locals only and the remaining 71 businesses are those that would serve locals, tourists and motorists passing through the town (SGS Economics and Planning, 2008). Further surveys by AECOM in 2008 and 2011 of businesses catering to passing motorists, tourists and locals, confirmed these proportions. The survey undertaken by AECOM in 2008 showed that retail businesses, representing the majority of Berry businesses, considered that less than 15 per cent of their turnover resulted from through traffic. Businesses most reliant on this form of trade were petrol stations, with 70 to 75 per cent of their turnover earned from this source. Accommodation businesses and food and beverage businesses considered that 24 per cent and 20 per cent respectively of their turnover resulted from through traffic.

The literature review of bypassed towns found that businesses that are most likely to be impacted by a bypass include service stations, some retailing, takeaway food and restaurants. The only accommodation category similarly impacted was budget priced motels and this occurred in one instance only (Mittagong). Businesses that served a resident community and hinterland were not adversely affected.

General trends for businesses within Berry included (SGS Economics and Planning, 2008):

- Customers came primarily from the north (Wollongong and Sydney) but some shops reported a smaller number of customers coming from the south.
- Berry is a destination town and many people travel there for shopping, food and browsing.
- People who come to Berry as a destination tend to stay longer in the town, often on a day trip, and spend more than people who stop briefly on their way through the town.
- More people visit and pass through Berry on weekends than weekdays.
- ‘Long haul’ highway travellers were not often mentioned, indicating that the bulk of trade was from people with a destination in the region.

Community character and cohesion

Community cohesion generally refers to intangible concepts such as a sense of belonging, attachment to a group, willingness to participate in activities and to share in outcomes. In a cohesive community, residents have a sense of belonging and feel a strong attachment to the community and their neighbours. The physical environment, including transport infrastructure, plays an important role in fostering or obstructing community cohesion.

The study area is predominantly rural in character, consisting mainly of large lot agricultural holdings. Agriculture has traditionally been dominated by the dairy industry, but more recently wineries and equestrian activities have become more prominent in the sector.

Existing physical connections and linkages in the study area, and particularly within Berry, are instrumental in shaping current community cohesion. Existing paths of travel by vehicle, bicycle and on foot are seen as critical by the local community to maintaining this current community cohesion, which also contributes to the community character of the town. Access to existing community infrastructure (educational facilities, health services, places of worship, etc.) is also seen as fundamental to creating and maintaining a sense of community cohesion and wellbeing.

Berry's community infrastructure consists of several educational facilities, health services, places of worship, community centres, arts and entertainment facilities, emergency services, open space, sporting and recreation facilities, and clubs.

Foxground and Broughton Village were small but active communities in the early and middle part of the twentieth century. As Berry became the dominant urban centre in the study area from the 1970's, these communities entered a period of decline as people moved away and community facilities closed given the lack of sufficient demand. However, friendships remain between farming families that settled in the area. The Toolijooa community has become stronger in recent years but remains a minor settlement.

Community values

From community consultation undertaken over the past five years during the route selection process and planning for the project (refer to **Chapter 6** for further details), it is clear that the local community values the high quality and intrinsic beauty of the surrounding rural environment and considers it an economic asset. This is because it draws tourists to the area as well as providing productive agricultural land. The community also highly values the existing community, recreation and open space facilities in the town. These elements make up the lifestyle qualities that have attracted people to the region.

Travel patterns

The Princes Highway is the major route for road traffic between Sydney and the South Coast. Over 80 per cent of traffic using this highway, within the study area, is through traffic. Since the Highway passes through Berry, all through traffic, including heavy vehicles, must pass through the town. Between 70 and 75 per cent of traffic passing through Berry does not stop (refer to **Section 7.1**).

The local road network within Berry currently consists of two access points between Berry and west Berry. One access is via the intersection of Queen Street and Kangaroo Valley Road and the second access is via North Street. There is direct access between North Street and Kangaroo Valley Road.

Within the broader study area, there is currently direct access from local roads and property access roads to the highway. Left hand and right hand turns are generally able to be made to and from the highway from local roads and property accesses.

Cyclist and pedestrian access

Within Berry, North Street is a popular pedestrian and cyclist route. North Street is used by pedestrians and cyclists to travel between Berry and west Berry. It is also used to access local recreation facilities such as the Camp Quality Memorial Park, Berry sportsground and Berry Riding Club.

Outside of Berry, there are limited opportunities for pedestrian movement along the Princes Highway within the project. This is due to the significant travel distances between towns coupled with the high speed limits along the highway.

There are no formal cycle specific facilities in Berry but Shoalhaven City Council promotes various cycle routes to and from Berry utilising the Princes Highway and other local and regional roads (for example Berry to Seven Mile Beach via the Princes Highway, Tannery Road and Beach Road, and Berry to Kangaroo Valley via Berry Mountain (AECOM 2011b)).

The proposed 1400 kilometre coastal cycleway stretching from the Queensland border to the Victorian border includes a section within the study area that follows the route of the Sandtrack. The Seven Mile Beach route described above connects Berry to the coastal cycleway. The purpose of the cycleway program is to deliver more sustainable transport choices, increase tourism, provide better coastal recreation access and grow bicycle-tourism industries. It is largely funded by RMS and implemented by local government, and has already resulted in over 330 kilometres of the route being constructed or committed to in the form of shared pedestrian and cycle paths or on-road cycle lanes along local streets. There are opportunities for Shoalhaven and Kiama Councils to apply for grants to improve the route for cyclists. There is also the opportunity to expand the network beyond the coastal cycleway utilising the road and rail network (refer to **Section 7.1**).

Recreation and community facilities

Berry has a wide range of community facilities and assets including places of worship, sporting grounds, recreational facilities, educational establishments and essential facilities and services. Many of these facilities were provided when the town was first established, including the old court house, hospital, post office and police station. Community facilities within Berry include:

- Berry community activities centre, which houses the Berry school of arts, Berry community cottage and coordination activities for the Berry country fair.
- Berry showground, which is the location of the Berry agricultural show and the Berry country fair.
- Berry sports and recreation centre.

Recreation within the study area is facilitated by the abundant natural features. Common recreational activities within Berry and the surrounding area include:

- Walking, jogging and cycling along North Street.
- Passive recreation in the many parks, rest stops and lookouts.
- Active recreation at the horse riding facilities, sporting facilities and grounds within Berry.
- Fishing at local creeks. Fishers generally visit Broughton, Bundewallah, Connollys and Broughton Mill creeks, which are accessed from road bridges.

7.10.3 Assessment of potential impacts

Socio-economic impacts would occur during the construction and operation phases of the project. As discussed in **Section 7.10.1**, a number of studies were used to assess the likely impacts of the project, especially the bypass of Berry.

Construction impacts

Potential positive and negative socio-economic impacts from construction of the project would result from the following physical changes that would occur within the study area:

- Changes in amenity. This would include increased noise and vibration, adverse changes to views and a reduction in air quality. Further details are provided in **Section 7.2**, **Section 7.6** and **Section 8.2**.
- Changed traffic conditions and access arrangements. This would include the temporary closure of Kangaroo Valley Road, purchasing and leasing of land, partial closure or temporary access to local roads and provision of temporary access to some properties. Further details are provided in **Section 7.1** and **Section 7.9**.

The construction phase would give rise to the following socio-economic impacts:

- Amenity impacts.
- Economic impacts, including impacts to the agricultural and tourism sectors as well as businesses in the township of Berry.
- Impacts on traffic conditions.
- Impacts to community cohesion.
- Impacts to community assets and recreation.

Amenity impacts

Amenity impacts during construction of the project would include any factors that affect the ability of a resident, visitor or business owner to enjoy their home and daily activities. Amenity impacts during construction of the project are discussed in detail in **Section 7.2**, **Section 7.6**, **Section 7.9.2** and **Section 8.2**.

Noise impacts during construction would be temporary in nature and would generally occur during daytime hours. Normal working hours are from 7am-6pm, Monday to Friday and 8am-1pm Saturday. When required, works would be carried out during extended hours. Based on consultation undertaken with affected residents, there is general support for extended working hours as this could lead to a shorter construction period. These works would be limited to the following times and locations:

- Between 6am and 7pm Monday to Friday for the Toolijooa cut, Broughton Creek floodplain and major bridge works (outside Berry township).
- Between 7am and 4pm on Saturdays for the Toolijooa cut, Broughton Creek floodplain and major bridge works (outside Berry township).
- Outside of known likely major traffic peaks (such as the Friday evening prior to a public holiday long weekend).
- Out-of-hours activities, as detailed in **Section 4.4.9** and **Section 7.2**.

The impact of construction activities would be the same as during normal construction hours and are discussed in **Section 7.2.4**. Mitigation and management measures are described in **Section 7.2.5**.

The project may cause construction fatigue for residents or motorists given the duration of the construction period.

Dust would be generated from earthworks associated with the construction of the proposed highway. The main sources of dust would be from blasting and crushing, the use of excavators, front-end loaders and dump trucks as well as wind erosion from exposed areas (PAE Holmes, 2011). This would be addressed by mitigation and management measures as described in **Section 8.2.4.**

The construction phase would also give rise to visual impacts to road users and to residents of rural properties in the vicinity and in Berry, from not only road works but associated materials stockpiles adjacent to the corridor.

Economic impacts

<u>Agricultural sector</u>

Construction impacts to agricultural land and businesses would arise from the use of productive agricultural land for ancillary facilities such as stockpiling materials. All land currently anticipated to be required for these facilities has been or would be acquired by RMS prior to use. However, should sites be required that are not located within either the road reserve or within RMS owned land, then additional land would need to be leased over the short term during the construction phase of the project. Refer to **Section 7.9.2** for further information.

Tourism sector

Potential visitors to the area may perceive that construction works would create an impact on their enjoyment of their stay, which may discourage them from visiting the area. This may impact local businesses in the tourism sector.

Businesses in the township of Berry

The project would be constructed in a way that would allow existing traffic arrangements to continue until the new interchanges are operational. Access to businesses and therefore highway trade would not be directly affected during construction although construction works north of Berry may encourage a small proportion of drivers to divert to the 'Sandtrack', which could have a minor impact on highway trade.

In the order of 500 jobs would be created over the course of the construction, based on a construction period of three years. Construction worker expenditure during the three year construction period would benefit local services in the vicinity of the highway, such as cafes and takeaways, service stations, trades and services suppliers and potentially some accommodation providers. The expenditure would have flow on effects to other businesses in the area.

Traffic conditions

An 80 kilometre per hour construction speed limit would be maintained where possible throughout construction. However, construction activities would inevitably impact traffic efficiency (in order to maintain road and workplace safety) for both local and regional commuters due to a short term reduction in travel speeds through construction zones and potential delays caused by temporary road closures and detours. In the unlikely event that the average speed along the whole route were to fall from 80 kilometres per hour to 50 kilometres per hour, a driver travelling the entire 11.6 kilometre distance may experience a delay of around six minutes. Traffic impacts are discussed further in **Section 7.1**.

Community cohesion and severance

Construction of the project has the potential to reduce cohesion within the community if road closures act as a barrier to through movement. This impact would be most prominent within the Berry community and would have the potential to occur even when road closures are temporary.

Construction of the project does not include any major works within the centre of Berry. The most significant modification to the town's road network would occur at the southern interchange for Berry, which would require a temporary road closure. During this time North Street would provide an alternative route between Berry and west Berry. This would mean additional traffic along North Street and the associated increase in traffic noise, for the duration of the closure of Kangaroo Valley Road. Traffic flows that would be expected to be diverted are detailed in **Section 7.1**. Whether or not North Street is closed and the extent and duration of these impacts are dependent on the construction programming to be determined during the detailed design process.

The majority of works in the vicinity of Berry would be constructed offline and although it is likely that there would be some adverse effects, such as reduced connectivity, where the offline sections connect with the active road network, these disruptions would only last for short periods of time.

Certain residents within the study area may experience severance impacts should access to their properties be cut as a result of the project. Any property accesses or local roads impacted by the project would be provided with an alternate access point (refer to **Section 4.4.8**). Consultation has been ongoing throughout the project and early consultation with potentially affected residents has kept the local community informed of pending changes to access arrangements.

Community assets and recreational activities

The following impacts to community assets and associated recreational activities may occur during the construction phase of the project:

- Changes to the Berry sportsground due to a small area (0.3 hectares) of land take, which does not affect buildings and which would not disrupt sporting activities or passive recreational activities. Refer to the discussion regarding operational impacts on community assets below.
- Relocation of the Berry Riding Club including the two smaller riding clubs which use its facilities during construction to an agreed site in the Berry area. The permanent solution for the Clubs would be determined in consultation with Shoalhaven City Council and may involve the reconfiguration of the facilities on the adjoining land.
- Disruption to passive recreational space at Mark Radium Park due to land take associated with the southern interchange.
- Disruption to the use of North Street as an existing recreational route for walking, cycling and jogging.
- Traffic disruption for vehicles travelling from outside of Berry to access recreational facilities or clubs within town. Access within Berry to recreational sites would not change.
- Recreational facilities in the vicinity of North Street would be exposed to construction noise during building of the bridge at Berry and upgrade to the north of Berry. Construction on this section of the project would only occur during standard working hours and hence Saturday afternoon and Sunday activities would not be affected. Construction noise would be minimised in accordance with standard construction mitigation measures as outlined in **Section 7.2**

Impacts on recreational activities during construction are expected to be minor.

Recreational fishers

Access to the existing Broughton Creek bridge would be maintained for recreational fishers throughout the construction of the project. However, construction works may temporarily restrict access to fishing sites near Broughton Creek bridge and near the Berry sportsground (Bundewallah Creek and Broughton Mill Creek).

The construction of the project also has the potential to impact the riparian and aquatic habitat in the vicinity of new bridges if sediment enters the water and the bank is altered to accommodate the bridge abutments. As discussed in **Section 7.3**, the project may result in potential risks to fish stocks including impediments to fish passage, sedimentation and pollution, which would be managed by the implementation of appropriate mitigation measures.

Operational impacts

Potential positive and negative socio-economic impacts of the project would be a result of the following physical changes that would occur in the project area:

- The bypass of Berry town centre. The removal of heavy vehicles from within Berry would improve noise levels in the town centre but would reduce visual amenity and increase road noise in other locations, particularly the North Street precinct. Further details are provided in **Section 7.2**, **Section 7.6** and **Section 8.1**.
- Changes to the local and regional road network. This would include severance of North Street, the closure of Victoria Street at the western end, a new link from Huntingdale Park Road to Hitchcocks Lane, changes to access between Berry and west Berry and changes to access along Kangaroo Valley Road due to the southern interchange. It would also include changed access arrangements to local roads and properties along the project and changed pedestrian and cyclist arrangements. Further details are provided in **Section 7.1**.

- Property acquisition and severance of rural properties. The project would require acquisition of around 110 hectares of land, affecting 90 properties. This would include the full or partial acquisition of urban and rural properties. Further details on property acquisition are provided in **Section 7.9**.

These changes to the study area would have the potential to result in the following socio-economic impacts:

- Amenity impacts.
- Impacts on community cohesion and the social character of the Berry township and broader study area. This would include impacts due to changed access arrangements and property acquisition and severance.
- Economic impacts, including impacts to the agricultural and tourism sectors and to highway reliant and non-highway reliant businesses. Impacts on recreational activities and community assets.

Amenity impacts

Amenity within Berry would be expected to improve as a result of the project. Removing a large proportion of traffic (especially heavy vehicles) from Berry would improve amenity in the vicinity of Queen Street by reducing traffic congestion, noise levels and improving air quality and pedestrian safety. This assumption is justified by case studies of towns that have been bypassed (refer to **Section 7.10.1**). When heavy vehicles in particular have been removed from a town, the result has been the universal improvement in amenity and lifestyle quality for the town concerned.

Throughout the study area and particularly within Berry, air quality is expected to improve as a result of the project. Predicted ground-level carbon monoxide, nitrogen dioxide and particulate matter concentrations for the project area in 2017 and 2027 would generally be lower than those for the existing alignment in future years if the project was not constructed (refer to **Section 8.1** for further detail). The reduced noise levels and improved air quality and pedestrian safety along the main street of Berry would be a significant benefit to the town and could be a catalyst for the redevelopment of businesses along the current route of the highway.

However, there is also potential for adverse amenity impacts to occur as a result of the project. These would generally be associated with visual impacts and noise impacts, especially in the vicinity of North Street, Berry. These impacts were recognised during the options and route selection process and the value management workshops and the route options were modified to minimise these impacts, particularly on the sportsgrounds and Camp Quality memorial park. The North Street corridor has been previously gazetted as a road corridor and there has been community awareness and expectation that the highway would be relocated along this corridor. One of the key factors in selecting this option was to avoid the potential impacts on the Pulman Street heritage precinct that would have resulted from construction of other route options.

The proximity of the bypass to North Street would have the potential to increase noise levels and interrupt views to the pastoral landscape and escarpment. The installation of measures to mitigate noise impacts adjacent to the upgrade, such as barriers and mounds, would also have implications for visual amenity.

The concept design for the upgrade has responded to community concerns about these impacts by moving the highway about 40 metres away from North Street, by reducing its height by up to two metres, and by reducing the overall height of the noise barriers from five to four metres. Sloped embankments and vegetative screening would be utilised between potential noise barriers and affected properties to reduce visual impacts. A further concern to residents was the height of the bridge at Berry and in response to these concerns RMS has lowered the maximum height of the bridge by 6.4 metres. This process has been facilitated by a series of alignment and urban design consultation workshops with the Berry community.

Amenity impacts associated with the project are discussed in **Section 7.2**, **Section 7.6** and **Section 8.2**.

Community cohesion and social character impacts

Community cohesion and social character impacts would arise as a result of:

- Changes to community connectivity, such as changed access arrangements.
- Changes to community wellbeing from impacts such as property acquisition.

<u>Connectivity and access arrangements</u>

The project would potentially have both positive and negative connectivity impacts within the study area and specifically within Berry.

The removal of the highway traffic from Berry would eliminate the existing physical barrier from the centre of town. The improved amenity along Queen Street would improve the quality of the Berry urban environment for businesses and the local community. This would create a more pedestrian friendly environment and reinforce a sense of community identity and community wellbeing. Benefits to the community and improved community cohesion have been shown in other towns that have been bypassed, such as Berrima, Karuah and Yass, and it is likely that Berry could expect the same outcome. See **Section 4** of the *Socio-Economic Technical Paper* at **Appendix M**.

Localities such as Broughton Village and Foxground are no longer active communities, with the closure of community facilities, churches and schools following a decline in population. However, friendships remain between farming families that settled in the area. The project would not sever these communities, and the community members have not expressed concern that the project would interfere with their ability to continue to interact with each other. While the Toolijooa community has grown in recent years, the route of the project is close to the existing alignment and would not affect the integrity of this community.

One access between Berry and west Berry (along North Street) would be permanently closed as a result of the project. The severance of North Street would not be expected to affect access by car between Berry and west Berry. However, the closure of the route would increase the distance that residents in west Berry would have to walk to destinations on North Street, including the Camp Quality Memorial Park and Berry sportsground. This could create a perception of increased isolation or severance among these residents.

Connectivity between Berry and the developing areas to the west and north west would be maintained by bridging Kangaroo Valley Road over the upgraded highway as part of the southern interchange for Berry. This would be connected to a footpath along North Street from the intersection of Queen Street and Kangaroo Valley Road. The bridge would retain the existing alignment and level of Kangaroo Valley Road and be sufficiently wide to provide for off road pedestrian and cyclist access adjacent to, but separated from the carriageway on both sides of the bridge. Pedestrian and cyclist arrangements would be provided to ensure that adequate access is maintained at the proposed roundabouts on Kangaroo Valley Road to the west of Berry. Pedestrian refuges at each leg of the roundabout and a shared path within the design improve pedestrian and cyclist facilities compared to the existing situation at this location.

West Berry residents accessing Berry by car would have an increased risk of severance impacts in the event of an incident on Kangaroo Valley Road at the southern interchange for Berry. An incident that closes Kangaroo Valley Road has the potential to cause disruption to access for west Berry residents travelling to other parts of Berry or the Princes Highway, especially considering the northern interchange for Berry contains only a southbound off-ramp. However these impacts are considered to be manageable and likely to be of limited risk and duration, given the low speed environment and the width of the overbridge that would allow vehicles to pass by an incident under traffic control. Further, if the northbound and southbound lanes of project can be accessed in either direction, motorists would be able to complete a u-turn at the Tindalls Lane interchange or at the Mullers Lane u-turn facility to access the Berry township or West Berry, with a small delay.

The introduction of median fencing would result in left-in and left-out only movements from local roads and private properties to and from the highway. Right hand turns across fast-moving two-way traffic would no longer be allowed. There are 12 accesses that would be restricted to left-in left-out movements as a result of the project and this would add up to around three minutes of additional travel time to affected properties but improve safety in the area.

U-turn provisions would be via the grade-separated interchanges at Toolijooa Road, Austral Park Road, Tindalls Lane and the northern and southern interchanges for Berry. Given that some interchanges would not include provision for all traffic movements, additional u-turn facilities would be provided on the existing highway north of Austral Park Road and south of Schofields Lane at Mullers Lane. U-turns would also be facilitated via a new roundabout at the junction of Tannery Road with the existing Princes Highway in Berry.

Community wellbeing

Land acquisition and severance may result in major changes to the lives of those affected giving rise to a sense of anxiety or uncertainty, a loss of amenity, financial costs and isolation.

Those residents whose property would be acquired as a result of the project would relocate to an alternative location. RMS would compensate owners for land acquisition in accordance with the Land Acquisition (Just Terms Compensation) Act 1991.

The economic impacts of property acquisition and land severance are discussed below.

Economic impacts

The project would improve connectivity to the NSW south coast and as such would enhance potential business opportunities in the area. It would facilitate improved access to the existing tourism industry at Jervis Bay, Batemans Bay and Ulladulla. In addition, industries in the Nowra area would benefit from more reliable access to markets and raw materials in the Sydney and Wollongong areas due to reduced travel times and increased road safety.

Within the study area, the project would have the potential to impact on businesses in the agricultural and tourism sectors. The project may also impact businesses that rely on traffic utilising the highway for trade as discussed below.

Agricultural sector viability

The project would require the acquisition of agricultural land within the study area, which has the potential to impact on the economic productivity and the viability of agricultural businesses. The project would also fragment rural properties, which may restrict agricultural operations. The majority of agricultural land directly and indirectly impacted by the project is currently used for livestock grazing associated with dairy or beef production, or for horse agistment. The greatest impact on agricultural land would occur where the project involves new sections of highway at Toolijooa Ridge, Broughton Creek floodplain and in areas north of Berry. Land uses within the study area are discussed further in **Section 7.9.1**. Where possible, impacts to agricultural land have been minimised through the options selection and design of the project. However, the full or partial acquisition of agricultural land could result in a loss of revenue to the owner and could affect the viability of the business.
This would be due to:

- The loss of productive land.
- Changes to the size and shape of paddocks (through strip acquisitions, severance or fragmentation of properties).
- Changes to farming conditions as a result of the road development affecting flooding behaviour, water supply.
- Changes to access between different parts of the property.

Land acquired for project that is outside the road reserve and used temporarily for ancillary facilities would be repackaged and sold on completion of the project. Where practicable, following the completion of the project and rehabilitation of the site, there would be potential for the sites to be returned to their previous use.

A total of 23 agricultural properties would experience direct impacts as a result of the project.

Of these, seven rural operators have said that their businesses would no longer be viable as a result of the proposal RMS has already acquired these properties in full. Of the seven properties, two were used for grazing beef cattle, two for silage, one for horse agistment, one as a mixed hobby farm and one for goat farming. The acquired properties are currently leased to tenants and are being used for similar operations, with the exception of the goat farm, which is now used for horse agistment.

There are 16 other agricultural businesses that would be affected by land acquisition and may experience a decrease in productivity. However, their viability is not expected to be affected since the extent of acquisition or the location of land to be acquired at the edge of a property would not affect business operations. Two dairy farms supplying milk to the Berry Rural Cooperative would be affected by partial acquisition but after consultation with the affected landowners, this is not expected to significantly affect their current operations and outputs. Consultation with the Berry Rural Cooperative has confirmed that the potential small loss in production is not expected to reduce the scale of the Cooperative's operation, turnover or workforce.

Refer to **Section 7.9.2** for further discussion on land use viability.

The economic impact of the project on the agriculture sector as a whole has been determined by estimating the contribution by a business to the gross regional product and the change in this following full or partial acquisition. The resulting estimates are considered reliable as indicators of the impact of the project.

The estimates of the gross direct economic impact of the project as well as the number of impacted agricultural businesses is contained in **Table 7-70**. The hobby farm that has been acquired has been excluded from **Table 7.70** because it does not provide an income and therefore an economic impact is not expected.

Table 7-70 Economic impact: agriculture sector

Potential loss of value added ($)		Economic activity of potentially directly affected agricultural businesses	No. of businesses impacted	No. of businesses acquired in full
Annual	Long-term[a]			
385,100	8,801,900	Dairy cattle farming	3	0
		Beef cattle farming	13	2
		Silage, hay and turf farming	3	2
		Agistment	1	1
		Goat farming	1	1
		Other[b]	2	1

Note:
a: Present value of annual loss of value added over 50 years discounted at seven per cent real discount rate (in discounting to present value, 50 years is a reasonable period to represent the permanent case).
b.Other businesses include a hobby farm and a maze.

The loss of productive agricultural land would also impact on the contribution of agriculture to the regional economy, with flow on effects to other sectors. For instance, the operation of a beef farm requires inputs and services from other suppliers, and the processing and transport of products creates further economic benefit.

Tourism and non-highway reliant businesses

The experience of other bypassed towns shows that improved amenity in the commercial precinct of Berry would likely result in increased turnover for non-highway reliant businesses in Berry. These businesses cater to locals and tourists and help to form the destination feel of the town. In particular, the experience of other bypassed towns such as Berrima and Goulburn suggests that businesses in Queen Street and the streets adjoining it would benefit significantly from improved amenity.

This could lead to greater economic activity within the town and in turn, expand business activity and employment in the area. The upgraded highway would be seen from a number of businesses such as bed and breakfast establishments in Berry and the surrounding areas. Views of the bridge at Berry are not expected to impact the numbers of tourists visiting the area and therefore the viability of these businesses given businesses would benefit from safer road access for guests, and views would be retained to the Cambewarra Range and escarpment. The bypass to the north of Berry would provide easy access to the town centre and accommodation in Berry as well as access to bed and breakfast establishments in the nearby rural areas.

Highway reliant businesses

Research carried out in bypassed towns that were established destination towns pre-bypass shows that, post bypass, their business sectors generally all performed well. Some highway dependent businesses in these towns have been able to reposition themselves and become sustainable in the longer term. This evidence indicates that the likely overall effect on business in Berry following the bypass would see the creation of new business opportunities as a result of improved amenity.

The project however has the potential to impact and reduce the viability of highway reliant businesses in the town of Berry from reduced traffic volumes passing through the town. It is estimated that there are 71 businesses in Berry that cater to highway traffic and locals and 34 that cater to locals only. Studies of highway bypass impacts in NSW (refer to **Section 7.10.1**) have shown that the most affected businesses are those directly serving the needs of the motorist such as motor vehicle services, particularly service stations, food and beverage outlets and, to a minor extent, accommodation establishments.

The design of the bypass means that Berry would be visible from the highway and from the southern interchange for Berry, which may encourage through traffic to continue to stop in the town, reducing the impact.

The impact of the project on highway reliant business was assessed in accordance with 'A Guide to Good Practice – Evaluation of the Economic Impacts of Bypass Roads on Country Towns' (RMS, 1996). It provides a worst case assessment in so far as it does not take account of any increase in turnover as businesses adapt to the conditions.

As business owners may be considerably uncertain about the extent of impact the project would have on through traffic and trade, the analysis considered three potential scenarios upon opening of the project. The three scenarios were based on varying amounts of highway traffic diverting to the bypass at Berry, being 78 per cent of highway traffic (central scenario, which reflects the traffic assessment), 100 per cent of traffic (as the worst case scenario) and 50 per cent (best case scenario).

The business effects assessed are the potential change in employment and turnover at highway reliant businesses. The potential change in economic contribution of each business to the study area was indicated by the value added per employed person (based on ABS National Accounts data). The value added by a particular business represents the contribution by a business to the gross regional product.

Table 7-71 summarises the estimated impacts on employment, turnover and value added as a result of the three scenarios.

Table 7-71 Economic impact on highway reliant businesses

	Low			Central			High		
	Decrease in full time equivalent jobs	Decrease in turnover	Loss in value added (annual)	Decrease in full time equivalent jobs	Decrease in turnover	Loss in value added (annual)	Decrease in full time equivalent jobs	Decrease in turnover	Loss in value added (annual)
Motor vehicle services	3	419,226	146,930	6	838,452	293,861	12	1,676,904	587,721
Food and beverage	4	181,903	136,955	8	363,806	273,909	17	727,611	547,819
Other retail	1	109,065	47,176	3	218,130	94,352	6	436,260	188,703
Total	**8**	**710,194**	**331,061**	**17**	**1,420,388**	**662,122**	**35**	**2,840,775**	**1,324,243**

Note: *Totals include rounding*

Under the central scenario and based on the turnover calculated by SGS in 2008 (refer to **Section 7.10.1)**, there is potentially a loss of up to 17 full time equivalent jobs as a result of the project and a decrease in turnover equivalent to two percent of total turnover in businesses at Berry.

The analysis shows that it is likely that the project would cause some businesses to experience a short-term decrease in turnover and reduced employment if they do not adapt to the new market conditions. However, the evidence from bypassed towns indicates that the repositioning of existing businesses and new opportunities would lessen the overall effect of reduced turnover and employment in highway affected businesses.

Recreation impacts

Recreation within the study area would have positive and negative impacts as a result of the project. These would generally be the result of impacts to community assets and impacts to recreational fishing.

Community assets

Community assets used for recreation have a role in promoting cohesion and interaction among community members. Therefore, any changes to these facilities caused by the acquisition of land or the proximity of the project may have a social impact on the surrounding community.

The buffer zone between North Street and the upgrade that would be up to 40 metres in parts would be made available for community uses, such as open space and the shared path extending the whole length of North Street (refer to **Section 7.6**). Uses would be developed in consultation with and to respond to the community's needs. A parcel of vacant land on the corner of George Street and Albert Street could also be added to the community assets in the area. The unused road space resulting from the closure of Victoria Street could be used as an extension to the parking area for Mark Radium Park, which would improve the amenity and useability of the facility.

Through the options selection process and the concept design, impacts to the Berry sportsground, Camp Quality Memorial Park and the Pulman Street and Tannery Road European heritage precinct have been avoided, where possible. However, around 0.3 hectares of land along the northern boundary of Berry sportsground would be acquired. This would only represent about six per cent of the total sportsground area and therefore the impact of the acquisition on the use of this land for recreation would be minor. As well as this, access to the sportsground would be maintained during the operational phase of the project.

The Berry Riding Club and the smaller riding clubs that use its facilities would be affected during construction of the project. A permanent solution for the clubs would be determined in consultation with Shoalhaven City Council during detailed design and may include the reconfiguration of the performance and training areas using adjoining land. Should the club be reinstated in its current location, this would occur as soon as practicable after construction in the area is complete and safe access can be provided. This would retain all the facilities of the Berry Riding Club and the smaller riding clubs in the same area. Car parking facilities consistent with the existing facilities will be provided as part of the relocation.

Recreational fishing

There are no impacts to the existing main fishing access point from the bridge over Broughton Creek. This access point would be bypassed by the project and would therefore become safer for fishers to use.

RMS has recognised that the project presents the opportunity to reduce conflict between fishers wishing to access creeks and the owners of private land adjacent to creeks. As such, the bridges over Bundewallah Creek and Broughton Mill Creek and the two new bridges over Broughton Creek would provide potential future access points for fishers using the RMS maintenance access points. The safer access at Broughton Creek bridge due to the reduction in traffic on the existing highway, and the additional accesses that would be provided at the new bridges would benefit recreational fishers.

7.10.4 Environmental management measures

Mitigation and management measures would be implemented to avoid, minimise or manage socio-economic impacts. These mitigation and management measures have been identified in **Table 7-72** and incorporated in the draft statement of commitments in **Chapter 10**.

Table 7-72 Mitigation and management measures

Potential impact	Mitigation and management measures
Construction	
Amenity	
Noise from construction works	Manage noise impacts as described in **Section 7.2**
Dust from construction works	Manage dust impacts as described in **Section 8.2**
Visual impacts of construction works	Reduce vegetation clearance where possible and progressively revegetate and landscape cleared areas as works are completed. Refer also to Landscape and visual amenity measures in **Section 7.6**
Traffic delays and road closures	Manage traffic and access arrangements as described in **Section 7.1** Through implementation of a Community Involvement Plan, provide timely, regular and transparent information about changes to access and traffic conditions, details of future work programs and general construction progress throughout the construction phase of the project. Provide information in a variety of ways including letter box drops, media releases, an internet site and variable message signs. Set up a 24 hour hotline and complaints management process.

Potential impact	Mitigation and management measures
Potential impacts on tourism due to potential delays from construction works	Provide information about access and timing of works on the project website to assist tourists to plan their journey to Berry. Provide signage from the highway to the services and tourist attractions within Berry township. No construction work is to be carried out on public holidays or over the Christmas and New Year holiday period. Prepare Traffic Control Plans to address peak tourist/holiday traffic such as Friday and Sunday afternoons and days immediately prior to and following public holidays.
Potential impacts on community cohesion and assets	Relocate the Berry Riding Club facilities to a nearby site agreed by the Club for the period that safe access cannot be provided to the grounds; Undertake works in the area of the Club as early as practicable in the construction program.
Recreation	Maintain access to the existing Broughton Creek bridge throughout the construction of the project.
Operation	
Amenity	Use a low-noise pavement along the Berry bypass section of the project. Provide noise barriers at North Street and Huntingdale Park Road. Consider the provision of architectural treatment to the 20 properties that have been identified that would experience noise levels above the controlling noise criterion. Continue to consult with the community with regards to potential amenity impacts and possible mitigation measures to be implemented. Manage noise impacts as described in **Section 7.2** Implement the urban and landscape design strategy. Other measures to mitigate impacts on Landscape Character and Visual Amenity are described in **Section 7.6**.
Economic	Continue consultation with agricultural business owners to address the impacts of land acquisition on the viability of farm operations. Repackage lots and sell parcels of acquired land to new owners or neighbouring owners. Provide sign posting to encourage highway traffic to visit Berry for a rest stop and as a tourist destination. Continue discussions with Shoalhaven City Council to assist in developing strategies to encourage the ongoing viability of businesses in the town of Berry and to encourage new businesses. This could include programs to enhance community areas and streetscapes.

Potential impact	Mitigation and management measures
Community cohesion	Provide signage between east and west Berry clearly identifying new routes and road closures. Provide functional and safe access to all properties affected by the project. Continue to consult the community when developing a plan to provide pedestrian access and cycle links over the proposed highway, connecting the east and west sides of town. Refer to the Pedestrian Access and Mobility Plan in the detailed design process as referenced in **Section 7.1**. Amend the existing incident response plans for the road network in consultation with emergency services to account for the altered road network at the completion of the project, such as the southern interchange for Berry. Carry out property acquisition in accordance with the RMS 'Land Acquisition Information Guide' (RTA, 2011) and under the terms of the *Land Acquisition (Just Terms Compensation) Act 1991* (refer **Section 7.9**).
Recreational activities and community assets	Consult with Shoalhaven City Council during detailed design to identify an appropriate option for the Berry Riding Club to identify an appropriate option for the club, including the reconfiguration of the facility. Continue to consult with the community with regard to potential uses for the buffer zone between North Street and the edge of the project. Maintain access to local creeks by recreational fishers where possible. Provide parking bays for bridge maintenance workers where practicable along the project and make these available for use by fishers wishing to access the river bank in the vicinity of bridges. Undertake consultation with DPI Fisheries on appropriate angler access signage and access infrastructure such as fence stiles.

8 Assessment of non-key issues

This chapter provides an assessment of the non-key environmental issues that may be associated with the construction and operation of the project. These issues are not nominated as key issues by the Director-General's environmental assessment requirements (DGRs) but impacts may still occur as a result of the project. In this chapter, the potential impacts for each issue are assessed and mitigation and management measures are identified. The proposed management and mitigation measures have influenced the development of the draft statement of commitments in **Chapter 10**.

8.1 Geology and soils

Geotechnical investigations have been undertaken to identify potential geotechnical, soil and fill issues for the project to assist in identifying mitigation and management measures for the construction and operation phases of the project.

The investigations and previous studies for this environmental assessment were undertaken between 2007 and 2011. These investigations into the surface, geological and soil characteristics of the project area were part of the route options development and the final concept design for the project, following the announcement of the preferred route. Geotechnical investigations included (but were not limited to) core drilling, piezometers, electric cone (piezocone), test pits and laboratory testing of soil and rock samples.

A preliminary contamination assessment undertaken during the route selection process (Maunsell Australia Pty Ltd, 2007) focused on large scale contamination issues. It included a limited site history and desktop study to identify potential areas of contamination, a site drive over and a review of the abovementioned geotechnical investigations.

Additional information sources have also been used to inform the assessment, including:

- NSW Office of Environment and Heritage (OEH) online database for notices under the *Contaminated Land Management Act 1997* or the *Environmentally Hazardous Chemicals Act 1985*.
- Soil landscape unit mapping completed for the former Department of Conservation and Land Management (DCLM).
- Erosion and Sedimentation Management Procedure (RTA, 2008).
- Acid sulfate soil risk maps prepared by the former Department of Land and Water Conservation (DLWC) (1997).

8.1.1 Existing environment

Topography

The project area consists of two main topographic groups being:

- The undulating hills and foothills extending north-west from the South Coast Railway line.
- The Shoalhaven lowland plain, extending south-east of the foothills towards the Shoalhaven Bight.

The elevated north-western portion of the project area is influenced by the Cambewarra Mountain Range (north-west of Berry) which is a narrow low range that runs roughly parallel with the coastline. The lower slopes of this range extend into the project area as the ridge lines approach Berry. Harley Hill and Toolijooa Ridge are situated towards the eastern part of the project area and are disjointed from the Cambewarra Range.

A ridge of moderate elevation, from Foxground to Toolijooa Ridge, and a flatter ridge to the south-west of Toolijooa Ridge, separates the Broughton Creek floodplain from the Crooked River floodplain.

Geology

The geology of the project area corresponds to the Permian Shoalhaven Group, which may be divided into the Volcanic Sandstones sub-group (also referred to as the Budgong Sandstone), the Volcanics Facies subgroup and Berry Siltstone formation.

The younger Volcanic Sandstones and the Volcanics Facies are interbedded volcanic sandstones and latites that are found following ridgelines through Toolijooa Ridge and high points to Harley Hill. These sub-groups are comprised of Jamberoo Sandstone, Kiama Sandstone and Bumbo Latite. The Berry Siltstone is comprised of siltstone and fine grained sandstones with interbedded shale. It occurs south-east of the Crooked River.

Soils

The former DCLM's *Soil Landscapes of the Kiama 1:100,000 Sheet* (Hazelton, 1992) identifies the presence of the following soil landscape units within the project area (refer to **Figure 8-1**):

- Kiama landscape unit, occurring in areas close to Toolijooa Road.
- Wattamalla Road landscape unit, occurring in steeper areas around Toolijooa Ridge.
- Shoalhaven landscape unit, which corresponds to creeks and floodplain areas at Broughton Creek and Berry.
- Coolongatta landscape unit, which largely corresponds to the undulating hills between Austral Park Road and north of Berry.

The Kiama landscape unit is characterised by sandy clay loams and stiff to hard clays. The erosion hazard is rated as moderate to extreme. Other limitations of the landscape unit include low wet bearing strength and potential for localised mass movement.

The Wattamalla Road landscape unit is characterised by shallow soils consisting of sandy and silt loams, very stiff to hard clays and extremely weathered rock developed in units associated with the underlying rock materials. The erosion hazard is rated as high to extreme. Other limitations of the landscape unit include low wet bearing strength, and the potential for localised mass movement.

The Shoalhaven landscape unit consists of alluvial soils, comprised of gravel, sand, silt and clay derived mainly from sandstone and shale that overlay buried estuarine sediments. The erosion hazard is rated as slight to low. The landscape unit is also subject to seasonal waterlogging and has potential for acid sulfate soils (ASS).

The Coolongatta landscape unit consists of sands, and stiff to hard clays. The erosion hazard for this landscape unit is extreme, and the topsoils are highly to moderately erodible. Other limitations of the unit include low wet bearing strength, and the potential for localised surface and mass movement.

Acid sulfate soils

ASS are a naturally occurring soil and sediment that contains iron sulphides. ASS can be classified into two types, being actual ASS and potential ASS (PASS). The latter PASS are waterlogged soils rich in iron sulphides that have not been oxidised. PASS are harmless to the environment if kept in this state or under water. Any exposure of PASS to air or the lowering of the watertable would lead to the development of actual ASS and sulphuric acid would be formed.

The project generally passes over geological conditions mapped by the then DLWC in 1997 as having no known occurrence of ASS. An area close to a section of the highway alignment south of Berry (refer to **Figure 8-2**) has been identified as being of low ASS risk and located at depths greater than four metres.

Following further consideration of the known geological information for the project area, an additional area where there is a low risk of PASS being encountered has been identified. This corresponds with areas with alluvial floodplain soils at the Broughton Creek floodplain, and at the bypass of Berry. These areas are shown on **Figure 8-3**.

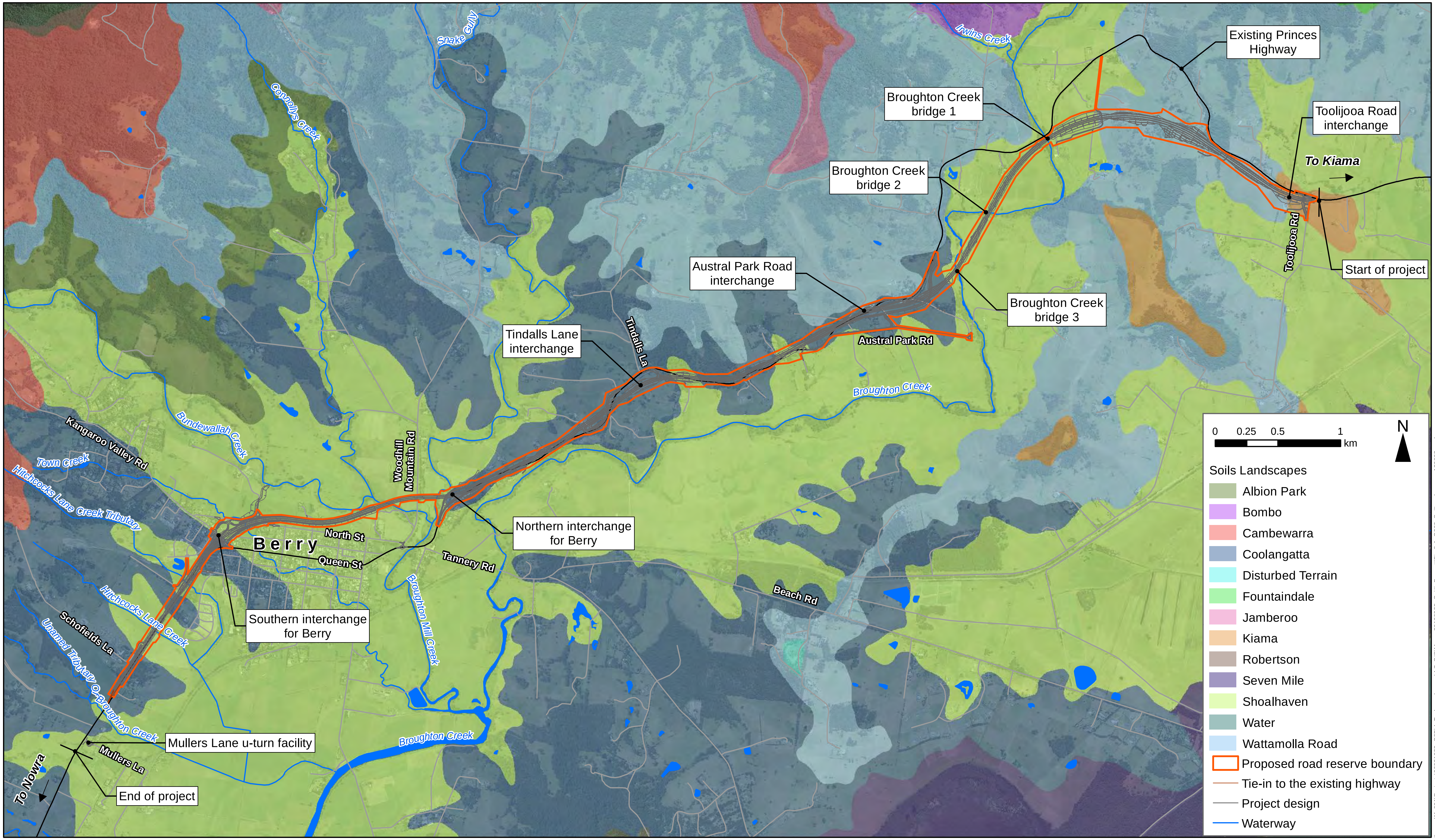

Figure 8-1 Soil landscape units according to *Soil Landscapes of Kiama 1:100,000 Sheet* (Hazelton, 1992)

Source: OEH (2011)

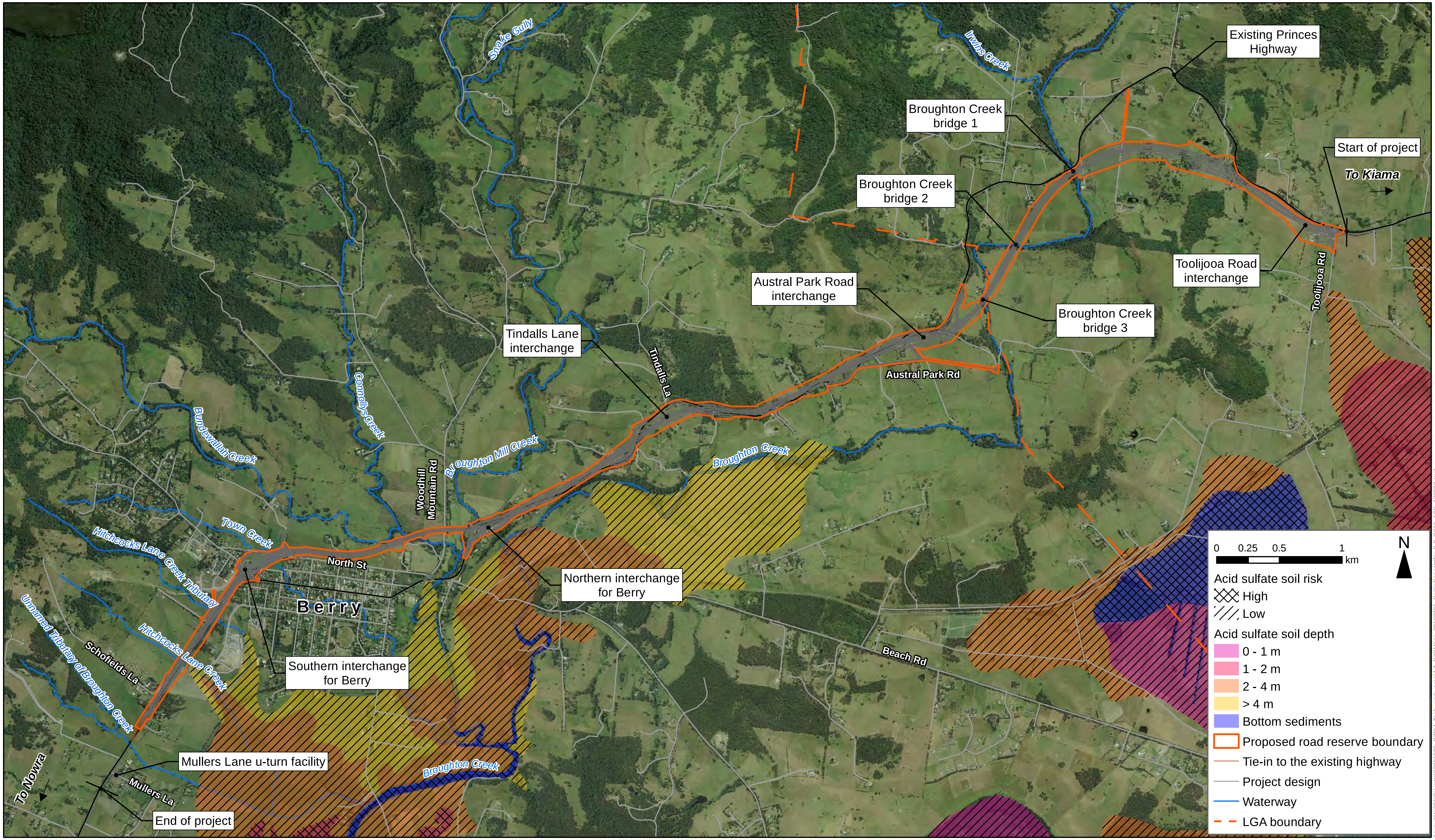

Figure 8-2 Acid sulfate soils in the project area

Source: DECCW (2002)

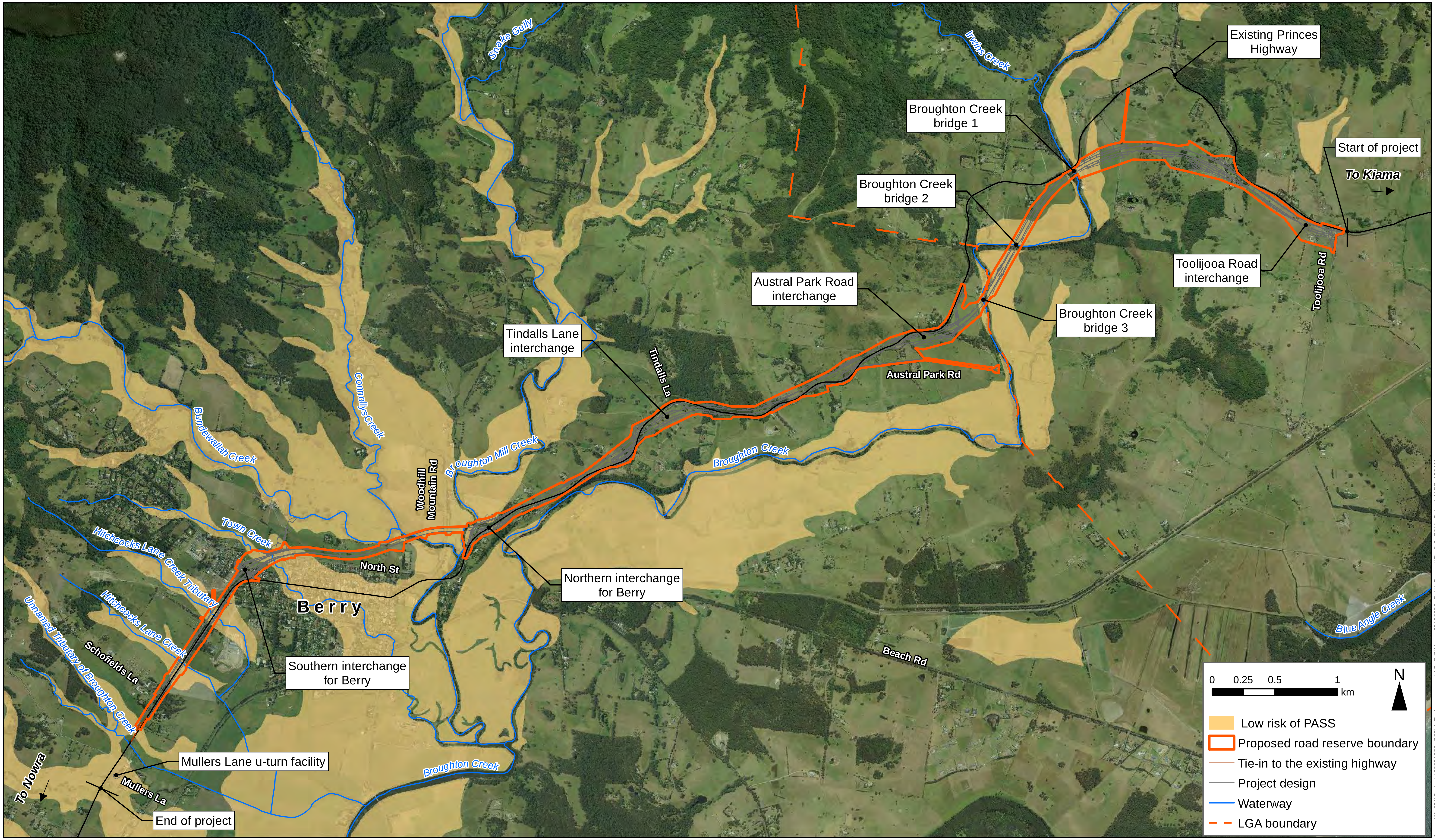

Figure 8-3 Additional areas of potential acid sulfate soil risk

Source: AECOM (2012)

Soft soils

Soft soils generally occur in low lying areas or floodplains, and correspond to areas where deep alluvial soils are present. Soft soils have limited resistance to loads, and as such, roads constructed on soft soils, without ground improvement works, risk ongoing maintenance as a result of ground settlement. This would result in poor road conditions and pavement damage.

The presence and depth of alluvial soils varies across the length of the project. The greatest depth of alluvial soils occurs at the Broughton Creek floodplain at around five metres below ground level. Alluvial soils occur to a lesser extent at stream channels between Austral Park Road and Tindalls Lane, and along the floodplain near Berry. Depths at these locations are estimated at around two to four metres below ground level.

Contamination

Rural land uses, such as dairying, livestock grazing and agriculture, are the predominant land uses in the project area. Turf farming is also undertaken in areas north of Berry near Broughton Mill Creek. These agricultural activities have the potential to give rise to soil contamination as a result of current or historic land use activities including:

- Application of pesticides, herbicides and fungicides.
- Cattle dip sites.
- Leaks from septic tanks, plant equipment, and fuel and chemical storages located within individual properties.
- Localised dumping of farm and household wastes, or use of fill of unknown origin.
- Presence of hazardous building material in structures, such as asbestos, lead and zinc.

Within Berry, the predominant land use is residential. However, the project does pass through recreational lands north of Berry at the sportsground and Camp Quality memorial park. Contamination may have occurred at these locations due to the filling of ground to create playing fields and the application of herbicides (in the case of the sportsground).

A preliminary contamination assessment undertaken during the route selection process (Maunsell Australia Pty Ltd, 2007) focused on large scale contamination issues. It included a limited site history and desktop study to identify potential areas of contamination, a site drive over and a review of geotechnical investigations undertaken concurrently to the assessment to gain an appreciation of the underlying soils and geology. Aerial photographs, interviews, land zoning maps, internet searches and the OEH/Environment Protection Authority (EPA) on-line database informed the site history and desktop study.

The information reviewed as part of the preliminary contamination assessment did not identify the presence of ‘major’ potential contamination sites. ‘Major’ potential contamination sites include large waste dumps, landfills, chemical manufacturing plants and fuel depots which are normally associated with larger scale contamination issues. In addition, interviews conducted with Council representatives, RMS representatives and a long term local resident as part of the preliminary assessment, did not identify the presence of any contamination from the following activities:

- Tanneries (other than a potential site avoided by the project near the David Berry Hospital).
- Cattle tick dip sites.
- Properties where use of pesticides/chemicals may have been intensive.
- Night soil depots.
- Timber treatment.
- Gasworks.
- Mining or extractive industries (other than the quarry avoided by the project).
- Power stations.

There was also little obvious evidence of significant land filling or fill stockpiling in areas of rural land use.

A search of the NSW OEH website did not identify any notices within the project area under the *Contaminated Land Management Act 1997* or the *Environmentally Hazardous Chemicals Act 1985*. A search was conducted again in August 2011 and confirmed that no notices have been issued in the project area.

8.1.2 Assessment of potential impacts

Erosion and sedimentation

The project would require the disturbance of the soil surface and subsurface across the length of the project. A greater level of disturbance to soils and the underlying geology would be required where cuttings and embankments are to be constructed. These include:

- A combination of substantial embankments and cuttings where the project passes through the Toolijooa ridgeline and crosses the Broughton Creek floodplain. The largest cutting would be around 900 metres long and up to 26 metres deep.
- A series of cuttings and embankments through the undulating landscape between Austral Park Road and the northern interchange for Berry. The largest cutting would be around 11 metres deep.
- A transition from an embankment of around two metres to a cutting along the North Street corridor. The majority of this section would be in a cutting, leading to the southern interchange from Berry.
- Embankments of up to around four metres south of Berry.
- The cutting of up to around 7.5 metres at the southern interchange for Berry.

Based on the underlying geology of the landscape, the following conditions would be encountered at these locations:

- Variably weathered and fresh Bumbo Latite, as well as Kiama Sandstone at Toolijooa Ridge.
- Alluvial soils within floodplain areas.
- Variably weathered Jamberoo Sandstone and Berry Siltstone (ranging from fresh to highly weathered) at the cuttings at Toolijooa, as well as between Austral Park Road and Schofields Lane.
- Residual soils across the project at varying depths, some of which are dispersive.

The presence of extremely and highly weathered rock at cutting locations could present stability and ongoing erosion issues in the long term. This is particularly relevant where steep cuts in soils and highly weathered rock are proposed, such as at the Tindalls Lane interchange.

Siltstone beds within the Berry Siltstone rock are also particularly prone to erosion and deterioration when exposed to water, which can be observed along the existing alignment (Coffey Geotechnics Pty Ltd, 2010). This presents a potential erosion impact in the short to long term.

Earthworks for cuttings and embankments would also facilitate the erosion of exposed soils and weathered rock that would potentially lead to embankment and cut slope instability and fretting. Soils within the project area are prone to erosion at varying levels, but all are assumed to be potentially dispersive and would require the implementation of erosion control measures.

Following the Erosion and Sedimentation Management Procedure (RTA, 2008), a number of locations have been identified as posing a high risk for erosion and sedimentation during construction (refer to **Figure 8-4**). These are locations where permanent basins are not proposed and where temporary construction sedimentation basins are not feasible due to space constraints or small catchment areas. However, erosion and sedimentation impacts can be effectively managed as discussed in **Section 8.1.3**.

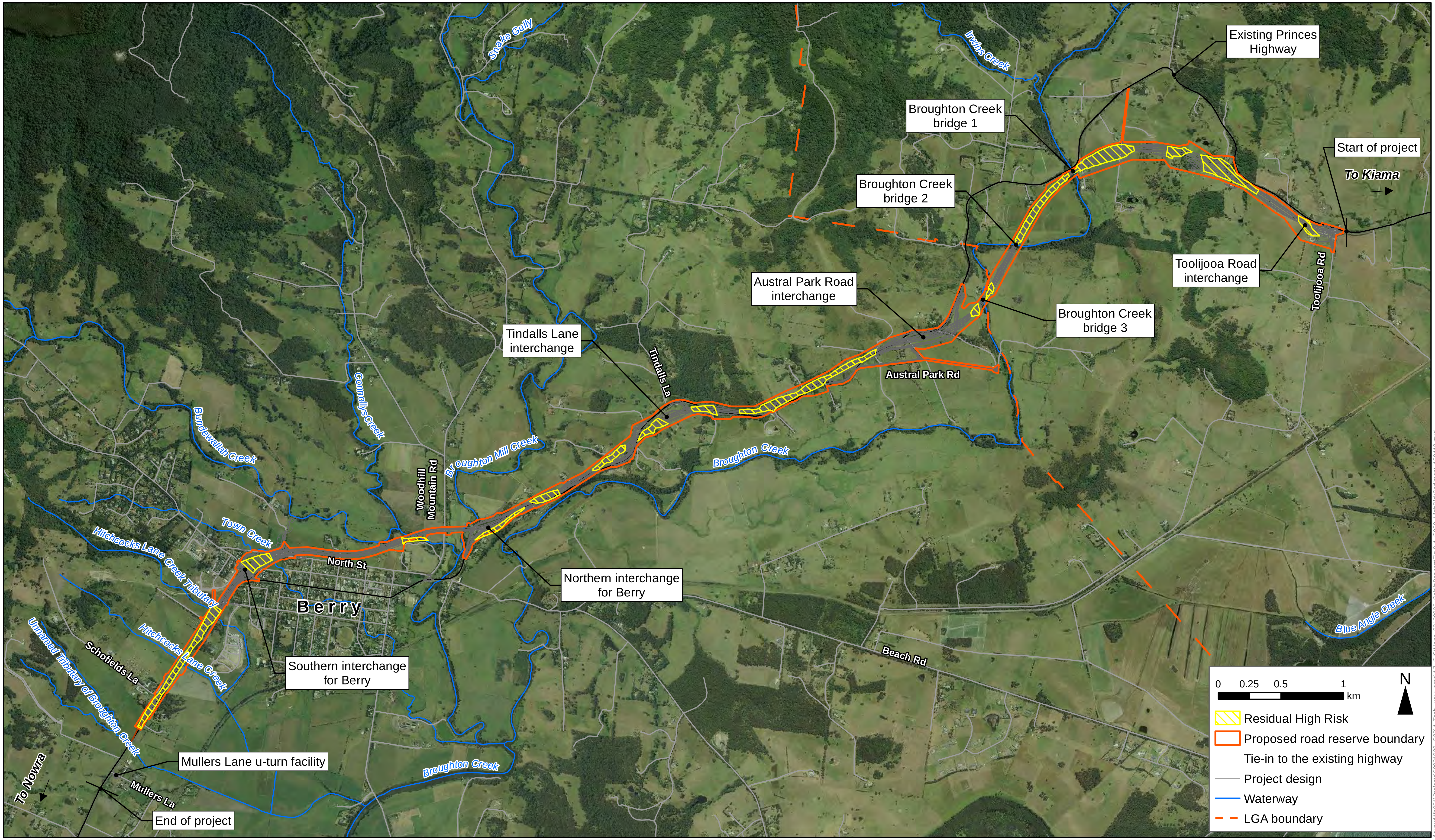

Figure 8-4 Residual high risk erosion and sedimentation area

Source: AECOM (2012)

The stockpiling of spoil and topsoil would also pose a risk for erosion and sedimentation during construction. Soil loss could occur due to the effects of wind or water in the absence of suitable stabilisation and management measures.

Soil loss during construction and/or operation could have a negative impact on agricultural productivity owing to the mobilisation and loss of soil by wind and water. Increased turbidity and suspended sediment loads in surrounding water bodies and drainage areas could reduce water quality which would impact aquatic ecology. Sediment-laden water also has the ability to block stormwater drainage structures and result in localised flooding, if drainage structures are not adequately maintained. Further discussion on this impact is provided in **Section 7.4**.

Acid sulfate soils

The risk of exposing of PASS or ASS as a result of the project is considered to be low and limited to floodplain areas at Broughton Creek and near Berry. The areas of low risk correspond to areas of construction of embankments, bridges, culverts, stormwater detention basins and other land forming works. Piling at proposed bridges and at interchange location areas could also require excavation through PASS to reach the required minimum rock socket depth.

Any exposure of PASS to air or the lowering of the watertable due to excavation would lead to the development of actual ASS. The resultant sulfuric acid and iron rich leachate would potentially have major environmental, agricultural and structural impacts in affected areas if not adequately managed. Potential impacts would include the following:

- Negative impacts to aquatic ecosystems by drainage from oxidised ASS into neighbouring waterways, such as Broughton Creek. This would result in habitat degradation, fish kills, reduced aquatic food resources, reduced migration potential of fish, reduced fish recruitment, increased susceptibility of fish to fungal infections, altered macrophyte communities, weed invasion by acid-tolerant plants and secondary water quality changes.
- Impacts on vegetation growth and agricultural productivity due to low soil pH levels causing stunted vegetation growth, the mobilisation of heavy metals (such as aluminium, iron and manganese), nutrient deficiencies, and decreased soil microbes.
- Structural damage and corrosion of steel and concrete structures due to acidity, resulting in significant ongoing maintenance costs.

The potential for these impacts to arise are considered low and would be adequately managed through the implementation of standard mitigation and management measures included in an acid sulphate soil management plan (ASSMP) identified in **Section 8.1.3.**

Soft soils

Embankments and bridge works would be constructed in areas with alluvial soils. The settlement of soils as a result of the loads being placed on these areas poses a risk to the project in the short term (in terms of time and cost) and long term (if not sufficiently mitigated). This is particularly relevant where major works on the Broughton Creek floodplain are proposed, including embankments of up to 16 metres in height, and to a lesser extent, embankment and bridge works near Berry. There is also potential for differential settlement between the current highway formation and the new highway, where widening works would be undertaken in areas known to contain alluvial soils.

Alluvial soils are of low strength and are highly compressible. The bearing capacity (or strength) of alluvial soils improves as settlement occurs. Based on the extent, depth and type of alluvial soils (or soft soils) along the project corridor, the extent of settlement is unlikely to be excessive. Ground improvements would be undertaken to ensure areas of soft ground are sufficiently stable for the construction of the project and the long-term durability of the completed project. This would be factored into the construction staging program for the project.

In selecting ground improvement methods, additional consideration would be given to corresponding areas of PASS, which may occur at the Broughton Creek floodplain and in areas close to Berry. However, as discussed above, the risk of encountering PASS is low and the potential impacts could be managed and/or mitigated through the completion of soil testing during detailed design and the implementation of an ASSMP.

Contamination

Based on the results of the preliminary contamination assessment described above, there is a low to moderate likelihood of land being affected by contamination as a result of current and historic agricultural practices along the alignment. While no issues relating to contamination along the project alignment arose during recent discussions with affected landowners, there still remains a possibility that contamination would be encountered on agricultural, residential or recreational lands as a result of:

- Asbestos, zinc and lead from hazardous building materials, the disposal of wastes within the property or the miscellaneous storage of plant and equipment.
- Herbicides, fungicides and pesticides (including organochlorins and organophosphates) due to application, disposal, leaks and spills with the property.
- Petroleum hydrocarbons (TPH), polyaromatic hydrocarbons (PAH), volatile organic compounds (BTEX), polychlorinated biphenyls (PCB) and heavy metals where property fuel stores have leaked, where spills have occurred or where fill of unknown origin is present.
- Elevated nutrients and pathogens where septic tanks have leaked.

In the event that contamination is encountered, the contamination is likely to be localised and manageable. Further, the types of contaminants that would be encountered would be unlikely to preclude the redevelopment of the land for the project, which represents a change to a less sensitive land use.

Construction activities also have the potential to cause the contamination of soil due to accidental spills of fuel, oils and other hazardous materials such as bitumen. Spillages of fuel, oils, chemicals and/or other hazardous substances may result in negative impacts on soil and the surrounding environment (as discussed in **Section 8.3**).

Appropriate management measures would be implemented during construction to reduce the risk associated with soil contamination. These are discussed below.

8.1.3 Environmental management measures

Mitigation and management measures would be implemented to avoid, minimise or manage geology and soil impacts. These mitigation and management measures have been identified in **Table 8-1** and incorporated in the draft statement of commitments in **Chapter 10**.

Table 8-1 Mitigation and management measures

Potential impacts	Mitigation and management measures
Construction	
Short and long term stability of embankments and cuttings	Create cut and fill batters at a maximum of 2:1 slope unless otherwise agreed during detailed design. In areas of particular risk due to fretting and spalling, investigate measures which may include: • Retaining structures or soil nailing at very steep or vertical cuts in soils and highly weathered rock, such as the Berry Siltstone. • Retaining structures at bridge abutments. • Wire mesh, spot bolting, shotcrete and benching at steeper slopes. • Erosion protection measures, such as drainage structures, hydro seeding, hydro mulching and geoweb. Mitigation strategies designed to minimise the visual impact of these measures are discussed in **Section 7.6** and **Appendix H**.
Disturbance of acid sulfate soils	Undertake testing for PASS during detailed design and seek opportunities to avoid them and to avoid any lowering of the water table in the vicinity. If this is not possible, limit areas of disturbance as much as possible and implement management measures documented in an ASSMP including actions such as: • Temporarily store bund and treat excavated material and use treated material appropriately. • Undertake specific leachate control procedures. • Implement protocols should any unexpected ASS related incidents occur. • Implement monitoring programs, such as water quality monitoring of areas downstream of PASS risk areas. Develop the ASSMP in accordance with the 'Guidelines for the Management of Acid Sulfate materials: Acid Sulfate Soils, Acid Sulfate Rock and Monosulphidic Black Ooze' (RTA 2005).

Potential impacts	Mitigation and management measures
Contamination	Undertake targeted soil contamination investigations during detailed design, as required. Investigate potentially contaminated areas of land in accordance with the ‘Contaminated Land Management Guideline’ (RTA, 2005) during detailed design, as required. In the event that contamination investigations indicate that the concentrations of contaminants on or adjacent to the project are above the intended land use criteria, develop an appropriate risk-based management plan approach in accordance with the ‘Contaminated Land Management Guideline’ (RTA, 2005). Develop a remedial action plan if contamination is found to pose unacceptable risks to the environment or human health. Remediation works would be undertaken in consultation with the EPA. Refuel construction vehicles and machinery offsite at a fuel station, within the site compound area or any other agreed location. Use drip trays when refuelling vehicles and/or machinery to capture any spills. Store fuel, chemicals and/or other hazardous substances within an appropriately bunded area (refer to **Section 8.3)**. Provide emergency spill kits. Regularly monitor and maintain equipment and vehicles.

8.2 Air quality

This section provides an assessment of air quality impacts associated with the construction and operation of the project. Air quality was not identified as a key issue in the Director-General's requirements (DGRs) for the project. However, an *Air Quality Technical Paper* (PAEHolmes, 2012) has been prepared for the project. The technical paper is provided in **Appendix N** and has been summarised below.

8.2.1 Approach to assessment

Air quality criteria

Carbon monoxide, oxides of nitrogen (nitric oxide and nitrogen dioxide , sulphur dioxide and particulate matter (including PM_{10}, total suspended particulates and deposited dust) are emitted by motor vehicles and are known to be potentially harmful to human health if the concentration is too great over a particular exposure period.

Carbon monoxide is produced from the incomplete combustion of fuels, where carbon is only partially oxidised instead of being fully oxidised to form carbon dioxide. When inhaled, carbon monoxide reduces the capacity of blood to transport oxygen, leading to symptoms including lethargy and headaches. Air quality goals set by the EPA provide a significant margin for safety to protect a wide range of people in the community, including the very young and the elderly.

Oxides of nitrogen are produced by motor vehicles when nitrogen from the air is oxidised at high temperatures and pressures in the combustion chamber. Nitrogen oxides emitted by motor vehicles are mainly made up of nitric oxide and nitrogen dioxide. Concern with nitric oxide is related to its transformation to nitrogen dioxide and its role in the formation of photochemical smog, which can cause harm to the eyes, respiratory system, plants and building materials. Nitrogen dioxide has been reported to affect respiratory function, although the evidence has been mixed and conflicting.

Particulate matter or dust can be generated by construction activity and/or the operation of a development. There are two ways in which particulate matter can affect humans and the environment:

- Health impacts, which arise when finer particles (below 10 microns in diameter, referred to as PM_{10}) enter bronchial and pulmonary regions of the respiratory tract.
- Amenity impacts, which arise when dust is deposited on surfaces, such as roofs, causing a reduction in amenity.

Particulate matter is emitted by motor vehicles due to the incomplete combustion of fuels, additives in fuels and lubricants, worn material that accumulates in the engine lubricant and brake and tyre wear. The presence of particulate matter can have health and amenity impacts.

Particulate matter emitted during dust-generating construction activity can also potentially have short-term health and amenity impacts.

There are three categories of particulate matter. These are PM_{10}, total suspended particulates (TSP) and dust deposition. TSP is a measurement of the total of all particles suspended in the air, of which PM_{10} is a subset. PM_{10} is one of the main causes of dust-related health impacts. Dust deposition is a measurement of the weight of dust falling on a given area over time, and is another way of measuring the amenity impact.

The EPA specifies ground-level concentration criteria for these pollutants within 'Approved Methods for the Modelling and Assessment of Air Pollutants in NSW' (NSW Department of Environment and Conservation (DEC), 2005). These criteria are provided in **Table 8-2**.

The criteria for sulphur dioxide is not included in **Table 8-2**, as emissions of sulphur dioxide from motor vehicles are minor and were not considered further in this assessment.

Table 8-2 EPA air quality assessment criteria

Pollutant	Averaging period	Goal	Source*
Carbon monoxide	1 hour	30 mg/m^3	WHO (2000)
	8 hour	10 mg/m^3	NEPC (1998)
Nitrogen dioxide	1 hour	246 µg/m^3	NEPC (1998)
	Annual	62 µg/m^3	NEPC (1998)
Particulate matter <10 µg (PM_{10})	24 hours	50 µg/m^3	NEPC (1998)
	Annual	30 µg/m^3	EPA (1998)
Total suspended particulates	Annual	90 µg/m^3	NHMRC (1996)
Deposited dust	Annual	4 g/m^2/month	NERDDC (1988)

** WHO – World Health Organisation, NEPC – National Environment Protection Council, EPA – Environment Protection Authority, NHNRC – National Health and Medical Research Council, NERDCC – National Energy Research, Development and Demonstration Council.*
mg/m^3 – milligrams per cubic metre
µg/m^3 – micrograms per cubic metre
g/m^2 – grams per square metre

Air quality modelling

The Caline series of dispersion models has been used to estimate the concentration of oxides of nitrogen, carbon monoxide and particulate matter that are likely to occur in the vicinity of the existing Princes Highway. The information input into this model includes meteorological conditions, traffic volumes, emissions information and receptor location information.

8.2.2 Existing environment

The existing air quality in the project area is mainly influenced by local road traffic. Agricultural and manufacturing activities, such as dairy and beef production, also contribute to air quality in the region, particularly dust emissions. However, the effects of agriculture and manufacturing on air quality are relatively small and localised only.

For the purposes of this assessment, 69 sensitive residential receivers were identified in the vicinity of the project. These sensitive receivers have been used to assess the air quality impacts of the project, when operational (refer to **Figure 8-5**). These receivers were chosen from over 600 in the region as they were the closest to the project. A total of 169 residences located closest to the proposed temporary ancillary construction facilities were also assessed as sensitive receivers and were used to model the potential construction impacts. A number of these residences were also assessed as operational receivers. The minimum distance of sensitive receivers from the boundaries of ancillary facilities varied from site to site. The closest receiver was located around 50 metres from a property boundary of an ancillary facility site.

Climatic conditions

Temperature, humidity and rainfall data was collected from the Nowra Royal Australian Navy (RAN) automatic weather station at HMAS Albatross, located around eight kilometres south-west of the central business district of Nowra. This data was collected between 1942 and 2000 (Bureau of Meteorology, 2011).

The annual average maximum and minimum temperatures recorded at the Nowra RAN automatic weather station are 21.3 and 11.3 degrees Celsius respectively. On average, January and February are the hottest months, with an average maximum temperature of 25.8 degrees Celsius. July is the coldest month, with an average minimum temperature of 6.2 degrees Celsius. February has the highest humidity, with a 9am average of 76 per cent, while August and September have the lowest humidity, with a 3pm average of 52 per cent.

The average annual rainfall recorded at the Nowra RAN automatic weather station is 1110 millimetres. February is the wettest month with an average rainfall of 120 millimetres. March is the driest month with an average rainfall of 24.4 millimetres.

Data on wind direction and wind speed was collected in 2000 from a site at the Gerroa Tip, which is located around five kilometres south-west of Gerringong. On an annual basis, the most common winds are from the west, west northwest and north east. The annual average wind speed is 2.4 meters per second. A stability class was assigned to each hour of the meteorological data using concurrent cloud cover information and the methodology of Turner as documented in the *Workbook of Atmospheric Dispersion Estimates* (Turner, 1970). Stability is dependent on a number of factors, such as wind speed, terrain and the temperature profile of the atmosphere. Class A is defined as very unstable through to Class F which is defined as very stable conditions.

In the project area, the most common stability occurrences were calculated to be D class (21 per cent of the time) and E and F classes (20 per cent of the time each). E and F class conditions would be more stable and would generally have lower wind speed than D class conditions. As a result, emissions are likely to disperse more quickly under D class conditions but more slowly under the E and F class conditions.

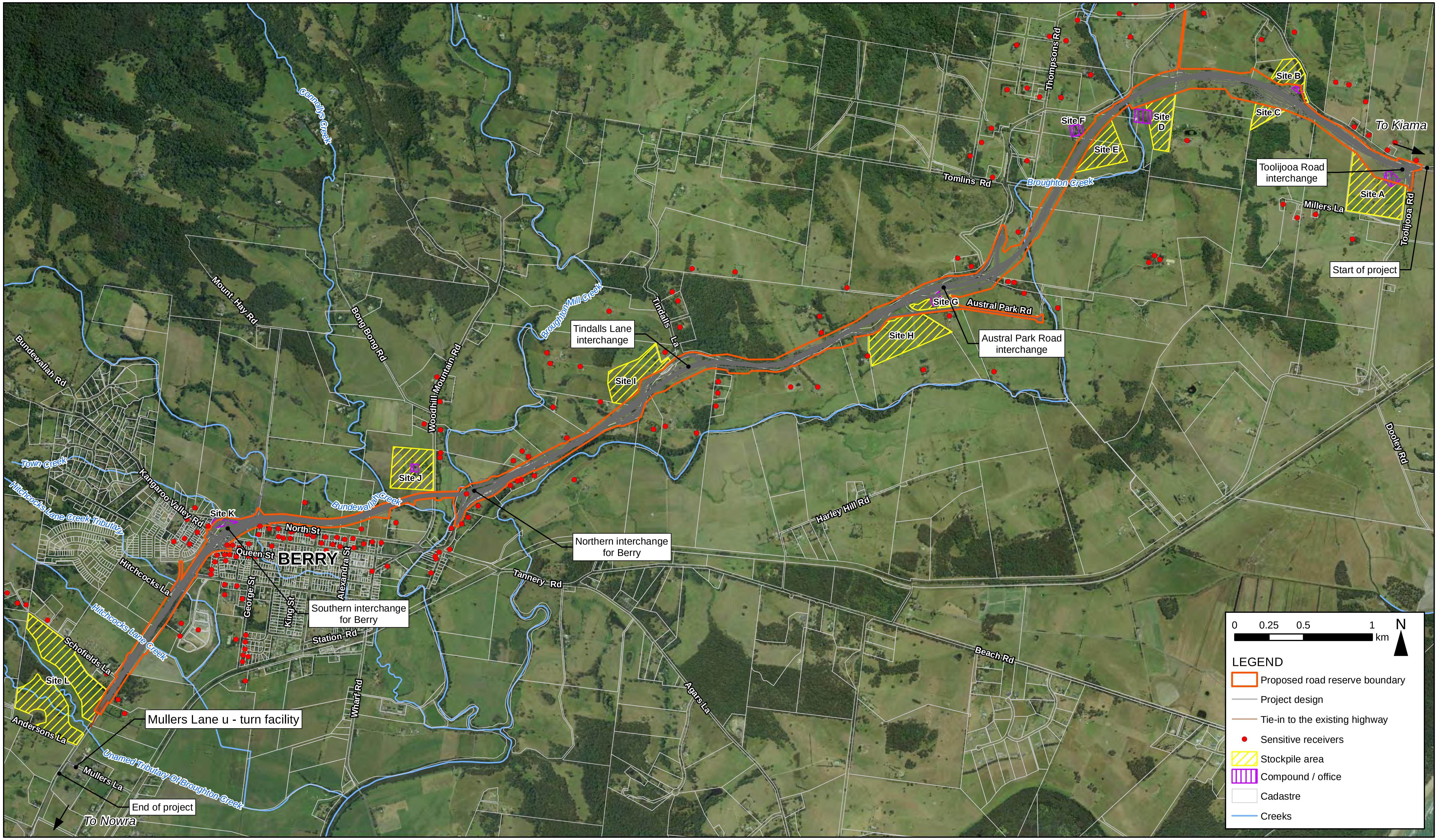

Figure 8-5 Location of sensitive receivers in the vicinity of the project

Source: Dept. of Lands (2007), Fugro (2007), RTA (2011)

Background air quality

Air quality standards and goals refer to pollutant levels, which include pollutants from both the project and existing sources.

Background air quality data for nitrogen dioxide and particulates (PM_{10}) was sourced from the closest EPA operated monitoring stations. Between 1997 and 2005, data was sourced from a monitoring station at Croome Road, Albion Park, around 20 kilometres north of Gerringong. This station was decommissioned in early 2005 and a new station was commissioned at Terry Reserve, Albion Park South in December 2005. Data was collected from the Terry Reserve monitoring station between 2005 and 2007. Data collected from these stations has been combined to provide an air quality dataset for a 10 year period between 1997 and 2007. Data for carbon monoxide was sourced from a monitoring site in Wollongong.

Between 1997 and 2007, air quality for the area was within EPA criteria for nitrogen dioxide and carbon monoxide with:

- Maximum nitrogen dioxide one hour average (166 µg/m^3) and annual average (31 µg/m^3) concentrations below the EPA goal air quality criteria of 246 µg/m^3 and 62 µg/m^3 respectively.
- Maximum carbon monoxide one hour average (10.6 mg/m^3) and eight hour average (5.3 mg/m^3) concentrations below the EPA air quality criteria of 30 mg/m^3 and 10 mg/m^3 respectively.

Maximum particulate concentrations (PM_{10}) were on occasion above the maximum 24 hour goal of 50 µg/m^3 over the 10 year period. This includes a concentration of 281 µg/m^3 in 2003 that corresponded with a recorded dust storm in the region. As particle pollution is affected by environmental factors such as bushfires and dust storms, other high levels recorded may also be attributed to these factors. The annual average concentrations of PM_{10} are below the EPA air quality criteria of 30 µg/m^3 with the exception of the annual average for 2003, which was likely the result of dust storms recorded in that year.

In 2007, Holmes Air Sciences (now PAEHolmes) conducted a modelling study which investigated the air quality impacts due to the existing highway within the project area (Holmes Air Sciences, 2007). The predicted concentrations for carbon monoxide, nitrogen dioxide and PM_{10} were below their respective air quality goals at the setback distances modelled (which had a range of zero metres to 50 metres from the existing highway). The results of this study are in the Air Quality Technical Paper at **Appendix N**.

8.2.3 Assessment of potential impacts

Construction impacts

Dust would be generated as a result of drilling, blasting, general earthwork activities, haulage and stockpiling associated with the construction of the project. The total amount of dust generated by construction activities would depend on the silt and moisture content in the soil, and the type of activity being carried out.

Airborne dust has the potential to cause health and amenity impacts during construction. Health impacts would be measured by concentrations of PM_{10} expected to be released by the project. Amenity impacts would be measured by expected dust deposition on surfaces. Amenity impacts would include dust settling on items such as solar panels and roof areas which may carry dust into rainwater tanks. As identified in **Section 8.2.2**, dust deposition criteria have been set to protect against these amenity impacts (NSW DEC, 2005).

For the purposes of the environmental assessment, the ancillary facilities have been considered separately to general earthwork activities as these facilities would potentially involve continuous operation throughout the 39 month construction period. General earthwork activities in any one location would not occur throughout the entire construction period.

Earthwork activities

The main activities that would generate dust during earthworks would include blasting and the exposure and movement of soil by excavators, front-end loaders and dump trucks. Wind erosion from exposed surfaces and spoil would also generate dust. Earthwork activities at Toolijooa ridge in particular have the potential to impact on neighbouring sensitive receivers due to the extent of excavation and blasting required for the large cutting.

To assess these potential impacts, a number of assumptions have been made including the number of blasts, the volume of rock requiring excavation and the surface area exposed to wind erosion (refer to the *Air Quality Technical Paper* (PAEHolmes, 2012) at **Appendix N** for further information). It was also assumed that blasting would only occur intermittently during the first 24 months of the 39 month construction period, and that no mitigation measures were implemented.

Dust emissions from vehicle movements on unsealed (haul) roads were included in the assessment. Assumptions were based on an estimation of haulage capacities and distances travelled. It should be noted that these sources are not easily quantifiable as distances travelled would be highly variable.

Based on these assumptions, it was estimated that around 103,370 kilograms of dust would be generated during the construction period or around 31,800 kilograms of dust per year. Dust emissions of this scale are unlikely to cause any significant adverse impacts at the nearest sensitive receivers. Major dust producing industries, such as quarries, emit dust at rates significantly greater than this and still comply with both health and amenity criteria.

However, there may be short-term amenity impacts at locations adjacent to the construction site when wind speeds are high. The implementation of the management and mitigation measures identified in **Section 8.2.4**, including the use of dust suppression techniques and ceasing dust generating activities during high winds, would assist to substantially reduce emissions and minimise potential impacts on sensitive receivers.

Ancillary facilities

At ancillary facility sites, exposed stockpiles affected by wind erosion are the main potential source of dust. To assess the potential impacts of these activities, conservative modelling was undertaken to predict the impacts at the closest sensitive receivers using a modified version of the United States Environmental Protection Agency (USEPA) Industrial Source Complex model. The conservative modelling has allowed for the assessment of the worst-case impacts associated with the project.

Modelling was undertaken for the maximum 24 hour and annual average particulate (PM_{10}) concentrations, the annual average TSP and dust deposition levels, to determine if levels at the closest sensitive receivers satisfy the air quality criteria provided in **Table 8-2**. In doing so, the following worst case scenario assumptions were made:

- All ancillary sites would involve stockpiling compounds.
- All stockpiles would be 50 per cent exposed at all times over a 12 month period.
- All stockpiles would be subject to wind erosion 24 hours a day.
- Wind erosion would be occurring from all stockpile compounds simultaneously over a 12 month period.
- No mitigation measures would be implemented.

This provides a worst case assessment as it is more likely that construction would occur in phases and therefore not all stockpiles would be active simultaneously for the whole year. In addition, management and mitigation measures would be implemented in accordance with the *Stockpile site management procedure* (RTA 2005) and the *RMS QA Specification R44 – Earthworks* to ensure that the typical (representative) potential impacts are minimised.

Figure 8-5 identifies the ancillary facilities (assumed to be stockpile compounds for the purposes of this assessment) and the sensitive receivers considered in the worst case assessment.

The results of the modelling study found that for the worst case scenario, annual average criteria for particulates (PM_{10} and TSP) would not be exceeded at any sensitive receiver due to wind erosion from the stockpile compounds with:

- The highest predicted annual average PM_{10} concentration at any of the sensitive receivers estimated to be around 6.4 $\mu g/m^3$. This is below the EPA assessment criteria of 30 $\mu g/m^3$.
- The maximum predicted annual average TSP concentration was eight $\mu g/m^3$. This is below the EPA assessment criteria of 90 $\mu g/m^3$.

For 24-hour PM_{10} concentrations at sensitive receivers, almost all predictions were below 10 $\mu g/m^3$. The most affected receiver, located near Austral Park Road, was predicted to experience a maximum 24-hour PM_{10} concentration of 38 $\mu g/m^3$. When considering the project alone, this would be below the EPA assessment criterion of 50 $\mu g/m^3$. However, as discussed in **Section 8.1.1**, existing background levels are often above this criterion. As such, the predicted levels at the most affected receiver as a result of the construction activities were considered further. The assessment concluded:

- The receiver would experience only two days in the year where predictions were above 20 $\mu g/m^3$.
- The 90th percentile 24-hour average PM_{10} level at the receiver was very low at four $\mu g/m^3$. The 90th percentile is the concentration at the receiver for 90 per cent of the time over the 24-hour period.

The low 90th percentile indicates that these higher values are infrequent and likely to be the result of winds blowing directly from the stockpile towards that particular sensitive receiver for a number of hours within the 24-hour period. This does not factor in any reductions in dust levels that can be achieved through mitigation measures, which can reduce the ground level concentration significantly over a 24-hour period.

Dust deposition criteria have been set to protect against amenity impacts (NSW DEC, 2005). The maximum acceptable increase in dust deposition over the existing dust levels from an amenity perspective is two g/m^2/month. So for the project alone, the incremental criterion is two g/m^2/month and for total deposition (including background) it is four g/m^2/month.

Predictions at almost all sensitive receivers are below two g/m^2/month for the annual dust deposition levels. However, there would be one sensitive receiver (the same receiver as detailed above) that may experience an annual average dust deposition level of three g/m^2/month as a result of the project. This would cause an exceedance of the incremental criterion but would be unlikely to exceed the cumulative criterion when added to existing background levels. With the implementation of management and mitigation measures described in **Section 8.2.4**, particularly during times of elevated wind speeds, the emissions are likely to be lower than those modelled and would be within the criteria. Therefore impacts of airborne dust on solar panels and rainwater tanks are unlikely.

Overall, the potential impacts on the single sensitive receiver would be a worst case impact and would be minor. These impacts would be managed, or potentially avoided, by implementing standard and best practice mitigation measures as outlined in **Section 8.2.4**.

Operational impacts

To assess the potential impacts of the operation of the project, air dispersion modelling was undertaken (using the CALRoads package). The modelling was used to predict concentrations of carbon monoxide, nitrogen dioxide and PM_{10} that are likely to occur due to vehicle emissions from the project at the nearest sensitive receivers. These were then assessed against the criteria set by EPA as provided in **Table 8-2**.

The model used is able to determine concentrations at sensitive receivers downwind of 'at-grade', 'fill', 'bridges' and 'cut section' highways located in relatively simple terrain. The model is applicable to any wind direction, highway orientation and receiver locations. Information that was entered into the model included:

- Meteorological conditions collected from a site at the Gerroa Tip.
- Traffic volumes, using predicted hourly traffic volumes for 2017 and 2027, and the percentage of heavy vehicles predicted for these years.
- Vehicle emissions information, using vehicle emissions data from the Permanent International Association of Road Congresses (PIARC) (PIARC, 2004) adjusted to reflect the age of NSW vehicle fleet using NSW traffic registration data from the Australian Bureau of Statistics Motor Vehicle Census (ABS, 2005).
- Receiver location information.

The findings of the air quality modelling are provided in **Table 8-3**, **Table 8-4** and **Table 8-5**. Each table provides the predicted emissions at the most affected sensitive receiver. Predictions are provided for the project alone as well as the cumulative impact of the project taking into consideration background air quality. Results for all 69 sensitive receivers are in the *Air Quality Technical Paper* at **Appendix N**.

Carbon monoxide

As shown in **Table 8-3**, predicted carbon monoxide contributions from the project alone are within the EPA assessment criteria at the most affected receivers for both the one hour and eight hour average periods and the two years modelled (being 2017 and 2027 as representative years following the completion of construction). These also remain below the EPA assessment criteria when factoring in background air quality levels. It is also noted that:

- Levels of carbon monoxide would be lower at receivers located further away from the roadway.
- The modelling does not account for the likelihood that the percentage of older, more inefficient vehicles would be lower in 2027, further reducing carbon monoxide emissions.
- Background air quality data used for the project is the highest level recorded and includes emissions from the existing highway, providing a conservative assessment of cumulative air quality impacts.

Overall, the results of the modelling indicate that it is unlikely that the EPA carbon monoxide criteria would be exceeded at sensitive receivers, as a result of carbon monoxide emissions from the project.

Table 8-3 **Predicted maximum carbon monoxide ground-level concentrations at the most affected sensitive receiver in 2017 and 2027**

	Maximum one hour average Carbon monoxide concentration (mg/m^3)		Maximum eight hour average Carbon monoxide concentration (mg/m^3)	
EPA criteria	**30 mg/m^3**		**10 mg/m^3**	
Maximum background	**10.6 mg/m^3**		**5.3 mg/m^3**	
Year	**2017**	**2027**	**2017**	**2027**
Project alone	0.4	0.6	0.1	0.2
Cumulative impact (including background)	11	11.2	5.4	5.5

Oxides of nitrogen

It is more difficult to estimate nitrogen dioxide concentrations than carbon monoxide concentrations. It is dependent on the rate of conversion of nitric oxide and other oxides of nitrogen into nitrogen dioxide, which increases as the distance of the receiver from the roadside increases. Studies conducted in 1997 by the then RTA suggest that a conversion rate of 15 per cent at ten metres from the roadway is conservative (RTA 1997). For the purposes of this assessment, it has been assumed that a 100 per cent conversion would occur. This is a highly conservative approach and assumes a worst case scenario.

As shown in **Table 8-4**, the predicted nitrogen dioxide concentrations from the project are well within the EPA assessment criteria at the most affected receiver for both the one hour and annual average periods and the two years modelled (2017 and 2027). These also remain below the EPA assessment criteria when factoring in background air quality levels, which is the highest level recorded over a 10 year period.

As such, it is not likely that nitrogen dioxide levels would be exceeded at sensitive receivers located along the project corridor.

Table 8-4 **Predicted maximum nitrogen dioxide ground-level concentrations at the most affected sensitive receiver in 2017 and 2027**

	Maximum one hour average Nitrogen Dioxide concentration ($\mu g/m^3$)		Maximum annual average Nitrogen Dioxide concentration ($\mu g/m^3$)	
EPA criteria	**246 $\mu g/m^3$**		**62 $\mu g/m^3$**	
Maximum background	**166 $\mu g/m^3$**		**31 $\mu g/m^3$**	
Year	**2017**	**2027**	**2017**	**2027**
Project alone	10.8	13.0	0.4	0.5
Cumulative impact (including background)	176.8	179	31.4	31.5

Particulates – PM_{10}

As shown in **Table 8-5**, the highest predicted 24-hour average PM_{10} concentrations and maximum annual average PM_{10} concentration contributed by the project alone at the nearest residential receiver are below the EPA criteria in 2017 and 2027. These are not significant increases and are not likely to result in adverse impacts on air quality at sensitive receivers.

Table 8-5 Predicted maximum ground-level concentrations for particulates at the most affected sensitive receiver in 2017 and 2027

	Maximum 24 hour average PM_{10} concentration ($\mu g/m^3$)		Maximum annual average PM_{10} concentration ($\mu g/m^3$)	
EPA criteria	**50 $\mu g/m^3$**		**30 $\mu g/m^3$**	
Median background	**63 $\mu g/m^3$**		**17 $\mu g/m^3$**	
Year	**2017**	**2027**	**2017**	**2027**
Project alone	0.6	0.6	0.1	0.2
Cumulative impact (including background)	63.6	63.6	17.1	17.2

To assess the cumulative impact of the project, the median background levels have been applied instead of the maximum value recorded. Median background levels are considered to be more appropriate to assess the potential cumulative impact of the project for PM_{10}, as:

- PM_{10} levels can be greatly affected by dust storms and bush fires, and in the case of 24-hour average levels, greatly affected by local dust generating activities that are short lived.
- The majority of readings recorded were below the EPA assessment criteria for the 24-hour average.
- The maximum recorded level for the annual average for PM_{10} represents the only year within the 10 year period that the EPA assessment criteria was exceeded, with all remaining years below the EPA assessment criteria (being 20 $\mu g/m^3$ and below).

Applying this approach, the median annual PM_{10} concentration remains within the EPA assessment criteria when factoring in existing background air quality levels at the most affected receiver (refer to **Table 8-5**). For the median 24-hour average, PM_{10} concentrations are above the EPA assessment criterion of 50 $\mu g/m^3$ (refer to **Table 8-5**). However, existing background levels are already above this criterion prior to the inclusion of the predicted emissions from the project.

In these cases, the degree to which the contributions from the project alone make up the relevant impact assessment criterion is then considered. The maximum predicted 24 hour average concentration from the project in 2017 is 0.6 $\mu g/m^3$. This represents about one per cent of the EPA assessment criteria, and this remains around the same in 2027. It is therefore unlikely that the EPA air quality goal would be exceeded as a result of the project. As such, the project is not likely to result in adverse impacts at sensitive receivers located along the project corridor.

8.2.4 Environmental management measures

Mitigation and management measures would be implemented to avoid, minimise or manage air quality impacts. These mitigation and management measures are identified in **Table 8-6** and incorporated in the draft statement of commitments in **Chapter 10**.

Table 8-6 Mitigation and management measures

Potential impacts	Mitigation and management measures
Construction	
Dust	Prior to the commencement of construction, develop an Air Quality Management Plan (AQMP), which would incorporate measures to minimise dust generation from the project and would form part of the overall construction environmental management plan (CEMP) for the project. The AQMP would include the following provisions: • Minimise dust generation from the project by: – Stabilising all disturbed areas as soon as practicable to prevent or minimise wind-blown dust. – Watering unsealed roads and sealing of roads where possible, with unsealed trafficable areas kept sufficiently damp during working hours to minimise wind-blown or traffic generated dust emissions. – Controlling truck speed and movements onsite and restrict trucks to designated roadways. – Installing truck wheel washes or using other dust removal procedures to minimise the transport of dust offsite, and regularly inspecting public roads to remove and dispose of any dust, soil or mud deposited on public roads by construction vehicles. – Modifying or stopping construction activities during periods of high wind, if necessary. – Maintaining stockpiles and handling areas in a condition that minimises windblown or traffic generated dust. – Using water sprays, sprinklers and water carts if needed to adequately dampen stockpiles, work areas and exposed soils to prevent the emission of dust from the site. – Regularly inspecting and maintaining erosion control structures to ensure silt does not become a source of dust. – Maintaining all equipment for dust control to keep it in good operating condition. The equipment would be operable at all times with the exception of shutdowns required for maintenance. • Locate dust monitors in areas close to sensitive receivers to monitor dust accumulation against the standard criteria. These would include areas where there is potential for amenity impacts due to dust deposition on roofs (leading to rainwater tanks) and solar panels. Dust monitoring would be undertaken on a monthly basis.

Potential impacts	Mitigation and management measures
	• On sites where there is a clear and unambiguous dust impact resulting from the construction of the project, implement appropriate management measures including: – Disconnect water tanks from roofing and maintain water supply to properties using tanks. – Wash-down of the roof at the completion of dust generating works to ensure a clean roof for water supply and reconnection of the water tanks. Stop dust generating activities should it become apparent that dust is leaving the site while those activities are being undertaken.
Vehicle and plant emissions	Maintain all vehicles, including trucks entering and leaving the site, in accordance with the manufacturer's specification to comply with all relevant regulations. Maintain all construction equipment to ensure exhaust emissions comply with the Protection of the Environment Operations Act 1997.
Operation	
	Air quality impacts during the operation of the project would be minimal and therefore no mitigation measures have been proposed.

8.3 Hazard and risk

Environmental hazards resulting from the construction and operation of the project, and the identification of measures to avoid, mitigate or manage these risks, are addressed throughout **Chapter 7** and **Chapter 8** of this environmental impact assessment.

Hazards arising from incidents during project construction and operation could also pose a risk to human health, as well as that of the environment. Such potential risks and appropriate management measures are discussed below.

8.3.1 Assessment of potential impacts

Construction

During construction, the following hazards and risks would be associated with the project:

- Potential environmental and human health hazards resulting from accidental releases or improper handling and storage of hazardous substances within the project area.
- Potential environmental and human health hazards resulting from releases of hazardous substances from vehicles transporting hazardous substances to the site in the event of an accident.
- Occupational health and safety hazards, such as dangers to construction workers, road users and the general public.
- Potential rupture or interference with underground services.

The types of hazardous substances that would be transported to the site and used within the project area during construction may include (but are not limited to):

- Diesel fuels.
- Oils, greases and lubricants.
- Explosives (Class 1).
- Gases (oxy-Acetylene) (Class 2.1).
- Bitumen (Class 3 PGIII).
- Paints and epoxies (Class 3 PGII and Class 3 PGIII).
- Herbicides (Class 6.1 PGII).
- Hydrated lime (non dangerous good).
- Curing compounds (non dangerous good).

The above classifications have been determined using the 'Australian Code for the Transport of Dangerous Goods by Road and Rail' (7th edition) (National Transport Commission, 2007).

The majority of these substances would be stored within the major construction compound sites. The storage, handling and use of the materials would be undertaken in accordance with the *Occupational Health and Safety Act 2000* and the 'Storage and Handling of Dangerous Goods Code of Practice' (WorkCover NSW, 2005).

Potential inadvertent toxic impacts, fire and explosions resulting from the handling, storage and transportation of hazardous materials may adversely affect the quality of the local environment and impact human safety. However, the potential for such incidents to occur is considered to be low in view of the following factors:

- The quantities of hazardous goods required are expected to be low and below the thresholds requiring preparation of a preliminary hazard analysis (PHA) as detailed in ‘Applying State Environmental Planning Policy 33 (SEPP 33): Hazardous and Offensive Development Application Guidelines’ (Department of Planning and Infrastructure (DP&I), 2011). As such, a preliminary hazard analysis is not required.
- Hazardous substances would be transported in accordance with relevant legislation and codes.
- The likelihood of a crash occurring during the transportation of hazardous substances to and from work sites and spillage to the receiving environment is considered low.
- The project is located in a sparsely populated area (with the exception of the Berry township) and it is unlikely the incident would impact on local properties. Risks to road users would be limited to those directly involved in the incident.
- Implementation of environmental management measures such as those identified in **Section 8.4.2** would reduce the risk to the environment, construction personnel and the public.

It is proposed that the explosives would not be stored at the construction compounds and would be transported to the site by the specialist contractor as and when required. In the event that the contractor wishes to store explosives, an assessment would need to be undertaken in accordance with ‘Applying SEPP 33: Hazardous and Offensive Development Application Guidelines’ (DP&I 2011). Depending on this review, the preparation of a PHA may be required before this activity could occur.

Rock falls and steep slopes also present a potential hazard during construction. Rock fall hazards occur where a risk of instability exists at proposed cuts, such as the major cut proposed at Toolijooa Ridge. A rock fall could potentially injure construction personnel, other persons in the vicinity of the activity and cause damage to construction equipment. Steep slopes may pose an additional risk for construction personnel, who could slip and fall, or be injured by unsecured equipment.

The potential rupture of underground services when excavating could give rise to hazards in the form of electrocution or fire if a gas main is impacted. Risks associated with these hazards would be minimised by undertaking utility checks (such as dial before you dig), consulting with the relevant service infrastructure provider and if required, relocating and/or protecting utilities within the project area prior to the commencement of construction. This would require particular attention when working over or in the vicinity of the Eastern Gas Pipeline, to avoid rupture of the pressurised gas pipeline.

Overall, the hazards and risks associated with the project during construction are considered low and would be managed with the implementation of the standard management and mitigation measures such as those identified in **Section 8.3.2**.

Operation

It is not anticipated that significant volumes of hazardous substances would be used by the RMS during operation of the project.

However, dangerous goods are permitted to be transported in significant quantities on the Princes Highway in accordance with relevant regulations and codes and may include:

- Flammable and combustible petrol, diesel and liquefied petroleum gas.
- Toxic gases, such as ammonia and chlorine.
- Corrosive acids and alkalis.
- Other toxic materials, such as pesticides.
- Nitrogen-based fertilisers.
- Bulk explosives.

The nature of the project means that there is an inherent risk of vehicle collision associated with its operation, which could result in the accidental spill of dangerous goods. This would have the potential to adversely affect the quality of the local environment and impact human safety, with potential hazards including toxic effects, fire and explosions. Contaminants either directly associated with the spill or hazardous material cleanup may enter the receiving environment from both paved and unpaved surfaces.

However, the potential for such a spill and consequential impacts is considered to be low in view of the following factors:

- Dangerous goods vehicle movements along the highway are expected to account for a very minor proportion of total daily traffic movements and the probability of a crash involving a truck containing dangerous goods is low.
- The high road design standard of the project would reduce the potential for road crashes relative to the existing situation.
- The existing stringent legislative controls on the transport of dangerous goods reduce the risk of impacts.
- The project is located within a sparsely populated area (with the exception of the Berry township), so most incidents would have limited potential to affect those not directly involved in the crash or incident.
- In the unlikely event of a traffic crash involving a vehicle carrying hazardous substances, any spills would typically be contained to the roadway area by the appropriate incident and emergency response teams. Runoff from bridges over watercourses and floodplains would be directed and captured in the permanent water quality basins or swales. These water quality treatment measures provide capacity to treat first flush from the pavement surface and reduce the risk of spills discharging onto adjacent land or watercourses.

Hazards and risks associated with the project during operation are considered low and would be managed with the implementation of standard management and mitigation measures identified below.

8.3.2 Environmental management measures

Mitigation and management measures would be implemented to avoid, minimise or manage hazard and risk. These mitigation and management measures have been identified in **Table 8-7** and incorporated in the draft statement of commitments in **Chapter 10**.

Table 8-7 Mitigation and management measures

Potential impacts	Mitigation and management measures
Construction	
General	Prepare site specific Hazard and Risk Management Plans as part of the Construction Environmental Management Plan (CEMP), which may include items such as: • Details of the hazards and risks associated with construction activities. • Risk management measures, including those identified in **Chapters 7** and **8** of this environmental assessment. • Procedures to comply with all legislative and industry standard requirements. • Contingency plans, as required. • Site-specific Occupational Health and Safety plans and safe work method statements. • Training for all personnel (including subcontractors) in site inductions, including the recognition and awareness of site hazards and the locations of relevant equipment to protect themselves and manage any spills.
Risks to the Eastern gas pipeline during construction	Consult with Jemena during detailed design to identify necessary protection measures for the Eastern gas pipeline, and to determine suitable construction methods when working in the vicinity of the pipeline. Prepare a safety management study, completed in accordance with the Australian Standard AS 2885.1-2007 Pipelines – Gas and liquid petroleum – Design and Construction, which would outline measures to be undertaken to ensure there would be no impacts to the pipeline.
Risk of contamination of the downstream receiving environment	Undertake a PHA if the quantities of hazardous substances during construction are found to exceed threshold levels provided in ‘Applying SEPP 33: Hazardous and Offensive Development Application Guidelines’ (DP&I, 2011). Store, handle and use hazardous construction materials in accordance with the *Occupational Health and Safety Act 2000* and the ‘Storage and Handling of Dangerous Goods Code of Practice’ (Workcover NSW, 2005). Provide secure, bunded areas around storage areas for oils, fuels and other hazardous liquids. Provide bunds around activities where there is a potential for spills and contamination.

Potential impacts	Mitigation and management measures
	Locate chemical storage areas outside areas subject to the 1 in 100 flood event. Where this is not feasible, provide sufficient freeboard to avoid inundation during events of this size. In the event of an incident leading to a spill of a hazardous substance during construction, use standard incident control measures in accordance with contingency plans for the worksite. Provide appropriately sized temporary sediment basins for the duration of construction. Carry out regular maintenance and inspection of all controls.
Risk of contamination from transportation of hazardous goods	Transport all hazardous substances in accordance with relevant legislation and codes, including the *Road and Rail Transport (Dangerous Goods) (Road) Regulation 1998* and the 'Australian Code for the Transport of Dangerous Goods by Road and Rail' (National Transport Commission, 2008). Manage specific risks associated with the transport of hazardous substances to and from work sites, including the risks associated with temporary changes in local traffic conditions during the construction period, through the implementation of measures detailed in the CEMP.
Operation	
Risk of contamination from transportation of hazardous substances	In the unlikely event of a spill, direct runoff from bridges away from watercourses and floodplains to permanent water quality basins or swales. Design water quality treatment measures to provide capacity to treat first flush from the pavement surface and reduce the risk of spills discharging onto adjacent land or watercourses. Confirm locations and design capacity during the detailed design phase of the project. Implement the Incident Response Plan (prepared by the then RTA) in the event of an accident, spill or any incident that results in the full closure of the highway. Activate the memorandum of understanding between RMS and the NSW Police Service, NSW Rural Fire Service, NSW Fire Brigade and other emergency services to manage the response to incidents on State controlled roads. Provide an emergency cross over when required.

8.4 Waste management

Various waste streams would be generated during the construction and operational phases of the project. These would include demolition wastes, green waste (vegetative matter), packaging materials, liquid wastes and excavated material.

8.4.1 Assessment of potential impacts

Construction

The following waste streams would be generated during construction:

- Demolition wastes from existing structures that require demolition, such as residences, farm sheds and other outhouses. Wastes would include pipe work, bricks, corrugated iron, fibrous cement and pavements.
- Excavated wastes, such as soil and rock, that are unable to be reused within the project.
- Contaminated soils or ASS that may be exposed during construction, and if exposed, would require off-site disposal (refer to **Section 8.1**).
- Surplus material from construction and general site reinstatement, such as fencing, sediment, concrete, reclaimed asphalt, sand bags and scrap metal.
- Packaging materials from items delivered to the site, such as pallets, crates, cartons, plastics and wrapping materials.
- Green waste from grubbing and clearing vegetation (including noxious weeds) that is unable to be reused within the project.
- Plant and vehicle maintenance waste, such as fuel, oil and chemical containers.
- General office wastes generated by onsite personnel, such as paper, cardboard, beverage containers and food wastes.
- Effluent generated at site amenities during construction.

Resource consumption and waste generated by the project would contribute to the emission of greenhouse gases during construction. The consideration of this impact and emission reduction opportunities are discussed further in **Section 8.5**.

Operation

During the operational phase of the project, roadside litter would be expected to occur along the length of the project. Additional wastes would be generated during routine maintenance and repair activities required over time. The type and volume of wastes generated would be dependent on the nature of the activity, but would predominately consist of green waste, oils, road materials used in repair and maintenance works as well as contaminated waste resulting from fuel spills and leaks.

With the implementation of standard work practices during routine maintenance and repair activities, the overall impact of operational waste streams and volumes would be minimal.

8.4.2 Environmental management measures

Mitigation and management measures would be implemented to avoid, minimise or manage waste streams generated as a result of the project. These mitigation and management measures have been identified in **Table 8-8** and incorporated in the draft statement of commitments in **Chapter 10**.

Table 8-8 Mitigation and management measures

Potential impacts	Mitigation and management measures
Construction	
Inappropriate management of waste	Manage and dispose all waste in accordance with relevant State legislation and government policies including the *Waste Avoidance and Resource Recovery Act 2001*, *Waste Avoidance and Resource Recovery Strategy 2007* (Department of Environment and Conservation (DECC), 2007) and the *Waste Reduction and Purchasing Policy* (RTA, 2009). Prepare a Waste Management Plan as part of the Construction Environmental Management Plan detailing appropriate procedures for waste management according to the waste management hierarchy of principles: • Avoidance of unnecessary resource consumption to reduce the quantity of waste being generated. • Recovery of resources for reuse onsite or offsite for the same or similar use, without reprocessing. • Recovery of resources through recycling and reprocessing so that waste can be processed into a similar non-waste product and reused. • Disposal of residual waste. Dispose of all residual waste to a suitably licensed landfill or waste management facility where there are no other feasible and reasonable options for waste avoidance, reuse or recycling. Waste materials requiring removal from the site would be classified, handled and stored onsite in accordance with the 'Waste Classification Guidelines: Part 1 Classifying Waste' (Department of Environment, Climate Change and Water (DECCW), 2009) until collection by a contractor for disposal.
Unnecessary resource consumption	Avoid unnecessary resource consumption by making realistic predictions on the required quantities of resources, such as construction materials. Resource recovery, which includes reuse, recycling and reprocessing, would be applied to the management of construction waste and would include: • Recovery of resources for reuse. Waste materials generated by the project would be reused either onsite or offsite where possible, including the reuse of top soil in landscape works. • Recovery of resources for recycling. Facilities would segregate resources for recycling such as paper, plastic, glass, aluminium cans and other recyclable materials generated during construction. These materials would then be sent to a local recycling facility for processing. • Recovery of resources for reprocessing. Cleared vegetation would be mulched or chipped onsite and used for landscaping, in the absence of a higher beneficial use being identified (such as harvestable timber, fence posts or use as 'fauna furniture' in proposed fauna underpasses). Use recycled products in construction to reduce demand on resources, where the use of the material is cost and performance competitive. This may include the use of fly ash and slag within concrete mixes.

Potential impacts	Mitigation and management measures
Excess spoil	Prepare a spoil management strategy to address excess spoil (refer to Section 4.4.3). The strategy would consider the following options: • Reduction of spoil volume through detailed design refinement or use within the project. • Undertaking of further geotechnical investigation during detailed design which may lead to design refinements that reduce the predicted volume of excess spoil. • Utilisation of excess spoil to flatten fill batters to blend the project into the existing landscape. • Utilisation of excess spoil in the formation of noise mounds, where feasible. • Consideration of steepening the profile of the cutting through Toolijooa Ridge. • Utilisation of excess spoil in the construction of other road projects. • Utilisation of excess spoil for preloading activities required to treat soft soils on the Broughton Creek floodplain. Provision of excess spoil to adjoining landowners, Shoalhaven City Council or other parties requiring spoil**. This may include the provision of excess spoil to Shoalhaven City Council to provide stock mounds in flood prone areas as part of its flood mitigation works in the Broughton Creek floodplain, which are still under investigation by the council. Excess fill material that cannot be used in the project, may be stockpiled for use on other road projects or other offsite uses (subject to the third party obtaining the relevant approvals).
Operation	
Roadside litter	Periodically inspect (RMS or its contractors) and remove roadside litter in accordance with the existing RMS road maintenance and litter collection program for the Princes Highway.

** Based on the current concept design.*

*** Any provision of excess spoil to a third party would be dependent on the demonstration by the third party that it has obtained the necessary approvals for the use of the spoil (such as a development consent from the local council or a licence under section 143 of the Protection of the Environment Operations Act 1997). Appropriate environmental controls would be installed at sites where excess spoil would be delivered.*

8.5 Greenhouse gas and climate change

Increasing public concern and debate regarding the likelihood and magnitude of climate change impacts in Australia has resulted in a number of national and state policy commitments addressing both climate change mitigation and adaptation. Most recently the Federal Government has enacted the *'Clean Energy Future Legislation Package 2011'* which introduces a Carbon Price from July 2012. The NSW and Federal Governments have also provided guidance regarding the assessment of climate change risks in the *NSW Climate Impact Profile, Illawarra Region* (Department of Environment, Climate Change and Water (DECCW), 2010) and *Climate Change Impacts and Risk Management: A Guide for Business and Government* (Department of Environment and Heritage Australian Greenhouse Office, 2006). These legislative, policy and guidance documents highlight the importance of assessing and mitigating such impacts for key infrastructure projects.

This section outlines the legislative and policy framework for the control of GHG emissions and climate change. It provides an assessment of the impacts of the project upon climate change, due to the release of greenhouse gas (GHG) emissions during construction and operation phases and to provide recommended mitigation measures. This section also provides an assessment of the potential impacts of climate change upon the project and recommended mitigation or adaptation measures.

8.5.1 Legislative and policy framework

GHG emission requirements and considerations are included in a growing number of legislative and policy mechanisms in Australia (State and Federal) and internationally.

The 'Kyoto Protocol to the United Nation Framework Convention on Climate Change' (UNFCCC) was signed in 1997 and Australia ratified the protocol in December 2007. The Kyoto Protocol's objective is to reduce GHG emissions through setting reduction targets for GHG emissions produced by ratifying countries. These targets are set using the countries' 1990 baseline emissions. Australia is committed to a target of 108 per cent of 1990 emission levels by the end of 2012. A key issue of ongoing international negotiations is how and if these targets will develop post 2012.

The Australian Government's climate change policies and regulations are managed by the Department of Climate Change and Energy Efficiency (DCCEE). The following are key federal climate change policies:

- The *Energy Efficiency Opportunities Act 2006* (EEO Act).
- The *National Greenhouse and Energy Reporting Act 2007* (NGER Act).
- The 'Clean Energy Future Legislative Package 2011' (including the Carbon Price).

'Securing a clean energy future. The Australian Government's Climate Change Plan' (DCCEE, 2011) details policies to reduce GHG emissions and transition to a clean energy future for Australia. The Federal Government has committed to a target of reducing carbon pollution by five per cent below 2000 emission levels by 2020 irrespective of what other countries do and by up to 15 or 25 per cent depending on the scale of global action. The long term carbon pollution reduction target is 80 per cent below 2000 emission levels by 2050.

One of the objectives of the NSW *Environment Planning and Assessment Act 1979* (EP&A Act) is to encourage ecologically sustainable development (ESD). GHG emissions associated with the project would contribute to global GHG emissions, which are relevant to the principles of ESD. **Chapter 11** provides further discussion of the how the principles of ESD have been applied to the project.

In November 2005 the NSW State Government released the NSW Greenhouse Plan (The NSW Greenhouse Office, 2005), which provides a strategic management approach to addressing climate change. In addition, the NSW 2021 State Plan, includes a target to minimise the impacts of climate change in local community as outlined in Goal 23: *to increase opportunities for people to look after their own neighbourhoods and environments.*

8.5.2 Methodology

GHG assessment methodology

The purpose of the assessment of the estimated GHG emissions generated through the construction and operation of the project is to:

- Identify the sources of GHG emissions associated with the project (construction, operation, maintenance and utilisation by traffic).
- Quantify the GHG emissions associated with each GHG source.
- Present the GHG emissions associated with the project.
- Identify opportunities (mitigation measures) which may be implemented to reduce the GHG emissions associated with the project.

GHG emissions are reported in this assessment as tonnes of carbon dioxide equivalent (tCO2-e).

GHG accounting and reporting principles

The GHG assessment uses the methodologies detailed in:

- The Greenhouse Gas Protocol: Corporate Standard (World Council for Sustainable Business Development and World Resources Institute, 2005).
- National Greenhouse Accounts (NGA) Factors (DCCEE, 2011).
- Greenhouse Gas Assessment Workbook for Road projects (the Workbook) (Transport Authorities Greenhouse Group (TAGG), 2011).

The assessment was also conducted according to the following GHG accounting and reporting principles:

- **Relevance** – Select and use GHG sources, sinks, data and methodologies appropriate for the project/organisation and intended use of GHG inventory results.
- **Completeness** – Include all relevant GHG emissions and information which support methodology and criteria used.
- **Consistency** – Use consistent data, calculation/modelling methods, criteria and assumptions to enable valid comparisons.
- **Transparency** – Include clear, sufficient and appropriate information to enable others to understand the basis for results and make decisions regarding use of GHG inventory results with reasonable confidence.
- **Accuracy** – Reduce bias and uncertainties, as much as practical.

In addition to the accounting and reporting principles presented above, the issue of materiality is also assessed in a GHG assessment. This is a core accounting and auditing principle which ensures that sources, assumptions, values and procedures included in the GHG assessment are material to the project. As materiality is valued within the context of the project being assessed, this can vary significantly. In this assessment, emissions are assumed immaterial if they are less than five per cent of the overall GHG inventory, as per the Workbook.

GHG calculation methodology

The Workbook provides a consistent methodology for estimating the GHG emissions for all of the major activities that are considered to contribute significantly to the overall emissions associated with a road project. The steps involved in undertaking a GHG assessment in accordance with the Workbook were adopted for this assessment and are illustrated in **Figure 8-6**. The calculation methods used to estimate the GHG emissions from liquid fuel combustion, electricity use, vegetation clearing, materials use and traffic use of the road post construction, are presented in **Appendix O**.

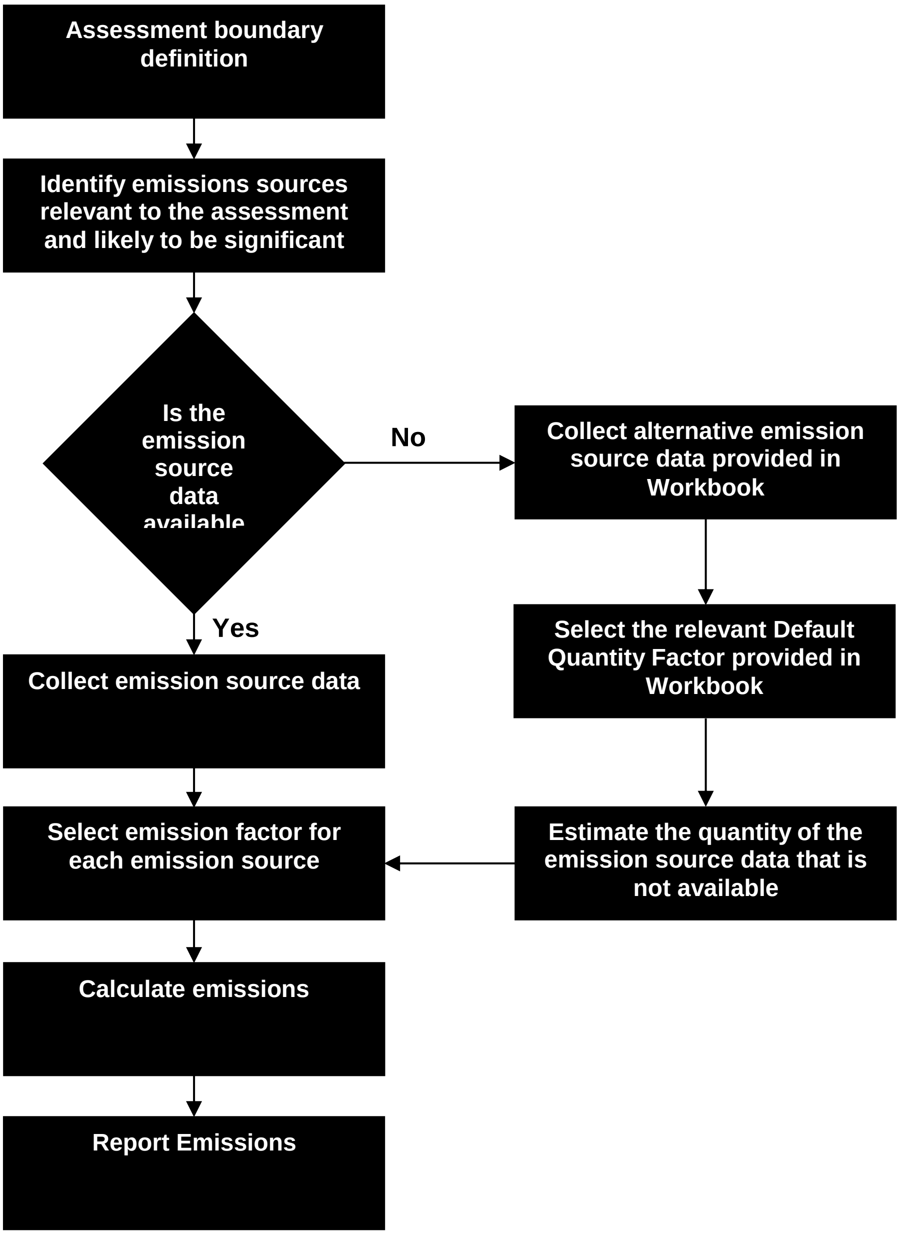

Figure 8-6 GHG emission quantification steps.

GHG inventory scope and boundary

The Workbook considers the GHG assessment boundary of a road project to include all emissions sources that can be impacted by decisions made by designers, constructors, managers and/or operators of the road. Following definition of the GHG assessment boundary, emissions sources are categorised into three different scopes, to identify and classify emissions sources according to the extent to which the project has operational control over the emissions. The three scopes are:

- **Scope 1** – Direct emissions: GHG emissions generated by sources owned or controlled by the project, e.g. emissions generated by the use of diesel fuel by project-owned construction plant, equipment or vehicles.
- **Scope 2** – Indirect emissions: GHG emissions from the generation of purchased electricity in project-owned or controlled equipment or operations. These GHG emissions are generated outside of the project’s boundaries, e.g. the use of purchased electricity from the grid.
- **Scope 3** – Indirect upstream emissions: GHG emissions generated in the wider economy due to third party supply chains as a consequence of activity within the boundary of the project, e.g. GHG emissions associated with the offsite mining, production and transport of materials used in the construction or maintenance of the road.

Some emission sources may be categorised into two scopes (ie Scope 1 and Scope 3 or Scope 2 and Scope 3), to account for GHG emissions generated by sources owned or controlled by the project (Scope 1) and associated indirect upstream GHG emissions, generated outside of the project boundary due to third party supply chains in direct relation to the project. For example, the use of fuel by project operated construction equipment would incur Scope 1 GHG emissions from the combustion of fuel in construction equipment on site and Scope 3 GHG emissions associated with the extraction, production and transport of the purchased fuel.

Table 8-9 and **Table 8-10** list the emissions sources and activities considered within the project construction GHG assessment boundary and project operation and maintenance GHG assessment boundary, according to scope.

Table 8-9 Construction GHG emission sources

Emission source category	Emission source	Emission scope		
		Scope 1	Scope 2	Scope3
Fuel	Mobile equipment	✓		✓
	Site vehicles	✓		✓
	Earthworks	✓		✓
	Material delivery			✓
	Equipment delivery			✓
	Waste removal			✓
	Spoil removal			✓
	Vegetation removal			✓
Materials	Construction materials			✓

Table 8-10 Operation and maintenance GHG emission sources

Emission source category	Emission source	Emission scope		
		Scope 1	Scope 2	Scope3
Fuel	Mobile equipment	✓		✓
	Material delivery			✓
Electricity	Street lighting		✓	✓
	Variable message sign		✓	✓
Materials	Maintenance materials			✓

The Workbook provides guidance on which emission sources are generally always significant, which emission sources may be significant on a project specific basis and those emission sources that generally would be insignificant and excluded from the GHG assessment boundary. Based on this guidance, the disposal of waste from demolition (including the disposal of excess spoil for reuse purposes) is considered insignificant to the assessment and is excluded from the GHG assessment boundary.

Based on a materiality criteria of five per cent, (as outlined in the section above) the removal of vegetation and the use of electricity in site offices during construction have been removed from the GHG assessment boundary, as the GHG emissions from these sources accounted for less than one per cent of total GHG emissions from construction.

Climate change risk/impact assessment methodology

Climate change poses an increasing and serious challenge to economic development, including new and existing infrastructure such as roads and highways. In order to assess the likely impacts, climate change risks need to be identified and prioritised in relation to the project. To prioritise the climate change risks identified, each risk has been rated based on the consequences and the likelihood of those consequences occurring. Climate change would affect the project and its associated infrastructure during the course of its design life (circa 100 years).

The climate change risk assessment is based on the latest available climate science and risk assessment research and publications, including the following:

- Fourth Assessment Report, Working Group I: Climate Change 2007 – The Physical Science Basis (Intergovernmental Panel on Climate Change (IPCC), 2007).
- Climate Change in Australia: Technical Report (CSIRO, 2007).
- NSW Climate Change Action Plan – Summary of Climate Change Impacts Illawarra Region (DECC, 2008).
- Climate Change and the NSW State Road Network, Climate Change Risk Assessment (AECOM, 2008).
- NSW Government 'Sea Level Rise Policy Statement' (DECCW, 2009)
- NSW Climate Impact Profile, Illawarra Region (DECCW, 2010) http://www.environment.nsw.gov.au/climateChange/20100171ClmtChngNSW.htm[1].

[1] *Accessed and information downloaded August, 2011.*

The climate change risk assessment undertaken for the project also applied an approach to risk assessment as recommended by:

- Australian and New Zealand Standard AS/NZS 4360 Risk Management.
- Climate Change Impacts and Risk Management: A Guide for Business and Government (Department of the Environment and Heritage Australian Greenhouse Office, 2006).

The following approach was used to complete the high level desktop climate change risk assessment:

- Overview of current climate science. This includes a summary of the literature review based on the sources listed above such as the Australian climate science and studies of the regional area (Illawarra region).
- Identification and prioritisation of the main climate change risks and associated projections. This assessment considers the climate change risks and projections for climate variables: such as temperature, precipitation, sea level rise, and extreme events.
- Consideration of each relevant climate change risk as it applies to the project (such as flooding and topography of the area) and identification of priority climate change risks for further assessment.
- Assessment of potential impacts of priority climate change risks.
- Recommendation of adaptation options (project mitigation measures) for the priority climate change risks.

8.5.3 Assessment of potential impacts

The GHG emission source data used to estimate the GHG emissions associated with construction, operation and maintenance of the project is provided in **Appendix O**. Note that these results are based on design information available at the concept design stage.

GHG emissions

Construction GHG emissions

According to the GHG assessment methodology, assumptions and inputs presented in this report (see **Appendix O**), the construction of the project would generate:

- 48,959 tCO_2-e direct, Scope 1 GHG emissions.
- 0 tCO_2-e indirect, Scope 2 GHG emissions[2].
- 50,627 tCO_2-e indirect, Scope 3 GHG emissions.

This results in total Scope 1, 2 and 3 GHG emissions for the project of 99,586 tCO_2-e. The detailed GHG assessment results are given in **Table O-1** of **Appendix O**. The GHG emissions results from key emissions sources associated with construction are shown in **Figure 8-7**. **Figure 8-8** illustrates the GHG emissions results by scope. The major source of GHG emissions would be from the use of diesel fuel to operate construction equipment on site, accounting for 95 per cent of direct Scope 1 GHG emissions and 50 per cent of total emissions (Scope 1, Scope 2 and Scope 3). The use of materials for construction of the pavement, bridges, drainage infrastructure and road furniture would also be a major source of GHG emissions, accounting for 89 per cent of indirect Scope 3 GHG emissions and 45 per cent of total GHG emissions (Scope 1, Scope 2 and Scope 3). Pavement asphalt and cement, concrete and structural steel would contribute significantly to the emissions associated with construction materials.

[2] Although electricity is purchased for site offices, see Appendix O, this is not included in the emissions inventory based on materiality criteria. Table 3.3 of Supporting Document for the Workbook also recommends excluding it from the GHG assessment boundary, as it would generally be insignificant to the assessment.

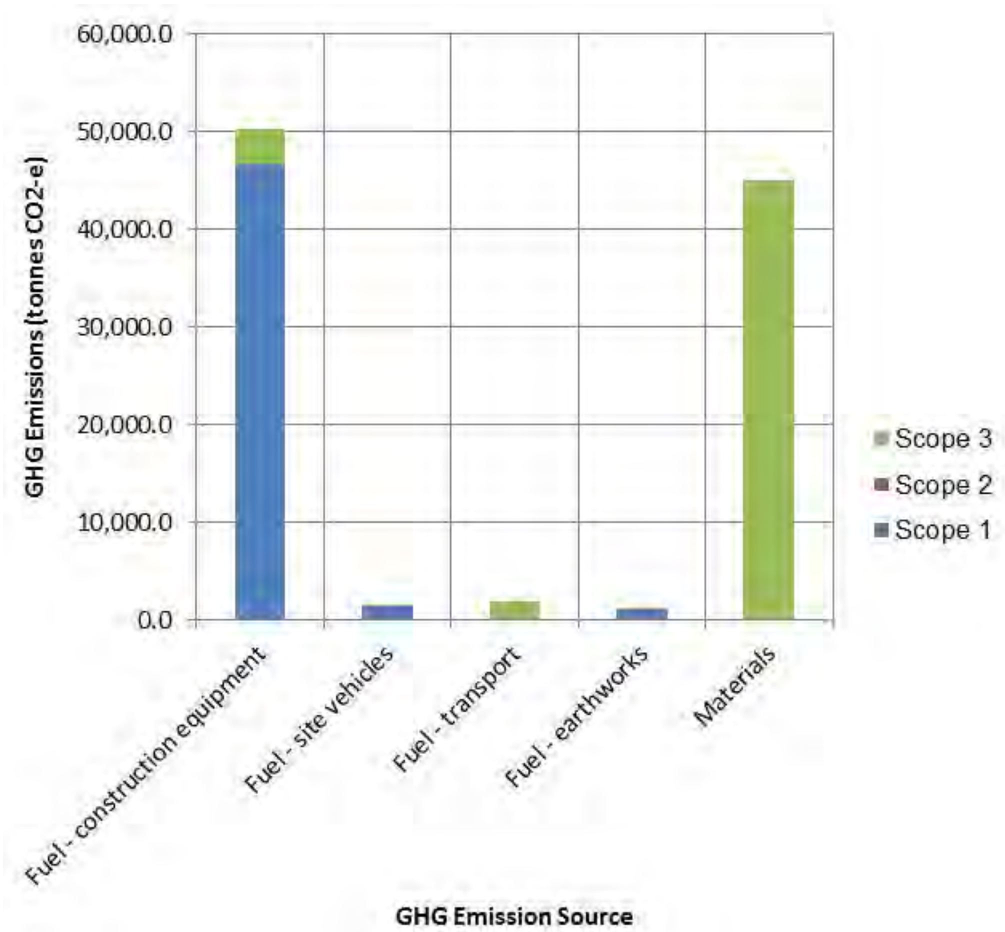

Figure 8-7 Construction GHG emissions assessment results

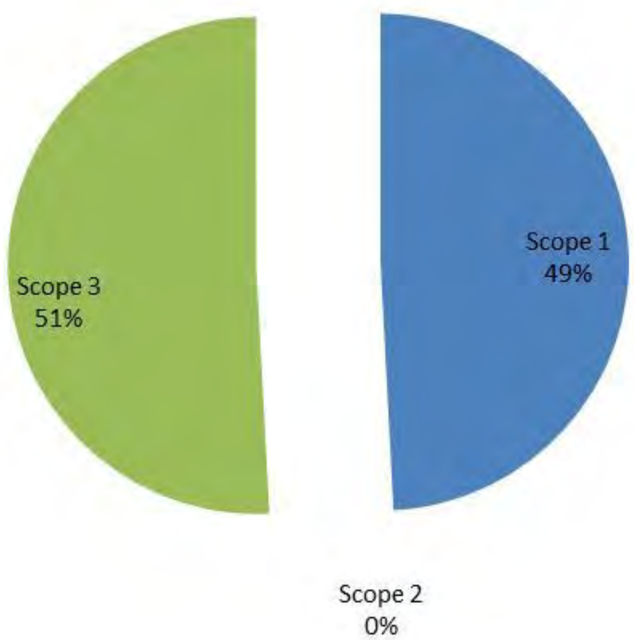

Figure 8-8 Construction GHG emissions by scope

Operation and maintenance GHG emissions

The estimated GHG emissions that would occur due to the operation and maintenance of the project are presented in **Table 8-11**. These have been calculated according to the GHG assessment methodology, assumptions and inputs presented in **Appendix O**.

Activities that would generate GHG emissions in the operation and maintenance stages of the project include:

1. Road infrastructure operation: The use of electricity for powering street lighting and a variable message sign.
2. Road infrastructure maintenance: Diesel fuel use for the operation of maintenance equipment and the delivery of maintenance materials.
3. Road infrastructure maintenance: Use of materials for maintaining the road pavement.
4. Vehicles using the road post construction: Use of the road post construction by traffic on the regional and local road network between Gerringong and Bomaderry bounded by the Princes Highway and 'Sandtrack' routes (the traffic impact footprint).

Annual use of electricity for powering street lighting and a variable message sign would incur 62 t CO_2-e indirect Scope 2 emissions and 11.9 t CO_2-e indirect Scope 3 emissions.

Emission estimates for the use of fuel, materials and the delivery of materials for the maintenance of the road pavement are based on the following maintenance activities occurring every 50 years (in accordance with 'typical' maintenance activities given in TAGG 2011):

- One major rehabilitation with the top 150 millimetres of all project pavement replaced. See **Appendix O** for areas and types of materials replaced.
- Five per cent of the full depth of all project road pavements replaced for patching/repair. See **Appendix O** for areas and types of materials replaced.

The use of fuel and materials to undertake these maintenance activities would result in 8334 t CO_2-e direct Scope 1 emissions and 7086 t CO_2-e indirect Scope 3 emissions. The total quantity of GHG emissions associated with the above road maintenance activities would be 15,420 t CO_2-e.

These GHG emissions generated during project operation and maintenance activities are relatively small in comparison with the GHG emissions savings associated with vehicle traffic use of the road.

To assess the contribution of GHG emissions from vehicles using the road post construction, total annual GHG emissions generated by vehicles using the Princes Highway and 'Sandtrack' as a consequence of 'do nothing' action (ie without the road construction) and as a consequence of operation of the project were considered (see the *Traffic and Transport Technical Paper* (AECOM 2012) for the traffic modelling methodology which was adopted to predict future traffic volumes for the project and the traffic impact footprint considered). The difference between total GHG emissions generated in the project and 'do nothing' scenarios was used to calculate the net GHG emissions attributable to operation of the project. The results, detailed in **Table 8-11** indicate that the project would generate less GHG emissions when compared to GHG emissions that would be emitted in the absence of the project, with:

- Around 13,551 t CO_2-e less net GHG emissions emitted by traffic using the project in the opening year (2017) when compared to GHG emissions emitted in the 'do nothing' scenario.
- Around 9843 t CO_2-e less net GHG emissions emitted by traffic using the project in the design year (2037) when compared to GHG emissions emitted in the 'do nothing' scenario.

Table 8-11 Operation and maintenance GHG emissions assessment results

Emission source category	Emission source	GHG emissions (t CO_2-e)			
		Scope 1	Scope 2	Scope 3	Total
Electricity use (per year)	Street lighting	0.0	52.6	10.1	62.7
	Variable message sign	0.0	9.4	1.8	11.2
Maintenance fuel combustion — diesel (over 50 years)	Mobile equipment	6,942.1	0.0	527.0	7,469.1
	Transport - material delivery	1,391.8	0.0	105.7	1,497.5
Maintenance Materials used (over 50 years)	Pavement - aggregate	0.0	0.0	153.5	153.5
	Pavement - cement	0.0	0.0	258.5	258.5
	Pavement - hot mix asphalt	0.0	0.0	5,554.8	5,554.8
	Pavement - Bitumen	0.0	0.0	347.4	347.4
	Pavement - lime	0.0	0.0	138.8	138.8
Total GHG emissions road use - opening year 2017 for' do nothing' option		0.0	0.0	121,982	N/A
Total GHG emissions road use - opening year 2017 with project		0.0	0.0	108,431	N/A
Net GHG emissions road use - opening year 2017 with project compared to 'do nothing' option		0.0	0.0	-13,551.0	-13,551.0
Total GHG emissions road use - design year 2037 for 'do nothing' option		0.0	0.0	145,763.0	N/A
Total GHG emissions road use - design year 2037 with project		0.0	0.0	135,920.4	N/A
Net GHG emissions road use - design year 2037 with project compared to 'do nothing' option		0.0	0.0	-9,842.6	-9,842.6
Total GHG emissions from major maintenance		8,333.9	0.0	7,085.7	15,419.6
Total yearly operational and road use GHG emissions or savings (not including major maintenance) 2017		0.0	62.0	-13,539.1	-13,477.1
Total yearly operational and road use GHG emissions or savings (not including major maintenance) 2037		0.0	62.0	-9,830.7	-9,768.7

The project would not significantly alter the vehicle kilometres travelled (VKT) in the traffic impact footprint. VKT projections for the project and 'do nothing' scenarios at 2017 and 2037, indicate that compared to the 'do nothing' scenario, the project would reduce VKT by approximately six per cent in 2017 and two per cent in 2037 (refer to **Table O-14** in **Appendix O** for VKT data). The GHG assessment results for the project and 'do nothing' scenarios indicate that compared to the 'do nothing' scenario, the project would reduce GHG emissions by 11 per cent in 2017 and seven per cent in 2037. As such, the predicted reduction in GHG emissions is due to reduced VKT together with increased average vehicle speeds (due to road network improvements) which would have improved vehicle fuel efficiency for most road sections.

Cumulative GHG emissions savings

Construction of the project would generate GHG emissions, however due to reductions in fuel use associated with the project, the GHG emissions savings relative to a 'do nothing' option (ie no road construction) would result in an overall GHG emissions reduction. **Figure 8-9** shows the cumulative GHG emissions and savings, from project construction to the design year 2037, including operational GHG emissions. It however excludes emissions from major road maintenance as these emissions are expected to occur from one major road maintenance event every 50 years, which is 30 years beyond the design year 2037 and the timeframe represented in **Figure 8-9**.

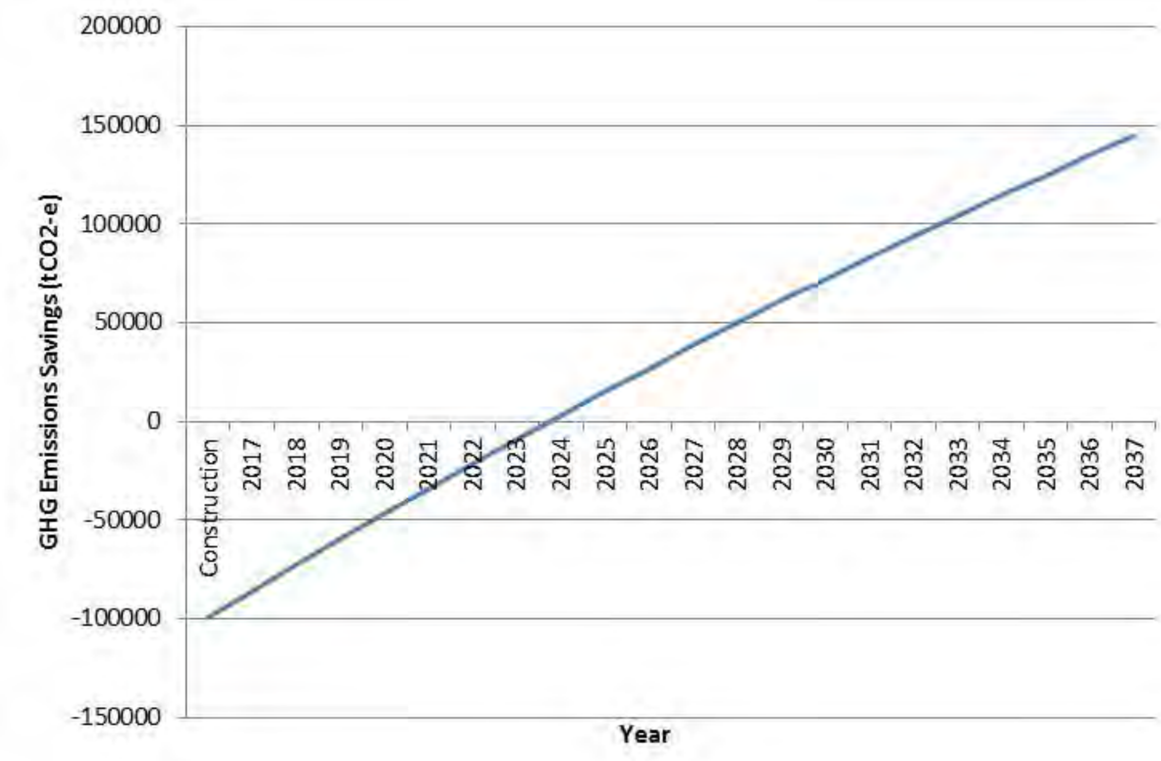

Figure 8-9 Cumulative GHG emissions savings including construction and operational emissions (not including major road maintenance)

Climate change projections and risks

In order to assess the risk to the project posed by climate change, the current climate science and model projections have been investigated.

Climate differs from region to region due to changes in the influencing factors, such as geographical location, latitude, physical characteristics, variable patterns of atmosphere and ocean circulation and in some cases, human interaction (IPCC, 2007). Consequently, climate change and the associated impacts can be expected to vary from region to region, with differences projected between climate changes on a national scale and a regional scale. As such, this literature review presents the climate change projections on an Australian national level and the regional projections for the Illawarra region on the NSW south coast, within which the project is proposed.

Australian national climate change projections have been sourced from the document *Climate change in Australia: technical report* (CSIRO, 2007), which was prepared in partnership between the CSIRO, the Bureau of Meteorology (BoM) and the Australian Greenhouse Office. The Australia and New Zealand IPCC 2007 regional projections were also referenced.

A summary of the climate change impacts for the Illawarra region have been developed for the year 2050 by NSW Government agencies and the University of New South Wales, based on information from the IPCC and CSIRO modelled data (DECC, 2008). Where data specific to the Illawarra region was unavailable, projections for the broader NSW region were used, in line with the data presented in the *NSW Climate Impact Profile - Illawarra Region* (DECCW, 2010).

Climate change risks

This assessment considers the climate change risks and projections for temperature, precipitation, sea level rise and extreme events.

Temperature

Figure 8-10 and **Figure 8-11** demonstrate the projections for mean maximum and minimum temperature changes for the Illawarra region. Both the minimum and maximum temperatures are anticipated to increase over all seasons, with changes between 1.5 degrees Celsius and three degrees Celsius projected by the year 2050 (DECC, 2008).

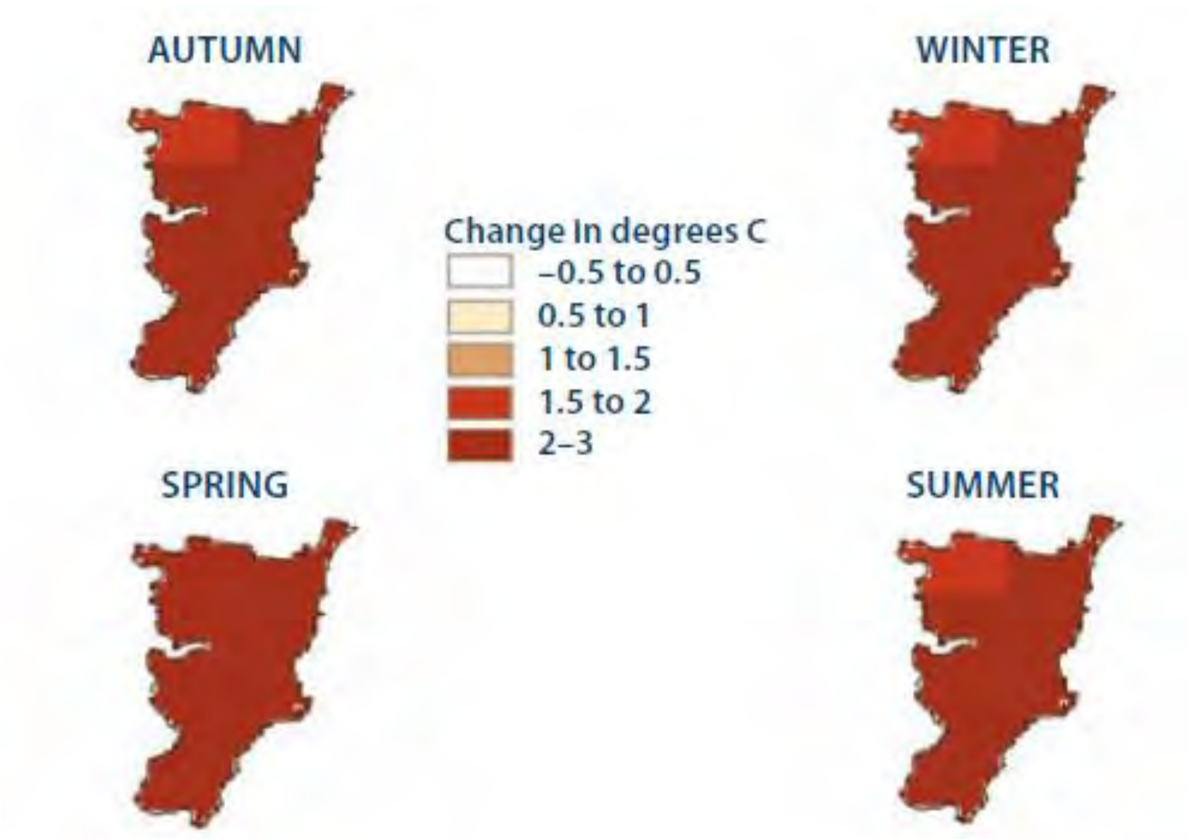

Figure 8-10 Projected change in mean maximum temperature by season, for the Illawarra Region in 2050 (DECC, 2008).

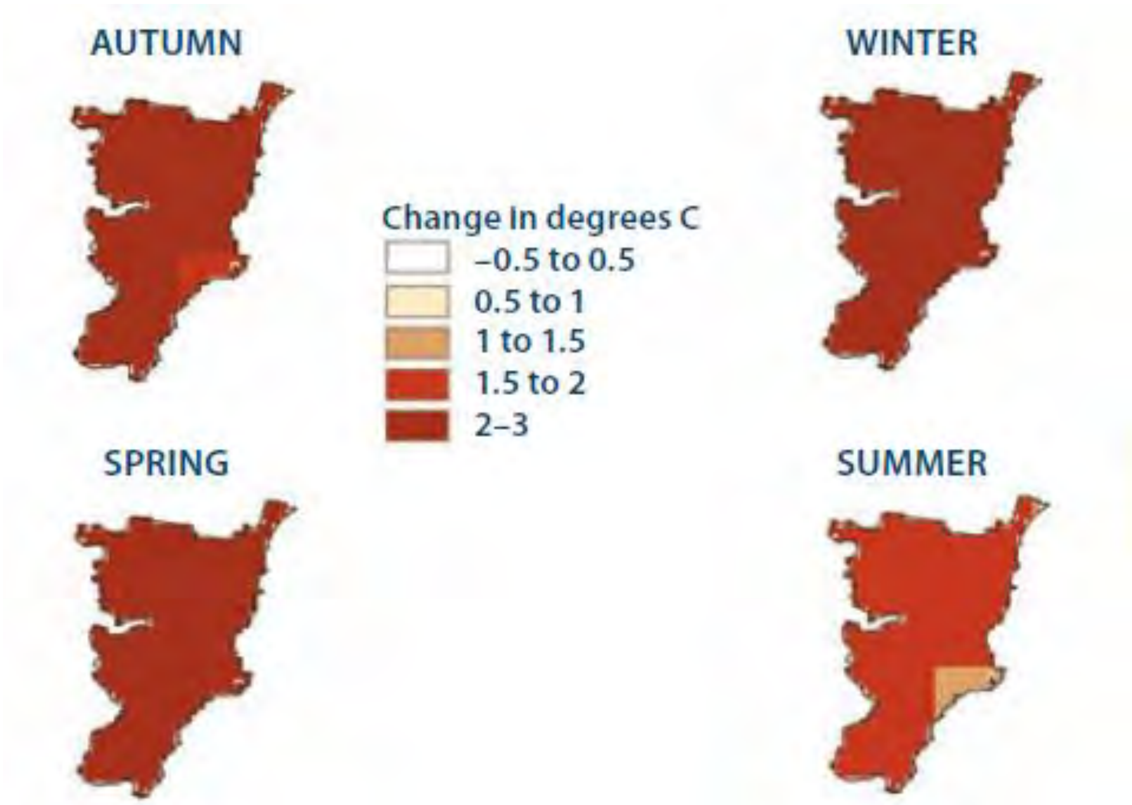

Figure 8-11 Projected change in mean minimum temperature by season, for the Illawarra Region in 2050 (DECC, 2008).

Precipitation

Precipitation across Australia has a large natural variability, and is sensitive to small differences in air and wind circulation patterns and other atmospheric processes (CSIRO, 2007).

The Illawarra region is projected to experience a substantial increase in summer rainfall and a slight to moderate increase in spring/autumn rainfall (refer to **Figure 8-12**). Rainfall along the coast in winter is likely to be similar to the existing levels.

Evaporation

Evaporation is projected to increase with temperature. Therefore, increases would be more significant in summer and spring. When considered in conjunction with projected changes in rainfall, increased evaporation could result in slightly drier conditions in winter and spring (DECC, 2008).

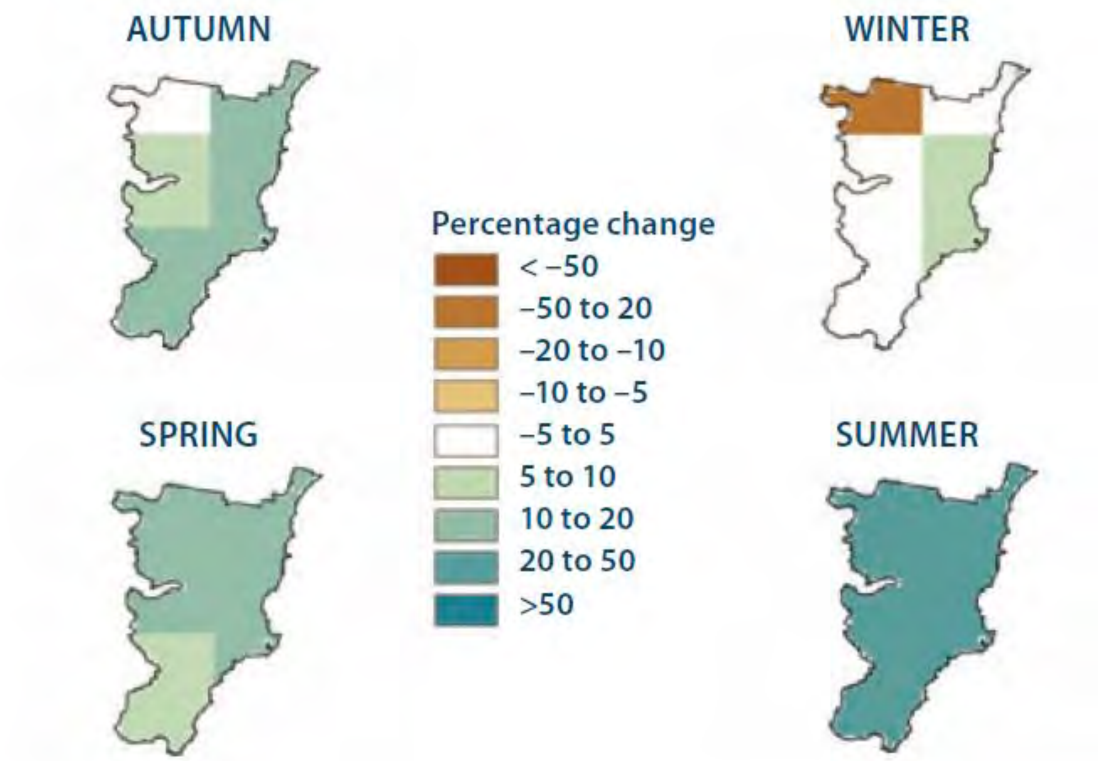

Figure 8-12 Projected change in seasonal rainfall for the Illawarra region in 2050 (DECC, 2008).

Sea level rise

Data for sea level rise is currently unavailable on a regional scale but impacts associated with sea level rise and storm events for NSW are anticipated to be significant. The NSW Government 'Sea Level Rise Policy Statement' outlines that the best national and international projections of sea level rise along the NSW coast are for a rise relative to 1990 mean sea levels of up to 40 centimetres by 2050, and 90 centimetres by 2100 (DECCW, 2009).

Sea level rise is expected to inundate and erode unconsolidated parts of the shoreline, and ultimately projected to result in a coastal recession of up to 20 - 40 metres by 2050 and 45-90 metres by 2100 (DECCW, 2010). Changes in rainfall events, storm frequency and severity, river flow and wind and wave action specific to a locality are likely to either amplify or reduce the erosion impacts of sea level rise, resulting in a varied level of impact along the NSW coastline.

Issues associated with ASS of the lower Shoalhaven floodplain are likely to continue in the short term, however, increased rainfall events and the intrusion of saline water from sea level rise are likely to decrease the occurrence and impact of such soil environments (DECC, 2008).

Sea level rise is relevant to the project area due to its proximity to the shoreline along parts of the route. As indicated above, impacts resulting from sea level rise such as coastal recession, inundation and erosion therefore have the potential to impact directly on the project area and as a result the structural integrity and design life of the asset.

Extreme events

Extreme weather events, such as storm surges, are projected to increase in severity, intensity and frequency. Tropical cyclones, however, while projected to increase in intensity, are anticipated to become less frequent rather than more frequent (IPCC, 2007).

The rise in sea level is also anticipated to increase the risk of flooding of the lower floodplain of the Illawarra region. Increases in the severity and duration of rainfall events are likely to result in flooding from urban streams and drainage systems. Although reports indicate that "major roads such as the Princes Highway are likely to be flooded from time to time at low-lying locations" (DECC, 2008), the highest risk areas are all located outside the project area (DECCW, 2010).

The risk of frequent, very high to extreme bushfires is predicted to increase across NSW. Increases in temperature, evaporation and high fire-risk days are likely to influence fire frequency and intensity across the region. The fire season is also likely to be extended as a result of warmer temperatures (DECC, 2008).

Uncertainty

Climate change model projections are tools used for understanding how the climate will respond to changes in GHG emission levels. These models are generated by a computer and include a number of variables to simulate climate. However, climate processes are complex and not all variables are known or able to be modelled. Most model projections are presented as averages for a given region or subregion, for which a level of uncertainty must be taken into account. Uncertainties to be considered include:

- Emission scenario uncertainty (uncertainty associated with the modelled data).
- Perception of uncertainty towards climate science. Uncertainty in this instance is perceived as a lack of knowledge, as opposed to prescribing a level of accuracy of the scientific results.
- Uncertainty associated with projecting climate change up to 2100. Although the project life is anticipated to be 100 years, much of the data modelled only projects impacts up to the year 2050 or 2070.

Climate change impacts to the project

This assessment is based on the following facts regarding the broader landscape of the project:

- The project area (as identified in the concept design) encompasses the foothill slopes of the escarpments around Berry and Toolijooa. The topography is primarily comprised of rocky outcrops, ridges and steep inclines, surrounded by floodplains and agricultural land use areas.
- The project involves three crossings of Broughton Creek, and a crossing at the confluence of Broughton Mill Creek, Bundewallah Creek and Connollys Creek. Embankments would be constructed along floodplains at Broughton Creek and north of Berry.
- The project is typically elevated between 40 – 100 metres above sea level and is shielded to some extent by Toolijooa Ridge to the east.
- During flood events, "major roads such as the Princes Highway are likely to be flooded from time to time at low-lying locations" (DECC, 2008).

Based on these area facts and the review of climate change variables and risks identified above, the following are considered priority climate change risks for the project:

1. Increased temperatures and evaporation.
2. Increased severity and frequency of heavy rainfall.
3. Increased severity and frequency of flood events resulting from heavy rainfall.
4. Increased intensity and frequency of fire-risk days resulting from increased temperatures and evaporation.

Table 8-12 outlines how these priority climate change risks would potentially impact the project. Further details are provided in the *Surface water, Groundwater and Flooding Technical Paper (AECOM 1012)* provided at **Appendix H**.

Table 8-12 Climate change risks and potential impacts

Climate change risk	Possible impacts/consequences of climate change risk	Evaluation of risk level after mitigation
Increased temperatures and evaporation	Bridge structural material degradation: through thermal expansion of bridge joints and paved surfaces, damage can occur to bridge structure material.	Negligible risk- The forecast increase in mean maximum and minimum temperature arising from climate change is within the range of temperatures presently experienced by bridge infrastructure across the state. Australian design standards allow for significantly hotter (hot inland desert) and cooler (Snowy Mountains) environments than predicted under Climate Change in the project region.
	Asphalt degradation: due to heat events deterioration can lead to melting, cracking or rutting.	Negligible risk- There is sufficient knowledge and experience to demonstrate that bituminous and concrete surfaces currently perform satisfactorily in Australia's extremely hot climates such as the tropical north and the dry inland where extreme weather conditions are similar to or more severe than predicted as a result of climate change on the NSW State Road network.
Increased intensity and frequency of fire-risk days resulting from increased temperatures and evaporation.	Public safety risk due to bushfire events	Negligible risks- There is currently a range of site-specific plans that are used on a day to day basis by traffic controllers, working with the Police, Ambulance, Fire and other emergency services to respond to unplanned incidents on the road network. Should climate change result in more frequent floods or fires, these plans are available for implementation, or may be updated over time should that be necessary.
Increased severity and frequency of heavy rainfall.	Asphalt degradation: due to heavy rainfall can lead to cracking, potholes or rutting.	Negligible risk- existing road pavements already cope with a wide range of rainfall events across the State within the range of climate change related changes. Standards and specifications are constantly being reviewed to ensure pavements perform to a high standard.
	Road foundation degradation: the road foundation can also deteriorate due to increased moisture resulting in cracking.	Negligible risk- existing road foundations already cope with a wide range of rainfall events across the State and standards and specifications are constantly being reviewed to ensure foundations perform to a high standard.
Increased severity and frequency of flood events resulting from heavy rainfall.	Flood damage to roads: overtopping and inundation of roads and other road infrastructure as a result of flood events can damage road materials through erosion or other failure modes.	Medium risk: Roads are designed to cope with a certain amount of overtopping. However with climate change, there may be changes in floodwater velocity and height which can increase the risk of damage. The road level has been designed not to be overtopped (to edge of shoulder) by the one in 100 year event including a six per cent climate change allowance.

Climate change risk	Possible impacts/consequences of climate change risk	Evaluation of risk level after mitigation
	Flood damage to bridges: overtopping and inundation of bridges as a result of flood events can damage bridge structure.	High risk- Bridges are difficult to modify once constructed. Flooding loads are well understood and the bridge structural design: • Allows for the passage of a 100 year average recurrence interval design flood with a six per cent climate change allowance in the design event); and • Effectively accounts for potentially larger increases in rainfall intensity by considering loads on the structure and lateral loads from overtopping floodwater by undertaking a sensitivity analysis modelling of a 1 in 2000 year event.
	Underpass flooding: flooding of culverts or underpasses can result in structural damage and deterioration of material.	High risk- Underpasses are very difficult to modify once constructed. Climate change related rainfall increases have been included through a six per cent climate change allowance in the design event. As new information about the impact of climate change on performance of materials becomes available, should there be concern that existing design practices or policies are insufficient, the policies, specifications or practices will be reviewed.
	Overloading of drainage systems and inaccessible drainage elements: as a result of flood events roads with poor or inadequate drainage systems can become overloaded or blocked. This can lead to a loss of strength and bearing capacity in the road foundation.	Medium risk- Inaccessible drainage elements (e.g. drainage culverts and pits) are very difficult to modify once constructed and typically have a structural design life of around 100 years. Climate change related rainfall increases have been accounted for by including a six per cent climate change allowance in the design event.
Increased severity and frequency of flood events resulting from heavy rainfall. Increased intensity and frequency of fire-risk days resulting from increased temperatures and evaporation.	Changes in landscaping and road-side vegetation: due to flood or heat events which can result in a variety of impacts including direct impacts on flora and fauna, biodiversity or habitat and blocked roads or damaged vehicles due to fallen trees.	Medium risk- It is recognised that changes to the climate will have an impact on vegetation and fauna. Climate change impacts will add to the stresses that are created by the fragmentation of habitats that occurs when a road is constructed through the landscape and as urbanisation occurs.

The project has been planned with an awareness of the potential for climate change impacts on the project. Drainage structures would adequately withstand future climatic changes, such as increased rainfall intensity and more frequent flood events. Specifically:

- The project has been designed and would be constructed to provide flood immunity on the carriageway for a 100 year flood event (without accounting for climate change).
- An additional six per cent increase in rainfall intensity has been factored into design of the drainage infrastructure for the project to ensure adequate drainage to take into account the effect of climate change.

While incorporation of climate change impacts into the design of the project would reduce the severity of those impacts, additional adaptation measures would be required to minimise the potential impacts associated with the expected climate change risks as discussed below.

8.5.4 Environmental management measures

Mitigation and management measures would be implemented to avoid, minimise or manage greenhouse gas and climate change impacts. These mitigation and management measures have been identified in **Table 8-13** and incorporated in the draft statement of commitments in **Chapter 10**.

Table 8-13 Mitigation and management measures

Potential impacts	Mitigation and management measures
Construction	
GHG emissions	Select the most fuel efficient plant, equipment and vehicles practicably available through consultation with subcontractors and suppliers. Ensure that all plant and vehicles are maintained regularly to maintain fuel efficiency Procure locally produced goods and services where feasible and cost effective to reduce transport fuel emissions. Specify construction materials with lower emissions intensity in the detailed design (eg recycled steel in place of virgin steel and asphalt in place of concrete) where engineering and other technical specifications can be met and the alternative is reasonable and feasible. This measure could also be applied to the selection of maintenance materials in the operational stage. Seek opportunities to reduce the quantity of construction materials used through innovative design and construction methodologies. Where reasonable and feasible, procure recycled content road construction and maintenance materials such as recycled aggregates in road pavement and surfacing (including crushed concrete, granulated blast furnace slag, glass, slate waste and fly ash). This measure forms part of RMS' implementation of the NSW Government's 'Waste Reduction and Purchasing Policy' (WRAPP). Consider the procurement of renewable energy technologies (eg solar photovoltaic, wind power) for power generation onsite during the construction stage. Design earthworks to, where reasonable and practicable, avoid long haulage distances and reduce excess spoil.

Potential impacts	Mitigation and management measures
Climate change impacts	Adopt standard climate change mitigation measures, including development of a Vegetation Management Plan, to avoid, minimise and mitigate impacts on habitats and the ecology of the project area consistent with RMS 'Draft Wildlife Connectivity Guidelines' and 'Protecting and Managing Biodiversity – Guidelines for RMS Projects' Refer to measures in **Section 7.3**. Review existing design policies, specifications or practices as new information about the impact of climate change on performance of materials (for road foundation, fill, asphalt, bitumen etc) and drainage structures becomes available with the aim of using materials less susceptible to degradation impacts of climate change.
Operation	
GHG emissions	Specify energy efficient street lighting appropriate for project needs. Encourage the use of less GHG intensive modes of transport by incorporating a shared pedestrian/cycle path at the Kangaroo Valley Road overbridge and bus pick up and drop off facilities in the design of the upgrade.
Climate change	Monitor and review the performance of structures and materials in response to climate change related events.

9 Environmental risk analysis

A detailed environmental risk analysis was conducted as part of this environmental assessment. This chapter outlines the environmental risk analysis process and identifies the key environmental issues. The Director-General's requirements (DGRs) in regards to an environmental risk analysis are detailed below.

Director-General's requirements	Where addressed
Environmental Risk Analysis *- Notwithstanding the above key assessment requirements, the EA must include an environmental risk analysis to identify potential environmental impacts associated with the project (construction and operation), proposed mitigation measures and potentially significant residual environmental impacts after the application of proposed mitigation measures. Where additional key environmental impacts are identified through this environmental risk analysis, an appropriately detailed impact assessment of this additional key environmental impact must be included in the EA.*	Chapter 9 Section 9.2

9.1 Environmental risk analysis process

An environmental risk analysis has been carried out to identify and confirm the key environmental issues for the project. Key issues are those that may have major or moderate impacts (actual or perceived) and require detailed assessment to determine the level or severity of potential effects and identify appropriate impact mitigation and management measures.

The environmental risk analysis process carried out for the project included:

- Preliminary environmental investigations to help identify the key environmental issues and inform the Part 3A Project Application.
- An assessment of the key issues identified in the DGRs for the project (refer to **Appendix A** for the DGRs).
- An environmental risk review to confirm the key environmental issues based on the results of the detailed investigations presented in this environmental assessment.

These steps are described in further detail in **Section 9.2** to **Section 9.4** below.

9.2 Preliminary environmental investigations

Preliminary environmental investigations were carried out prior to the preparation of this environmental assessment to inform the Part 3A Project Application. The outcomes of these investigations identified the following as key environmental issues for the project:

- Traffic and transport.
- Noise and vibration.
- Biodiversity.
- Landscape character and visual amenity.
- Aboriginal cultural heritage.
- Land use and property.
- Socioeconomic.

The outcomes of the preliminary environmental investigations were documented in the Part 3A Project Application, which was submitted to the Director-General of the NSW Department of Planning and Infrastructure in conjunction with the *Foxground and Berry Bypass Preliminary Environmental Assessment* (RTA, 2010). The purpose of the preliminary environmental assessment was to assist the Director-General in identifying the environmental impact assessment requirements for the project, including the key issues to be addressed in the environmental assessment.

9.3 Assessment of the key issues identified in the DGRs

The key environmental issues identified in the DGRs are consistent with, but add to the key issues identified in the preliminary environmental assessment. The DGRs identified the following as the key issues to be addressed in the environmental assessment for the project:

- Traffic and transport.
- Noise and vibration.
- Biodiversity.
- Surface water and groundwater.
- Flooding.
- Landscape character and visual amenity.
- Aboriginal cultural heritage.
- Non-aboriginal heritage.
- Land use and property.
- Socioeconomic.

The above-listed key issues have been assessed in detail as part of the preparation of this environmental assessment. These results of this assessment are presented in **Chapter 7**.

9.4 Environmental risk review

An environmental risk review was undertaken as part of this environmental assessment to help identify any additional key issues, other than those already identified in the DGRs. This risk review was based on a qualitative assessment of information obtained during the environmental impact assessment process, including the results of specialist investigations. It involved:

- Identifying all relevant environmental issues (actual and perceived), including but not limited to the key issues identified in the DGRs.
- Examining the relative potential environmental risks associated with each of the identified issues.
- Assigning a risk category to each of the identified issues based on the criteria outlined in **Table 9-1.**

The results of the risk review are presented in **Table 9-2**. No additional key issues, other those specified in the DGRs, were identified as an outcome of the risk review.

Table 9-1 Environmental risk category criteria for identified environmental issues

Risk Category	Description
Key issue	High or moderate impact (actual and perceived) requiring further investigation to identify specific management and mitigation measures.
Other issue	Moderate or low impact that can be managed effectively with standard and best practice management and mitigation measures

9.5 Confirmation of key environmental issues

The following issues have been confirmed as the key environmental issues for the project based on the information presented in this EA:

- Traffic and transport.
- Noise and vibration.
- Biodiversity.
- Surface water and groundwater.
- Flooding.
- Landscape character and visual amenity.
- Aboriginal cultural heritage.
- Non-aboriginal (historic) heritage.
- Land use and property.
- Socio-economic.

All key issues have been addressed in **Chapter 7**.

Table 9-2 Environmental risk analysis summary

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
Key issues					
Traffic and transport	Yes	**Construction risks**			
		Reduced safety to road users, cyclists and pedestrians during construction.	A traffic management plan (TMP) would be developed to identify, manage and respond to any changes in road safety as a result of the highway construction works. This includes signage and traffic control devices. Negligible impacts following management.	Key issue	Section 7.1
		Reduction in traffic efficiency for local and regional traffic due to construction activities.	A TMP would include both the general approach and the specific controls required at selected locations to minimise traffic disruptions. Offline works would be undertaken wherever possible to minimise delays to highway traffic. Construction methods and staging would be designed to minimise disruptions caused by road closures and online works (subject to other project constraints). Construction works that would significantly impact the performance of the road network would be scheduled, where possible, during periods that have typically lower traffic volumes. An 80 km/h construction speed zone would be maintained, where possible. Access to local roads and properties would be maintained. A local and regional communications strategy would be implemented to provide advanced notice of any major or prolonged impacts, and real-time information regarding current impacts. Despite the implementation of management measures, there would be a temporary residual impact on the network efficiency.	Key issue	Section 7.1
		Temporary transfer of traffic from the Princes Highway to the 'Sandtrack' and Toolijooa Road.	The TMP would be developed to identify traffic management requirements during construction, including any changes to road safety on the 'Sandtrack' as a result of the highway construction works.	Key issue	Section 7.1

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
		Temporary road closures, particularly during construction of the southern interchange for Berry.	Construction methods and staging would be designed to minimise road closures. Temporary detours would be designed to minimise delay and ensure that road safety is maintained. Measures to minimise network disruptions would be detailed in the TMP, and would include strategies to communicate changes for road users prior to and during construction. Negligible impacts remaining following implementation of these management measures.	Key issue	Section 7.1
		Operational risks			
		Reduction in traffic efficiency on the Princes Highway due to traffic growth, including the transfer of traffic from the 'Sandtrack'.	The four lane divided highway would provide sufficient capacity to accommodate additional traffic capacity to the design year of 2037 and beyond. The operational performance of the project would be monitored following completion of construction to ensure that the road network performs as efficiently as expected.	Key issue	Section 7.1
		Impact of increased highway traffic on the adjacent unimproved section of the highway between Schofields Lane and Cambewarra Road to the south of the project area.	A temporary tie-in would be provided to safely merge highway traffic between the project and the existing highway at Schofields Lane. RMS has commenced planning for the Berry to Bomaderry upgrade.	Key issue	Section 7.1
		Impacts to local road and property access due to the introduction of a central median and safety barrier, and left in left out only arrangements.	U-turn movements would be catered for at interchanges, the dedicated u-turn facilities at Mullers Lane and Austral Park Road, and the roundabout at Tannery Road. There would be a permanent increase in travel times for local residents affected by the left in left out arrangements. This is considered to be justified by the long-term safety gains to local and regional road users.	Key issue	Section 7.1

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
		Impacts to local roads and local traffic routes, including impacts to bus routes, garbage trucks and emergency services.	Rawlings Lane would be realigned to connect with the western portion of North Street, with a u-turn facility. North Street would be permanently severed and traffic would need to use Queen Street and the Berry bypass. This would minimise the additional travel required for road users who would be diverted. Victoria Street would be permanently closed at the western end and traffic accessing the highway southbound would be redistributed along the local road network. Additional travel times would be minimal and the affected local roads would continue to function within capacity and with minimal impact to the amenity. Turning facilities for garbage trucks and buses would be provided to maintain current services on Rawlings Lane and North Street. Residual impacts would include increased travel time for buses, garbage trucks and other services. Bus stops along the highway would be consolidated and provided at Toolijooa Road and Tindalls Lane interchanges. Changes to bus routes and/or stops would be made in consultation with bus service providers and communicated to patrons prior to and during the changes to services. Changes may result in an inconvenience for passengers but it would increase safety at bus stops and interchanges, and may reduce travel times.	Key issue	Section 7.1
		Operational impacts on pedestrians and cyclists.	Any design for Kangaroo Valley Road bridge at the southern interchange for Berry and other pedestrian/cyclists connections including those along North Street, would aim to support and complement the Pedestrian Access and Mobility Plan (SCC, 2006) developed by Shoalhaven City Council for Berry. Provisions for cyclists would comply with the NSW Bicycle Guidelines (RTA, 2005) and *NSW Bicycle Guidelines and Austroads Cycling Aspects of Austroads Guides*	Key issue	Section 7.1

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
Noise and vibration	Yes	**Construction risks**			
		Exceedance of construction noise management levels, including noise from ancillary construction sites.	A construction noise and vibration management plan (CNVMP) would be prepared prior to construction commencing. Construction noise impacts would be minimised through the use of best practice construction methods and reasonable and feasible noise mitigation. The potential for residual noise impacts would remain. If required, the location and height of temporary noise barriers at ancillary construction sites would be determined by the contractor during detailed design. The CNVMP would contain a community involvement plan, which would detail communication strategies for sensitive receivers that would be exposed to levels above noise management levels. Noise complaints would be dealt with through a complaints management procedure identified in the community involvement plan. Temporary noise impacts would occur during construction.	Key issue	Section 7.2
		Work outside of standard construction hours, including extended work hours and out of hours work.	Extended construction hours and out of hours work would be required for certain activities. . Wherever practicable, noise intensive works would be planned in the following order of priority to minimise the potential impacts on sensitive receivers: standard working hours, extended working hours, evening working hours, and night time working hours. Specific details of all out of hours work required would be provided to the Office of Environment and Heritage (OEH)/Environment Protection Authority (EPA) as part of the CNVMP. Affected residents and the OEH/EPA would also be informed of the timing and duration of approved work at least 48 hours before that work starts or as provided for in a site Environment Protection License Temporary noise impacts would occur during construction, but would be minimised by implementing these management measures.	Key issue	Section 7.2

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
		Exceedance of vibration limits causing human discomfort and structural damage in buildings.	Safe working distances would be adopted to minimise human discomfort and structural damage in buildings due to vibration. The CNVMP would require the use of certain equipment to achieve optimum safe working distances. Where safe working distances cannot be achieved, attended vibration monitoring, use of monitoring systems on equipment, negotiated agreements with affected receivers and dilapidation surveys of affected properties, would be undertaken (where appropriate).	Key issue	Section 7.2
		Increased blasting limits	A Blast Management Plan would be prepared for the project. This would include a program for smaller 'test' blasts to determine the correct setback distances for the project. Consultation would be undertaken when activities are predicted to not comply with the blasting criteria, or where simultaneous blasts are proposed. Residual impacts would be negligible.	Key issue	Section 7.2
		Increased traffic noise due to increased heavy construction related vehicle volumes	Implementation of traffic management practices to minimise road traffic noise from construction vehicles. Temporary noise impacts would occur during construction, but would be minimised by implementing the traffic management measures.		Section 7.2
		Operational risks			
		Exceedance of operational noise criteria at affected receivers.	Noise mitigation measures include the use of low noise road pavement materials, at source mitigation measures (noise barrier along North Street and along the southbound and northbound off-ramps at the southern interchange for Berry) and at receiver mitigation (architectural treatments). The final design and/or types of treatment for residences would be determined during detailed design, and the consideration of other factors, such as community views and urban design. Following the opening of the project, noise monitoring would be undertaken to confirm noise predictions and if additional noise treatments are required.	Key issue	Section 7.2

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
Biodiversity	Yes	**Construction and operational risks**			
		Loss of or disturbance to endangered ecological communities (EECs), including the river flat eucalypt forest.	The permanent and temporary loss of the EEC would be minimised through detailed design and through the revegetation and rehabilitation of riparian vegetation (river flat eucalypt forest EEC or similar) in strategic places. Temporary water crossings would be located to minimise the need for additional clearing of riparian vegetation. To offset the permanent loss of EEC vegetation, offsets would be provided as detailed in the Biodiversity Offset Strategy.	Key issue	Section 7.3
		Disturbance to terrestrial habitats, including increased fragmentation, edge effects, reduced connectivity and disturbance to wildlife corridors.	The Vegetation Management Plan (VMP) would detail measures to manage potential impacts on habitat for threatened flora and fauna. Clearing would be kept to the minimum area required for the project, and would be managed in accordance with the RTA Biodiversity Guidelines (RTA, 2011). This includes staged clearing, fauna rescue and relocation. Areas to be cleared would be fenced to identify 'no go' areas. Habitat features (such as hollow bearing trees) would be retained where possible. Measures to minimise the potential for edge effects for retained habitats and native vegetation would include weed management and erosion and sediment control. Fauna fencing, underpasses and rope bridges would be provided to minimise impacts on wildlife corridors and retain connectivity where vegetation (especially riparian vegetation) requires removal. Residual fragmentation impacts may occur depending on the final locations of revegetation and rehabilitation work.	Key issue	Section 7.3
		Impacts to or removal of threatened or migratory species (aquatic and terrestrial).	Impacts to and loss of threatened or migratory species would be unlikely, provided that mitigation measures to minimise the loss of habitat or connectivity are implemented. An unexpected finds procedure would be incorporated into the Construction Environmental Management Plan (CEMP) to ensure the appropriate management of any threatened species found on site during construction.	Key issue	Section 7.3

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
		Disturbance to aquatic habitats, including impacts to State Environmental Planning Policy (SEPP) 14 wetlands and reductions in water quality.	Aquatic ecosystems in the vicinity of the project are impacted by the surrounding agricultural land uses and existing water quality is low. Disturbance to aquatic habitats would be minimised by avoiding the removal of large woody debris and maintaining water quality. Where large wood debris is encountered, a priority management response would be implemented (ranging from lopping, relocating, removal). If removal is required, the offsets strategy would provide compensatory response. Water quality would be managed in accordance with the soil and water management plan (SWMP) as detailed in surface and groundwater. It is unlikely that any SEPP 14 wetlands would be impacted by the project. Residual impacts would be negligible.	Key issue	Section 7.3
		Invasion of environmental weed species.	The VMP would include weed management strategies to be implemented during the construction and operation of the project. Residual impacts would be negligible.	Key issue	Section 7.3
		Increased mortality or injuring of fauna during construction and operation.	Fauna fencing, underpasses and rope bridges would be provided at strategic locations to provide crossing locations for fauna. Management of fauna during construction and operation would be in accordance with the Biodiversity Guidelines (RTA, 2011). Residual impacts would be negligible.	Key issue	Section 7.3

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
		Alterations to flow regimes and interruptions to fish passage.	Transverse drainage structures would be used to allow the unrestricted passage of natural flows and changes in the natural flow regime. Impacts to fish passage would be minimal given that there would be no permanent in stream structures and construction methods would be developed during detailed design, to minimise any construction impacts including the construction of bridge piers and temporary creek crossing and construction pads. Bridge structures would be preferable for temporary crossings, however if culverts are required, fish passage may be maintained by minimising changes to the natural flow, channel width and water depth through the culvert cells. Changes to hydrology at Town Creek, Bundewallah Creek and Broughton Creek (near the bridge 2 embankment) would have a minor impact on aquatic ecology. This impact is not considered to be significant.	Key issue	Section 7.3
Surface water and ground-water	Yes	**Construction risks**			
		Spills from construction vehicles, equipment and plant.	Construction mitigation measures to minimise impact on water quality would include traffic control measures, appropriate maintenance of vehicles and the implementation of occupational health and safety practices in the storage and handling of dangerous and hazardous goods. There would be negligible residual impact following implementation of recommended controls.	Key issue	Section 7.4

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
		Runoff, erosion and sedimentation during construction activities.	A SWMP would be developed and would include mitigation measures such as erosion control, construction sequencing, at source controls, bunding and contamination prevention. Sediment basins would be constructed in accordance with the 'Blue Book'. Operational water quality control basins would be used to supplement (where appropriate) construction sedimentation basins. A soil conservationist would be engaged to provide advice throughout the construction period on erosion control strategies. There would be negligible residual impact following implementation of recommended controls.	Key issue	Section 7.4
		Impacts on groundwater quality and quantity.	During detailed design, additional geotechnical investigations would be completed to inform design opportunities to minimise impacts on groundwater quality and drawdown. Groundwater mitigation and management measures would be incorporated into the SWMP. This would include a groundwater monitoring plan that would monitor the performance of mitigation measures during and after construction. If dewatering is required at deep cuts that intersect groundwater, it would be discharged to creeks (under licence) or stored temporarily in sedimentation basins to reduce turbidity prior to discharge. Bunding would be provided around fuel depots and stockpile areas, with response plans to address fuel leaks and spills at machinery compounds or during refuelling. If present, the depth of excavation in alluvium soils would be minimised to reduce the risk of acid sulphate soil (ASS) infiltration to groundwater. There would be negligible residual impact following implementation of recommended controls.	Key issue	Section 7.4

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
		Use of recycled water from Berry and Gerringong-Gerroa sewage treatment plants during construction.	The SWMP would contain mitigation, monitoring and management measures to manage potential human health and environmental risks that may arise from the use of recycled effluent. Water quality would be tested prior to use. There would be negligible residual impact following implementation of recommended controls.	Key issue	Section 7.4
		Impacts on dams and water catchment areas (stock and domestic).	No domestic drinking water catchments are located within the study area. During construction, water quality in stock drinking water catchments would be protected with standard mitigation measures for erosion control and contamination prevention.	Key issue	Section 7.4
		Acid runoff from ASS	Further testing would be completed during detailed design and prior to the commencement of construction to determine the risk of disturbing potential acid sulphate soil (PASS). If the presence of PASS is confirmed, priority would be given to avoidance and minimising the extent of disturbance. If required, measures would be incorporated into the SWMP.	Key issue	Section 7.4
		Operational risks			
		Modifications to waterways resulting in water quality impacts. This includes impacts associated with flow changes in Town Creek.	Works in and around waterways would be managed to protect bank stability, prevent sedimentation and minimise impacts to waterways. The diversion of Town Creek flows would be designed to minimise scour impacts on Bundewallah Creek and within the diversion channel. The revegetation of the diversion channel would also minimise impacts on water quality within the diversion channel and within Bundewallah Creek. The reduction in flows in Town Creek south of the project (in Berry) would reduce the flushing efficiency of the creek and would lead to increased sedimentation. Given the existing degraded condition of Town Creek through Berry, sediment accumulation should not have any significant adverse impacts on water quality.	Key issue	Section 7.4

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
		Road impacts on dams and water catchment areas (stock and domestic).	The drainage catchments for a number of farm dams would be reduced as a result of the project. For the majority of these dams, this would be less than 20 per cent of original dam catchments. Undertake consultation with affected landowners prior to the commencement of construction where there would be permanent losses in dam catchments. No domestic drinking water catchments are located within the study area.	Key issue	Section 7.4
		Impact to surface water quality and receiving environments from spillages due to vehicle and truck accidents.	The alignment of the new highway is safer and therefore the likelihood of accidents would be decreased. If spills occur, these would be directed to and captured by the permanent water quality basins upstream of sensitive receivers or elsewhere by swales.	Key issue	Section 7.4
		Impact to surface water quality and receiving environments due to runoff from road surfaces.	Water quality treatment measures for runoff from road catchments would be implemented, including swales and water quality basins. Biofiltration systems would be provided, where appropriate, to mitigate impacts on downstream sensitive receiving environments.	Key issue	Section 7.4
		Impacts on groundwater dependent ecosystems (GDEs)	The risk to downstream GDEs is low. Local GDEs are within elevated areas and would continue to be sustained. Impacts to downstream GDEs would also be low, as flows in Broughton Creek would remain virtually unchanged and surface water discharged under licence to the creek from operational water quality basins would be treated in accordance with best practice.	Key issue	Section 7.4
		Road impacts on groundwater quality and quantity, including draw down and flow to springs.	Groundwater recharge decreases would be minor given the small road surface compared to the size of the catchment. Draw down in the vicinity of Toolijooa Ridge cut is not expected to impact other users. This would be confirmed during detailed design. A groundwater monitoring program would be compiled in consultation with the OEH/EPA and NSW Office of Water (NOW) to assess the performance of groundwater mitigation measures. RMS' Incident Response Plan would address risks to groundwater quality due to accidental spillages.	Key issue	Section 7.4

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
Flooding	Yes	**Construction risks**			
		Inundation of construction ancillary sites during flood events, leading to environmental impacts.	Flood prone sites would be avoided, where possible. If flood prone land is to be used, a risk management approach would be taken for ancillary sites, with restrictions or additional mitigation measures to be provided.	Key issue	Section 7.5
		Operational risks			
		Modifications to waterways impacting on flood regimes. Flows in Town Creek to be diverted to Bundewallah Creek.	Drainage structures would be designed to allow for the natural flow of floodwaters and existing overland paths to be maintained post-construction where possible. Piers would be located outside main creek channels, and the intrusion of bridge abutments into the 100 year ARI flood extents would be limited. Bridges would be designed to maintain existing flow paths and to as far as possible, minimise increases in flood levels and velocities. The diversion of Town Creek flows to Bundewallah Creek would alleviate flooding impacts in Berry. The diversion channel and outlet would be designed to minimise scour protection. Increases in flood levels in Bundewellah Creek as a result of the diversion would have localised impacts around the outlet of the diversion swale, but would be minimised to a large degree by the larger Bundewallah Creek flows. Any increases in flood levels downstream associated with the Town Creek diversion and additional flows in Bundewallah Creek and Broughton Mill Creek would be addressed during detailed design and alleviated by appropriate flood mitigation developed in consultation with any affected property owners. Increases in flood levels upstream of bridges would occur, but would not impact on habitable structures and would mostly impact agricultural land.	Key issue	Section 7.5

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
		Changes to flood behaviour, including duration, time of inundation and afflux, taking into account the impact of climate change on the project.	Culverts would be designed to minimise impacts on flow and the project has been designed to achieve flood immunity during the 1 in 100 year flood event. Where high velocities are predicted, scour protection would be specified for the applicable drainage structures. Embankment protection measures would be identified during detailed design in response to the change in flood flow paths as a result of the embankment between Broughton Creek bridges 2 and 3. The design of bridges and drainage structures have accounted for a six per cent increase in rainfall intensity to cater for potential impacts of climate change. An adaptive management approach would respond to any climate change impacts over and above the six per cent increase.	Key issue	Section 7.5
		Changes to regional hydrology	The project has been designed for the 1 in 100 year flood event, and would have adverse flood impacts during a probable maximum flood (PMF) event. However, critical infrastructure and evacuation routes should not be affected.	Key issue	Section 7.5

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
Landscape character and visual amenity	Yes	**Construction and operational risks**			
		Loss of visual connectivity to and from Berry due to the roadway, bridges and noise barriers. Loss of connectivity and visual amenity along North Street and the severance between Berry and west Berry (including Huntingdale Park Estate).	During detailed design, opportunities to further reduce the overall footprint of the project would be considered, where possible. The scale and final design of noise attenuation would be determined in consultation with the affected community, including the use of mounds, barrier height, barrier materials and use of landscaping. RMS will engage with the local community during design development and outcomes will feed into the detailed design. The existing landscape would be blended up to the edge of the highway and the noise barrier around North Street by reducing the steepness of the embankments. RMS will engage with the local community to gather feedback as the design develops, foster broader community support and ownership for the design outcome and facilitate integration of the project with the existing pedestrian access mobility plans (PAMP) for the township of Berry. Existing vegetation would be reinforced to integrate the bridge at Berry within the landscape. The bridge would be designed to achieve a simple structure with design elements that complements the surrounding landscape setting. The Kangaroo Valley Road bridge would be designed level with the surrounding land to provide continuity and to minimise the perceived severance between east and west Berry. This includes providing a wide bridge, with a landscaped verge between the shared path and carriageway on both sides of the bridge. While residual impacts can be minimised through design in consultation with the local community, connectivity and visual impacts to and from Berry, particularly around North Street, would remain.	Key issue	Section 7.6

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
		Poor integration with existing landform resulting from large embankments, cuttings and bridges. New structures within landscape would occur at Toolijooa Ridge, Kangaroo Valley Road, Broughton Creek and Berry bypass.	Reinforcing existing landscape patterns by integrating the highway with the existing landscape through design (such as by flattening the batters), would minimise the impact of the project on the visual landscape. Existing vegetation would be avoided, where possible. New vegetation would be integrated with the existing landscape character and vegetation communities. The urban and landscape design strategy would include measures to blend and extend the pastoral landscape to the edges of the carriageway. There would be residual impacts given that the project would add new structures into the landscape.	Key issue	Section 7.6
		The integration of local roads.	The transition points between the highway and local street networks would be clearly defined. Any modifications to local roads would be designed to ensure that they remain as local roads and operate independently and with minimal impact from the highway. There would be negligible residual impacts.	Key issue	Section 7.6
		Loss of and reduced access to recreational facilities.	There would be a permanent loss of recreational space at Mark Radium Park. The impact would be minimised by ensuring that the project is well integrated with the remaining recreational space. RMS would engage with the local community to gather feedback as the design develops, foster broader community support and ownership for the design outcome and facilitate integration of the project with the existing PAMP for Berry. Recreational and pedestrian and cyclist access along North Street and across the Kangaroo Valley Road overbridge would be maintained through the inclusion of shared pedestrian and cyclist facilities at these locations. There would be a residual impact due to the permanent loss of recreational park space.	Key issue	Section 7.6

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
Aboriginal cultural heritage	Yes	**Construction and operational risks**			
		Impact to recorded archaeological sites and potential archaeologically sensitive areas (PASAs).	Where possible, impact to recorded archaeological sites and PASAs would be avoided. If impact is likely, archaeological salvage actions would be conducted prior to impact. Subject to stakeholder agreement, salvaged material would be curated in culturally appropriate manner (this may include re-positioning into landscape following construction). Salvaged material would be listed on the RMS' section 170 register. Protocols for unanticipated archaeological finds and human remains would be adopted. Potential for residual impacts to non-salvaged artefacts remaining within the road easement.	Key issue	Section 7.7
		Impact on the ethno-historically recorded locations of Brookside historic encampment and 'Dicky Wood's meadow' battle ground (though the exact site location is not known).	Brookside encampment would be managed within the locality, in accordance with the management of archaeological recordings. Direct impact to natural soil profile in area of the battle ground would be minimised by adopting a construction methodology which minimises the disturbance to the natural soil profile. Where practicable, the removal of top soil would be avoided or minimised prior to the placement of fill. There remains some potential for encountering human remains within the general area of Dicky Woods Meadow battle ground. To effectively manage this potential, prior to the start of construction works, further and targeted archaeological salvage excavation would be conducted in areas of anticipated direct impact such as from pier, abutment and swale construction.	Key issue	Section 7.7
		Impact to cultural landscape values of Toolijooa Ridge (TRCL).	Impacts to cultural values would be minimised through mitigation measures such as minimising adverse visual impacts, re-establishing natural vegetation and minimising impact to wildlife corridor values. There would be residual impacts given that the upgraded highway would be a significant introduction to the cultural landscape.	Key issue	Section 7.7

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
		Impact to generalised cultural values associated with large and old growth fig trees.	Large and old-growth fig trees would be avoided (where possible), with fig species to be re-planted as part of a rehabilitation program where avoidance is not feasible.	Key issue	Section 7.7
Non-Aboriginal heritage	Yes	**Construction and operational risks**			
		Impact to specific heritage deposits.	Salvage actions and archival recordings would be conducted where disturbance to sites of heritage significance cannot be avoided. Potential for the permanent loss or damage of heritage items exists.	Key issue	Section 7.8
		Contextual impacts to existing structures.	Retain local heritage values by avoiding impact to local heritage structures and maintaining the visual amenity and landscape within which the items are set. The potential for a permanent loss of heritage value and visual amenity exists, should heritage items not be appropriately managed.	Key issue	Section 7.8
		Impacts to cultural landscapes.	Impacts to cultural landscapes, including the Southern Illawarra Coastal Plain and Hinterland, would be minimised by reducing visual amenity impacts. This would be in accordance with the urban and landscape design strategy. Residual impacts would include the upgraded highway being viewed as a structural intrusion into the local viewshed. This would permanently impact on the visual and cultural amenity of the project area and its surrounds.	Key issue	Section 7.8

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
		Direct impact to Federation cottage (G2B H11, 77 North Street, Berry) which is of moderate local significance.	Archival recording of the item would be completed prior to the commencement of construction. Residual impacts may include the permanent loss of a significant heritage item or the loss of heritage value to that particular item. These residual impacts could be minimised through archival recording of the item prior to the commencement of construction, monitoring of ground disturbance with the aim to record and recover any significant relics, recovering (in the event of demolition) suitable materials for reuse in local infrastructure (with commemorative identification) and making the property available to a third party for conservation or relocation within or near Berry.	Key issue	Section 7.8
Land use and property	Yes	**Construction and operational risks**			
		Construction related impacts on land use (ancillary facilities)	Land used for ancillary construction facilities to be rehabilitated at completion of construction. Negligible impacts remaining.	Key issue	Section 7.9
		The acquisition of 63.7 hectares of private and Council owned land.	Acquisition of land to be negotiated with the land owner in accordance with the provisions of the *Land Acquisition (Just Terms Compensation) Act 1991* and the Land Acquisition Information Guide (RTA, 2011). Agricultural land in excess of project needs to be repackaged and sold following the completion of the project. Residual land in Berry to be considered for community uses along North Street and the southern interchange for Berry. Negligible impacts remaining.	Key issue	Section 7.9

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
		Changes to property accesses and internal farm accesses	Changes to internal and external accesses to be negotiated with land owners during detailed design. Access to be maintained during construction. Consultation with and notification of property owners and the community regarding the construction schedule, changes to property accesses and changes to local roads. Negligible impacts remaining.	Key issue	Section 7.9
Socio-economic	Yes	**Construction risks**			
		Amenity impacts from construction activities, such as noise, dust and visual impacts.	Construction amenity impacts would be managed as per the traffic and transport, noise and vibration, and landscape character and visual amenity sections above, and the air quality section below. Mitigation measures would be incorporated into the CEMP. Given that impacts would be temporary in nature, residual impacts would be negligible.	Key issue	Section 7.10
		Alienation of sections of the community due to construction activities and locations, particularly within Berry.	Construction of the project would not involve any works within the centre of Berry. The most significant cohesion impacts would occur around Kangaroo Valley Road where temporary road closures would be required. Alternative routes would be required for any necessary road closures and the community would be regularly informed of construction activities. Road closures during construction would be temporary and residual impacts would be negligible.	Key issue	Section 7.10
		Construction traffic impacts, including, temporary disruptions and delays to local and highway traffic and temporary changes to access arrangements to local properties.	Alterations to traffic flow and access would be managed through the TMP. Where feasible and appropriate, a variable message sign would be used to communicate road changes to road users. The community consultation strategy would ensure that residents and road users are advised of any changes in a timely manner. Residual construction traffic impacts would be minimal given that they would be temporary in nature.	Key issue	Section 7.10

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
		Creation of construction jobs and the flow on effects to other businesses in the vicinity of the project.	Construction of the project would be a positive social and economic impact and therefore no mitigation measures have been proposed.	Key issue	Section 7.10
		Temporary loss of productive agricultural land for ancillary sites.	Land utilised for construction ancillary sites would be rehabilitated, consolidated and sold on completion of the project. Where possible, the sites would be returned to their original uses. There would be minor residual impacts where land cannot be reused for agricultural purposes following construction.	Key issue	Section 7.10
		Temporary impacts to recreational activities, including amenity impacts at parks and sports ground, temporary loss of recreational land and restricted fishing access.	Amenity impacts to users of recreational facilities would be managed as per the traffic and transport, noise and vibration, and landscape character and visual amenity sections above, and the air quality section below. Mitigation measures would be incorporated into the CEMP. Access to recreation areas such as Mark Radium Park and Berry sportsground would be maintained during construction. Ongoing discussions with Shoalhaven City Council and the Berry Riding Club would aim to identify a temporary site for the Berry Riding Club during the construction period. Construction impacts to recreational fishing would be managed in accordance with the mitigation measures presented in the aquatic ecology assessment. This would include managing sedimentation and pollution in order to minimise impacts to fish stocks and maintaining access to the existing Broughton Creek bridge throughout the construction period.	Key issue	Section 7.10
		Operational risks			
		Amenity improvements in Berry due to the removal of highway traffic from Queen Street.	Positive air quality and traffic impacts, therefore no mitigation measures have been proposed.	Key issue	Section 7.10

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
		Reductions in amenity, particularly around North Street and west Berry.	New permanent structures such as noise barriers, bridges, embankments and cuttings would have a permanent visual amenity impact. The visual prominence of these features would be reduced through design as discussed in Section 7.6 Landscape character and visual impact. While the prominence of these features would be reduced, a residual visual amenity impact would remain for these new structures. Noise attenuation strategies would be developed during detailed design. Residual noise impacts would be managed through architectural property treatments. Community consultation would continue throughout the detailed design and construction phases of the project to inform the community about mitigation measures to be implemented.	Key issue	Section 7.10
		Severance of communities, including property acquisition, severance of properties and reduced access to community and recreational facilities.	Community consultation and information sessions would aim to minimise any cohesion impacts experienced. Continued community consultation would develop a plan to maintain pedestrian access and cycle links over the proposed highway (along Kangaroo Valley Road), between Berry and west Berry. The risk of major incidents closing the sole access between Berry and west Berry via the Kangaroo Valley Road bridge would be managed with an incident response plan. There would be a residual impact of permanent property acquisition as well as the permanent severance of North Street, reducing pedestrian access between Berry and west Berry.	Key issue	Section 7.10
		Loss of productive agricultural land and impacts to the economic productivity and viability of agricultural properties.	Impacts to agricultural businesses would be managed through continued consultation with business owners. In accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*, where a property would be divided into two parts, a suitable, safe and economically justifiable means of connecting the portions of land would be considered and discussed with the property owner. There would be a residual impact of the loss of agricultural land where rural properties are fully acquired.	Key issue	Section 7.10

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference[1]
		Changes to local access arrangements and traffic movements, including increased travel times for local residents.	The RMS has discussed functional and safe access with individual property owners and consultation with affected property owners would continue during the detailed design process. There would be a residual impact of increased travel times for some residents, however this would be offset by improved road safety for all road users.	Key issue	Section 7.10
		Positive and negative impacts on local and regional businesses, including improved accessibility to markets and decreased turnover for highway-reliant businesses.	Negative impacts to local businesses would be managed through sign posting and traffic management to encourage highway traffic to visit Berry for a rest stop. There may be residual impacts for some highway-reliant businesses, however these would be mitigated through continued discussions with Shoalhaven City Council to assist in developing strategies to encourage the ongoing viability of businesses in the town and to encourage new businesses, for example, programs to enhance community areas and streetscapes.	Key issue	Section 7.10
		Impacts to recreational land and activities, including Mark Radium Park, Berry Sportsground, Camp Quality Memorial Park, the pony club and recreational fishing.	RMS would continue discussions with the Berry Riding Club and Shoalhaven City Council to establish a new location or facilities arrangement for the club. In consultation with the community, the buffer zone between North Street and the edge of the project would likely be set aside for use as a public open space following the construction of the project. Access to local creeks would be maintained where practicable. This would include the use of the existing Broughton Creek bridge, the use of parking bays for bridge maintenance workers and consultation with the Department of Primary Industries (DPI) - Fisheries on appropriate angler access signage and access infrastructure such as fence stiles.	Key issue	Section 7.10

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference
Other issues					
Geology and soils	No	**Construction and operational risks**			
		Erosion and sedimentation during and following earthworks including the construction of cuttings and embankments.	Erosion and sedimentation would be managed in accordance with the Blue Book 2 (Department of Environment and Climate Change (DECC), 2008) and follow the RMS Erosion and sediment management procedure (RTA 2008). Measures would be monitored and maintained. Operational sediment basins would be utilised during construction and operation. Where capacity is not sufficient during construction, construction only sediment basins, scour erosion controls and sediment capture devices would be implemented. The detailed design would ensure that cut and fill batters would satisfy the short and long-term stability requirements. Management measures that would be considered during detailed design would also include retaining structures and soil nailing where appropriate. There would be minimal residual erosion and sedimentation impacts following the implementation of appropriate management measures.	Other issue	Section 8.1
		Unearthing, disturbing or spreading contaminated soil.	It is expected that there would be a low to moderate likelihood of impacting contaminated land during construction. Impacts to potentially contaminated land would be minimised by reducing the disturbance to ground during construction. Residual impacts associated with the disturbance of contaminated areas of land would be managed through a remedial action plan, if the contamination is found to pose unacceptable risks to the environment or human health.	Other issue	Section 8.1

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference
		Exposing, disturbing or spreading acid sulfate soil.	Testing would be completed during detailed design and prior to construction to quantify the risk of disturbing PASS, particularly in areas of excavation. If PASS cannot be avoided, the disturbance of PASS would be managed through an acid sulfate soil management plan (ASSMP) which would provide procedures for storage, bunding, treatment, use and monitoring. The ASSMP would be developed in accordance with the Guidelines for the Management of Acid Sulfate materials: Acid Sulfate Soils, Acid Sulfate Rock and Monosulphidic Black Ooze (RTA 2005).	Other issue	Section 8.1
Air quality	No	**Construction risks**			
		The impact of dust (PM_{10} and total suspended particles) construction work on sensitive receivers. Sensitive receivers may also experience increased levels of carbon monoxide and nitrogen oxides from construction vehicles and equipment.	Standard air quality mitigation measures would be implemented through an air quality management plan. Mitigation measures would include road watering and sealing, wind breaks, vehicle and equipment maintenance, installation of truck wheel washes or other dust removal procedures and watering or revegetating stockpiles and exposed areas. On sites where there is a clear and unambiguous dust impact resulting from the construction of the project, management measures would include: • Disconnecting water tanks from roofing and maintaining water supply to properties using tanks. • Wash-down of the roof at the completion of dust generating works to ensure a clean roof for water supply and reconnection of the water tanks. Residual impacts would be negligible.	Other issue	Section 8.2

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference
		Operational risks			
		The impact of carbon monoxide, nitrogen oxides and particulate matter (PM_{10}) from increased vehicular traffic on sensitive receivers during operation of the upgraded highway.	Air quality impacts during the operation of the project would be minimal and therefore no mitigation measures have been proposed. Residual impacts would be negligible.	Other issue	Section 8.2
Hazard and risk	No	**Construction risks**			
		Impacts to human health and the environment resulting from the handling, storage and transport of hazardous substances.	The transport, storage, handling and use of hazardous construction materials would be undertaken in accordance with Occupational Health and Safety (OH&S) legislation and codes. Secure, bunded areas would be provided where materials are stored at the site. Protocols and equipment for incident response would be implemented. . Measures would be incorporated into the CEMP to address the specific risks associated with the transport of hazardous substances to and from work sites. There would be an inherent residual risk of impact, however with the implementation of management measures this would remain low. The potential impacts associated with higher quantities of hazardous materials (that exceed relevant thresholds) being present on site would be managed through the completion of a preliminary hazard analysis (PHA).	Other issue	Section 8.3
		Occupational health and safety hazards, such as dangers to construction workers and road users.	Site specific hazard and risk management plans would be prepared and implemented as part of the CEMP. These would include environmental risk management measures, contingency plans, site-specific OH&S plans and safe work method statements. There would be an inherent residual risk of impact, however with the implementation of management measures this would remain low.	Other issue	Section 8.3

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference
		Potential rupture or interference with underground services, in particular the Eastern Gas Pipeline.	Mitigation measures would include the completion of utility checks, consultation with the relevant service infrastructure providers and relocation and/or protection of utilities within the corridor prior to the commencement of construction. A safety management study would be prepared for construction work that crosses the Eastern Gas pipeline (in consultation with Jemena) to ensure there would be no impact to the pipeline. There would be an inherent residual risk of impact to human health and the environment.	Other issue	Section 8.3
		Operational risks			
		Accidental spills of dangerous goods as a result of vehicle collisions that would represent risks to human health or the environment.	Both permanent sedimentation basins and swales would provide capacity to treat first flush from the pavement surface and reduce the risk of spills discharging onto adjacent land or watercourses. There would be an inherent residual risk of impact, however with the implementation of management measures this would remain low.	Other issue	Section 8.3
Waste management	No	**Construction risks**			
		Inappropriate management of waste generated during construction of the project. This has the potential to adversely impact visual amenity and aesthetics, water quality and may proliferate and spread noxious weeds.	All wastes would be managed and disposed of in accordance with relevant State legislation and government policies. Standard work practices and internal RMS waste policies and specifications would be implemented during construction. A management strategy would be developed to limit the amount of excess spoil and to develop appropriate disposal methods. The project is likely to generate excess spoil which would require disposal.	Other issue	Section 8.4

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference
		Operational risks			
		Inappropriate management of waste generated during the operation and maintenance of the project.	Standard work practices and internal RMS waste policies and specifications would be implemented during routine maintenance and repair activities. Rubbish bins would be installed in the heavy vehicle rest area and litter collection activities would be implemented.	Other issue	Section 8.4
Greenhouse gas and climate change	No	**Construction and operational risks**			
		Release of greenhouse gases emissions during construction.	Standard procedures would be implemented to reduce greenhouse gas emissions associated with the use of carbon based fuels and energy sources, the removal of vegetation, and emissions resulting from the use of materials to construct the project. This would include, where feasible and reasonable, the use of fuel efficient plant and vehicles, the use of renewable energy sources, strategies to minimise resource consumption and strategies to recycle or use recycled materials.	Other issue	Section 8.5
		Release of greenhouse gases during operation (including maintenance).	Greenhouse gas emissions resulting from the use of the project by vehicles are predicted to reduce when compared to the road network in the absence of the project owing to improved vehicle fuel efficiencies from the enhanced road network design and travel time efficiencies. During detailed design, measures to reduce greenhouse gas emissions over the life of the project would be implemented, where reasonable and feasible. This includes the use of energy efficient street lighting, use of renewable energy sources for the variable message sign and heavy vehicle rest area. Strategies to minimise greenhouse gas emissions associated with future maintenance of the highway would be implemented at that point in time. These would be similar to strategies implemented during the construction of the project (eg use of recycled materials).	Other issue	Section 8.5

Issue	DGRs key issue?	Potential impacts	Analysis – Proposed mitigation measures and impacts remaining after their application.	Risk category prior to mitigation	EA reference
		Climate change impacts on the project.	A six per cent increase in rainfall intensity has been factored into peak flow estimates to account for likely climatic changes (increased rainfall). An adaptive approach would provide the most appropriate methodology for the management of future climate change. This would involve including climate change considerations in maintenance procedures, such as monitoring, review and maintenance of road surfaces and drainage structures.	Other issue	Section 8.5

[1] *Refers to relevant section of this environmental impact statement (EIS) where the issues are described in detail.*

10 Draft statement of commitments

This chapter outlines the draft statement of commitments (key actions) proposed by RMS to avoid, minimise, manage, mitigate, offset and/or monitor impacts identified in the environmental assessment. The RMS is committed to implementing the project as described in **Chapter 4**, inclusive of the mitigation measures outlined in **Chapter 7** and **Chapter 8**. The RMS intends to achieve the outcomes and key actions detailed in the draft statement of commitments (SoC). Any consortium or contractor involved in the design, construction and/or operation phases of the project would be required to undertake all works in accordance with these commitments.

Director-General's requirements	Where addressed
*A **draft Statement of Commitments (SoC).***	
The SoC must incorporate or otherwise capture all measures to avoid, minimise, manage, mitigate, offset and/or monitor the impacts of the project and the residual impacts.	Table 10.1

From an early stage, the environmental assessment considered the project's potential environmental issues and identified the desired environmental outcomes. This influenced how the concept design was developed and highlighted the management measures required to avoid or reduce environmental impacts.

The commitments, which are listed in **Table 10–1**, are designed to avoid, manage, mitigate, offset and/or monitor the environmental impacts of the project during pre-construction, throughout construction and into the operational phase. The table outlines the desired outcome, the actions that the RMS will undertake to achieve this outcome, and the timing (that is, when the commitment would be implemented). It is presented in a format that is readily auditable and transparent.

Table 10-1 Draft statement of commitments

Outcome	Ref #	Key action	Timing	Reference document
Environmental management				
Compliance and continuous improvement in environmental management.	M1	The head contractor for the project will have an ISO14001 accredited environmental management system.	Pre-construction and construction.	ISO 14001:2004 Environmental Management Systems – requirements with guidance for use. RMS QA specification G36 – environmental protection.
	M2	Suitably qualified and experienced personnel will develop, implement and regularly audit the project specific environmental management plans, procedures and training for all personnel.	Pre-construction and construction.	Guideline for the Preparation of Environmental Management Plans (Department of Infrastructure, Planning and Natural Resources (DIPNR) 2004). RMS QA specification G36 – environmental protection. All relevant RMS policies, specifications, guidance notes and environmental directions.
	M3	The environmental management plans and procedures will incorporate all necessary environmental management measures including those identified in Chapters 7 and 8 of the environmental assessment and, where appropriate, subsequent environmental management measures arising from the submissions report.	Pre-construction and construction.	Chapters 7 and 8 of the environmental assessment. Submissions Report Conditions of approval.
	M4	An environmental performance and compliance program will be prepared and maintained for the duration of the project to enable tracking and progressive reporting on achievement of stated commitments, compliance with conditions of approval and other regulatory or licensing aspects of the project.	Pre-construction, construction and operation, as required.	

Outcome	Ref #	Key action	Timing	Reference document
Community consultation				
The community is informed about the project.	C1	The community will be informed through: • Letter box drops, media releases and community updates. • An internet site established and maintained for the duration of the project. • The Berry project office • Email to registered stakeholders • Road signs (electronic and static). • Targeted consultation with affected individuals or groups. • Notification of the environmental assessment.	Pre-construction and construction.	Community Involvement and Communications. Draft: A resource manual for staff (RTA, June 2008). Community Involvement Plan.
	C2	Changes to property access will be negotiated with affected residents prior to the commencement of the relevant construction activity.	Pre-construction.	Community Involvement and Communications. Draft: A resource manual for staff (RTA, June 2008). Community Involvement Plan.
	C3	Affected residents will be informed of work outside of extended construction hours prior to the commencement of that work.	Pre-construction.	Community Involvement and Communications. Draft: A resource manual for staff (RTA, June 2008). Community Involvement Plan.
The community can make enquiries and complaints and will receive a timely response.	C4	The community will be able to make enquiries or complaints using the project's postal, email and web page addresses, the Berry project office or the project's business hours toll free number. These contact details will be publicised. All complaints will be acknowledged within 24 hours (or as otherwise specified in the Environment Protection Licence (EPL)), and tracked until resolved.	Pre-construction and construction.	Community Involvement and Communications. Draft: A resource manual for staff (RTA, June 2008). AS 4269 Complaints Handling. Community Involvement Plan. Environmental Protection Licence.

Outcome	Ref #	Key action	Timing	Reference document
Traffic and transport				
Construction traffic impacts on the highway and local traffic are minimised.	T1	A Traffic Management Plan (as part of the Construction Environmental Management Plan) will be developed to ensure traffic impacts are managed and minimised.	Pre-construction	
Continuous access to local roads will be provided.	T2	Construction staging will be planned to maintain access, in some capacity, to the local road network during the proposed road closures.	Pre-construction and construction.	RMS *Traffic Control at Work Sites* (RTA 2003). RMS QA Specification G10 Control of Traffic. *Community Involvement and Communications. Draft: A resource manual for staff* (RTA, June 2008). Section 7.1 of the environmental assessment.
Efficiency for highway users is improved once operational.	T3	Traffic levels and operational performance will be monitored six and 12 months after construction, particularly during peak periods.	Operation.	Section 7.1 of the environmental assessment.

Outcome	Ref #	Key action	Timing	Reference document
Noise and vibration				
Construction noise and vibration impacts are minimised.	NV1	A Noise and Vibration Management Plan (as part of the Construction Environmental Management Plan) will be developed to ensure noise and vibration impacts are managed and minimised.	Pre-construction	*Interim Construction Noise Guidelines 2009* (Department of Environment, Climate Change and Water (DECCW), 2009). RMS *Environmental Noise Management Manual* (RTA, 2001). NSW Government's *Environmental Criteria for Road Traffic Noise* (Environment Protection Authority (EPA) 1999). AS 2436-1981 Guide to noise control on construction, maintenance and demolition sites. *Technical Basis for Guidelines to Minimise Annoyance Due to Blasting Overpressure and Ground Vibration* (Australian and New Zealand Environment Conservation Council (ANZECC), 1990). *Assessing Vibration: A Technical Guideline* (Department of Environment and Conservation (DEC), 2006). German Standard DIN 4150 Part 3. Section 7.2 of the environmental assessment. Submissions report. Conditions of approval.

Outcome	Ref #	Key action	Timing	Reference document
	NV2	Construction would generally be confined to approved construction hours, including any extended working hours, which will be specified in the approved Construction Environmental Management Plan for the project. Specific exceptions identified within this Environmental Assessment would also be included for out of hours work for emergency situations, traffic safety and efficiency or safe transport of plant or materials. Specific out-of-hours work activities would be assessed on a case-by-case basis by the EPA.	Construction.	Section 7.2 of the environmental assessment.
	NV3	Potentially affected sensitive receivers will be given adequate prior notice of the construction program in accordance with the EPL, kept informed throughout the construction period, and provided with a 24-hour hotline number for complaints. A specific notification procedure will be developed for loud noise generating activities, extended hours or out-of-hours activity. Noise complaints will be dealt with through a standard complaints management procedure identified in the community involvement plan.	Construction.	Section 7.2 of the environmental assessment.
Operational noise impact is minimised.	NV4	Increases to operational noise above the Environment Protection Authority (EPA) base criteria at noise-sensitive receivers (modelled for up to 10 years after project opening) will be mitigated where feasible and reasonable. The mitigation measures will be developed in consultation with a qualified and experienced acoustic specialist and the affected property owner.	Pre-construction and construction.	NSW Government's *Road Noise Policy* (Office of Environment and Heritage (OEH), 2011). RMS *Environmental Noise Management Manual* (RTA, 2001). Section 7.2 of the environmental assessment.

Outcome	Ref #	Key action	Timing	Reference document
	NV5	Operational noise monitoring will be undertaken within one year of project opening in accordance with the RMS *Environmental Noise Management Manual* (RTA, 2001). If monitoring indicates a clear trend that traffic noise levels exceed those predicted, all feasible and reasonable measures will be investigated in consultation with a qualified and experienced acoustic specialist and the affected property owner.	Operation.	NSW Government's *Road Noise Policy* (OEH, 2011). RMS *Environmental Noise Management Manual* (RTA, 2001). Section 7.2 of the environmental assessment.
	NV6	Where feasible and reasonable, existing noise levels that are >65 dBA $_{Leq(15hr)}$ (day) and >60 dBA $_{Leq(9hr)}$ (night) at noise sensitive receivers will be mitigated using feasible and reasonable measures and in consultation with a suitably qualified and experienced acoustic specialist and the affected property owner.	Pre-construction and construction.	NSW Government's *Road Noise Policy* (OEH, 2011). RMS *Environmental Noise Management Manual* (RTA, 2001). Section 7.2 of the environmental assessment.
Biodiversity				
Minimise impacts on flora.	F1	A Flora and Fauna Management Plan and Vegetation Management Plan (as part of the Construction Environmental Management Plan) will be developed to ensure flora and fauna impacts are managed and minimised.	Pre-construction	Chapter 7.3 of the environmental assessment. Submissions Report. Conditions of Approval.
	F2	Prior to construction, areas containing river flat eucalypt forest will be identified and marked. Disturbance will be limited to areas specified for removal and all other areas will be avoided.	Pre-construction and construction.	Chapter 7.3 of the environmental assessment.
	F3	Ancillary facilities and stockpile sites will be located at least 50 metres away from sensitive areas and stockpiling materials on adjacent vegetation will be avoided.	Pre-construction and construction.	Section 7.3 of the environmental assessment.

Outcome	Ref #	Key action	Timing	Reference document
Minimise impacts on fauna.	F4	A suitably qualified and experienced ecologist will conduct a pre-clearance fauna survey prior to any clearing of native trees. Habitat trees and nests will be identified marked and retained where possible. Clearing and felling procedures will be implemented to reduce the risk of injury to any nesting fauna. An ecologist will be present to supervise the removal of hollow bearing trees.	Pre-construction and construction.	Section 7.3 of the environmental assessment. *RMS Biodiversity Guidelines:* Guide 1 - Pre-clearing process for fauna rescue associated with road works (RTA, 2011). RMS *Biodiversity Guidelines*: Guide 4 - Clearing of vegetation and removal of bushrock (RTA, 2011) DEC (2004) Threatened species survey and assessment: Guidelines for developments and activities (working draft).
	F5	Natural and artificial habitat features, such as bat roost and nest boxes, will be installed to replace hollow-bearing trees that are removed.	Pre-construction and construction.	Section 7.3 of the environmental assessment. *RMS Biodiversity Guidelines:* Guide 8 - Nest Boxes (RTA 2011) Threatened species survey and assessment: Guidelines for developments and activities (working draft).
Minimise impacts on wildlife corridors and connectivity.	F6	Fauna mitigation structures, such as fauna underpasses, fauna overpasses and fauna fencing will be provided as detailed in Section 7.3. These structures will be designed to assist the safe passage of fauna underneath or over the highway.	Pre-construction, construction and operation.	Section 7.3 of the environmental assessment.
	F7	Riparian vegetation will be retained, where possible, under bridges, at temporary creek crossing sites, adjacent to ancillary sites and in the vicinity of rope bridges. Roadside vegetation will be retained in the vicinity of rope bridges.	Pre-construction, construction and operation.	Section 7.3 of the environmental assessment.

Outcome	Ref #	Key action	Timing	Reference document
Manage pest and weed species.	F8	Weed and pest species will be proactively managed throughout the project, and training will be provided to staff.	Pre-construction, construction and operation.	Section 7.3 of the environmental assessment. *RMS Biodiversity Guidelines:* Guide 6 - Weed management (RTA, 2011). *RMS Biodiversity Guidelines:* Guide 10 – Aquatic habitats and Riparian Zones (RTA 2011). *Noxious Weeds Act 1993.*
Minimise impacts on water quality and aquatic ecology.	F9	Erosion and sediment control measures will be implemented. These will include scour protection and water quality basins.	Pre-construction, construction and operation.	Section 7.3 and 7.4 of the environmental assessment.
Minimise alterations to natural flow regimes and impacts on fish passage.	F10	Permanent and temporary waterway crossings will be designed and constructed in accordance with the fish habitat classification of each waterway.	Pre-construction and construction.	Why do fish need to cross the road? Fish passage requirements for waterway crossings (NSW Fisheries, DPI, 2003)
Offset residual vegetation loss.	F11	A biodiversity offset package will be developed in accordance with the biodiversity offset strategy and in consultation with OEH and DTIRIS. The area of restoration would be guided by a simulated assessment of the project impacts and potential offsets using the BioBanking Assessment Methodology with a minimum of 2:1 for riparian vegetation to meet DTIRIS requirements. A simulated BioBanking assessment undertaken for the project determined that native vegetation removed would be offset at an average ratio of 5.3:1 in order to achieve the ‘improve or maintain’ standard.	Pre-construction.	Section 7.3 and Appendix F of the environmental assessment.

Outcome	Ref #	Key action	Timing	Reference document
Monitor the effectiveness of flora and fauna management and mitigation measures.	F12	Undertake bi-annual monitoring of nest boxes and bat roost boxes by a qualified and licensed ecologist during construction and annual monitoring for a period of three years post completion of construction with the provision to review the continuation and/or frequency of monitoring after the completion of three years monitoring Undertake bi-annual monitoring of dedicated fauna underpasses and rope bridges (using equipment such as remote cameras) by a qualified and licensed ecologist for a period of three years post completion of construction with the provision to review the continuation and/or frequency of monitoring for a further two years in the event a negative impact on species is detected. Conduct regular checks of fauna fencing to identify and fix any damage. Conduct road kill monitoring during operation of the project over a 12 month period at weekly intervals. The monitoring would include a record of the species (if possible) and the GPS location.	Operation.	Section 7.3 of the environmental assessment. RMS Biodiversity Guidelines (RTA 2011).
Surface water and groundwater				
Minimise water quality impacts during construction and operation.	SG1	Detailed design will confirm the configuration and location of water quality basins, swales and biorentention systems at sensitive receiving environments to ensure that the project water quality design criteria are achieved in response to any design refinements.	Pre-construction.	*Managing Urban Stormwater: Council Handbook* (EPA, 1998). Section 7.4 of the environmental assessment.

Outcome	Ref #	Key action	Timing	Reference document
Minimise water quality impacts and impacts to the flow regimes of Town Creek and Bundewallah Creek.	SG2	During detailed design, the design and revegetation strategy of the Town Creek diversion will include measures to maintain flushing efficiency and to mitigate erosion risk at the connection with Bundewallah Creek. The design of the diversion would be finalised in consultation with OEH, DPI (Fisheries), the NSW Office of Water (NOW) and effected landowners.	Pre-construction.	Section 7.4 of the environmental assessment.
Minimise impacts on farm dams.	SG3	Detailed design will verify if there might be any potential permanent losses to farm dam catchments, in consultation with affected landowners and investigate reasonable and feasible options to mitigate possible impacts.	Pre-construction.	Section 7.4 of the environmental assessment.
Minimise impacts on groundwater levels.	SG4	As the detailed design progresses any potential for changes in the groundwater table and any resulting impacts will be reviewed in response to any design refinements. Where necessary, measures to manage the changes will be designed and implemented during construction and operation.	Pre-construction, construction.	*NSW State Groundwater Quality Protection Policy* (Department of Land and Water Conservation (DLWC), 1998). *(Draft) NSW State Groundwater Quantity Management Policy* (DLWC, n.d.). Section 7.4 of the environmental assessment.
	SG5	The need for dewatering and groundwater monitoring program(s) will be reviewed as the detailed design is refined, and appropriate discharge and treatment strategies for construction activities will be prepared, if required.	Pre-construction, construction.	*NSW State Groundwater Quality Protection Policy* (DLWC, 1998). *(Draft) NSW State Groundwater Quantity Management Policy* (DLWC, n.d.). *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC, 2000). Section 7.4 of the environmental assessment.

Outcome	Ref #	Key action	Timing	Reference document
Maximise water efficiency and minimise water quality impacts.	SG6	A Soil and Water Management Plan (as part of the Construction Environmental Plan) will be developed to ensure water resources are used in the most efficient manner with a focus on achieving water savings, targeting water recycling and re-use and appropriate use of treated effluent, where feasible.	Pre-construction, construction.	TIP Sheet – Use of Reclaimed Water TO10 (RTA, December 2006). The National Guidelines for Water Recycling: Managing Health and Environmental Risks (Natural Resource Management Ministerial Council et al, 2006). Section 7.4 of the environmental assessment.
Flooding				
Minimise impacts of ancillary facilities.	F1	Ancillary chemical storage facilities will be located above the 1 in 100 year flood level.	Construction.	Section 7.5 of the environmental assessment.
	F2	Sites for ancillary facilities will satisfy the criteria provided in Chapter 4 of the environmental assessment unless otherwise approved through the CEMP.	Construction.	Section 7.5 of the environmental assessment. *Stockpile Site Management Procedures* (RTA, 2011).
	F3	A weather monitoring and response program will be considered to proactively respond to major weather events.	Construction.	Section 7.5 of the environmental assessment.
Minimise changes in current flow regimes.	F4	Waterway structures will be designed to maintain existing flow regimes, where possible.	Pre-construction, construction and operation.	Section 7.5 of the environmental assessment.
Manage the impacts associated with changes to flooding and drainage.	F5	Detailed design will seek to further minimise any increase in the peak flood levels in the 1 in 100 year flood event.	Pre-construction.	Section 7.5 of the environmental assessment.
	F6	Any potential increases in flood levels at Berry in the 1 in 100 year flood event that result from the construction of the project will be verified in response to any design refinements as the detailed design is developed and necessary mitigation will be implemented in consultation with landowners, where relevant.	Pre-construction.	Section 7.5 of the environmental assessment.

Outcome	Ref #	Key action	Timing	Reference document
	F7	Stock refuge will be maintained at Broughton Creek bridge 2 and will be determined during detailed design in consultation with landowners.	Pre-construction, construction and operation.	Section 7.5 of the environmental assessment.
Minimise impacts on channel structure.	F8	In response to any design refinements, the development of the detailed design will include ongoing consideration to limit impacts on overland flow paths at the embankment between Broughton Creek bridge 2 and Broughton Creek bridge 3, and upstream and downstream channel structures, including the Town Creek diversion (eg through culvert sizing, energy dissipation measures, scour protection and other design features to control flow intensity and direction).	Pre-construction, construction and operation.	Section 7.5 of the environmental assessment.
	F9	Stream bank/bed erosion controls will be installed and maintained in accordance with the provisions of the 'Blue Book'.	Pre-construction, construction and operation.	Managing Urban Stormwater – Soils and Construction Volume 1 (Landcom, 2004). Managing Urban Stormwater – Soils and Construction, Volume 2D – Main Road Construction (DECCW, 2008).
Landscape character and visual amenity				
Community acceptance, support for and ownership of the design of the project are maximised.	LVA1	Continued engagement with the local community to gather feedback as the design develops with consideration for the urban and landscape design strategy for the project.	Pre-construction.	Community Involvement and Communications. Draft: A resource manual for staff (RTA, June 2008). Section 7.6 of the environmental assessment.
Loss of pedestrian and cyclist amenity is minimised and the project integrates with existing pedestrian access mobility plans (PAMP) for Berry.	LVA2	Continued engagement with the local community to gather feedback as the design develops and facilitate integration of the project with the existing PAMP for Berry.	Pre-construction.	Existing PAMP for Berry. Community Involvement and Communications. Draft: A resource manual for staff (RTA, June 2008). Section 7.6 of the environmental assessment.

Outcome	Ref #	Key action	Timing	Reference document
Landscape character and visual amenity impacts associated with major elements of the project are minimised.	LVA3	The detailed design will be developed with reference to the minimum reference design requirements and the findings of the CM+ Urban Design Study for the following project components: • All bridges within the project, with consideration of the Bridge Aesthetics Design Guidelines (RTA 2003). • Embankments across Broughton Creek west of Toolijooa Ridge. • Noise attenuation measures along the length of the project.	Pre-construction.	Bridge Aesthetics Design Guidelines (RTA 2003). Noise Wall Design Guideline (RTA 2006). Section 7.6 of the environmental assessment.
Visual amenity impacts during construction are minimised.	LVA4	Construction areas will be clearly identified to reduce the extent of vegetation requiring removal. Soil that has been stripped, stockpiled and/or reinstated as part of the construction works will be appropriately managed.	Pre-construction and construction.	RMS QA Specification G40 Clearing and Grubbing. RMS QA Specification R178 Vegetation. RMS QA Specification R179 Landscape Planting. Section 7.6 of the environmental assessment.
Aboriginal cultural heritage				
Aboriginal sites to be avoided are protected from impact.	AH1	A Heritage Management Plan (as part of the Construction Environmental Management Plan) will be developed to ensure heritage impacts are managed and minimised.	Pre-construction	Section 7.7 of the environmental assessment. Submissions Report. Conditions of approval.
	AH2	Aboriginal sites to be avoided will be fenced and signposted as exclusion zones before and during any works in the vicinity.	Pre-construction and construction.	Section 7.7 of the environmental assessment.
	AH3	Disturbance to the natural soil profile of G2B A13 and G2B A14 will be avoided, where possible.	Pre-construction and construction.	Section 7.7 of the environmental assessment.

Outcome	Ref #	Key action	Timing	Reference document
	AH4	All construction personnel will receive training in the management of Aboriginal cultural materials, including legal obligations, the application of protocols and the recognition of Aboriginal cultural materials.	Pre-construction and construction.	Section 7.7 of the environmental assessment.
Any unknown Aboriginal objects and/or places encountered are assessed.	AH5	If skeletal remains or unknown Aboriginal objects or places are encountered, all works that would potentially impact the find will stop immediately. Works will not re-commence until appropriate clearance has been received or as determined through the implementation of the Unexpected Finds Procedure (RMS, 2012).	Construction.	*National Parks and Wildlife Act 1974.* RMS *Unexpected Heritage Finds Procedure.* *Environmental Planning and Assessment Act 1979.* Skeletal remains - Guidelines for the management of human skeletal remains under the *Heritage Act 1977* (NSW Heritage Office, 1998).
	AH6	Should previously unidentified Aboriginal objects or items be located during the works, all work will cease in the vicinity of the find until specialist Aboriginal heritage advice is received.	Construction.	*National Parks and Wildlife Act 1974.* RMS *Unexpected Heritage Finds Procedure.* *Environmental Planning and Assessment Act 1979*.
Non-Aboriginal (historic) heritage				
Impacts to Non-Aboriginal heritage items are avoided or minimised.	H1	Non-Aboriginal heritage items to be avoided that are located inside the construction footprint will be fenced and signposted as exclusion zones before and during any works in the vicinity.	Pre-construction and construction.	Chapter 7.8 of the environmental assessment.

Outcome	Ref #	Key action	Timing	Reference document
	H2	An archival recording of Glen Devan (G2B H11) and its grounds will be conducted prior to the commencement of construction. This recording would include documentation of construction methods and materials exposed during any demolition works. The RMS would remain open to the possibility of a third party or agent proposing to conserve all or part of the G2B H11 structure by moving it to a new location within or near Berry, at that party's expense. RMS would seek third parties who may be interested in conserving all or part of the G2B H11 structure(s). If no interested third party or agent is identified, it would be demolished. In the event of demolition, recover and reuse (with commemorative identification) suitable demolition material in appropriate local, infrastructure such as interpretive or entrance features, way-side stop facilities, landscaping or artwork.	Pre-construction.	Chapter 7.8 of the environmental assessment.
Any unknown non-Aboriginal heritage encountered is assessed.	H3	If any unknown non-Aboriginal heritage items are encountered, all works that would potentially impact the find will stop immediately. Works will not recommence until appropriate clearance has been received or as determined through the implementation of the Unexpected Finds Procedure (RMS, 2012).	Pre-construction and construction.	*Heritage Act 1977.* RMS *Unexpected Heritage Finds Procedure.* *Environmental Planning and Assessment Act 1979.*

Outcome	Ref #	Key action	Timing	Reference document
Archival records are prepared and made available to the public.	H4	Prior to any actual impact, an archival record will be prepared for any directly impacted item. Copies will be kept in the RMS library and distributed to the Kiama library and Shoalhaven library (Nowra branch).	Pre-construction.	*How to prepare archival records of heritage items* (NSW Heritage 1998). Chapter 7.8 of the environmental assessment.
Land use and property				
Appropriate compensation will be paid for property acquisition.	P1	Negotiation for all property acquisitions will be in accordance with the RMS' *Land Acquisition Information Guide* (RTA, 2011) Compensation assessment will be in accordance with the *Land Acquisition (Just Terms Compensation) Act 1991*.	Pre-construction.	*Land Acquisition Information Guide* (RTA, 2011). *Land Acquisition (Just Terms Compensation) Act 1991.* Section 7.9 of the environmental assessment.
Property access will be maintained.	P2	Property access will be maintained during construction. If temporary or alternative access is required, it will be provided in consultation with the affected landowner/s.	Construction.	*Community Participation and Communications. A Resource Manual for Staff* (RTA, 2010). Section 7.9 of the environmental assessment.
Socio-economic impact				
Minimise impacts on agricultural businesses.	S1	Ongoing consultation with affected agricultural business owners will be undertaken. RMS will acquire properties in accordance with *Land Acquisition (Just Terms Compensation) Act 1991*. Impact on business is considered in accordance with this Act..	Pre-construction, construction and operation.	Community Involvement and Communications. Draft: A resource manual for staff (RTA, June 2008). Community involvement plan. Land Acquisition Information Guide (RTA, 2011). Land Acquisition (Just Terms Compensation) Act 1991.

Outcome	Ref #	Key action	Timing	Reference document
Minimise impacts on tourism and highway reliant businesses.	S2	Sign posting and traffic management to encourage highway traffic to visit Berry for a rest stop will be provided. Continued discussions with Shoalhaven City Council will be held to assist in developing strategies to encourage the ongoing viability of businesses in the town and to encourage new businesses.	Pre-construction, construction and operation.	Community Involvement and Communications. Draft: A resource manual for staff (RTA, June 2008). Community involvement plan.
Maintain access and connectivity to local roads, properties and between Berry and west Berry during construction and operation.	S3	Through the implementation of the Traffic Management Plan and the Community Involvement Plan, residents and road users will be advised in a timely manner before any changes to local road or property accesses are implemented. Functional and safe access will be provided to all local roads and properties in the study area.	Pre-construction, construction and operation.	Community involvement plan. Traffic management plan.
Minimising amenity impacts during construction.	S4	Implementation of the Construction Environmental Management Plan (CEMP) which will include: • Notifying residents prior to undertaking noisy activities. • Establishment of a 24 hour hotline and complaints process. • Avoiding vegetation clearance where possible and progressively revegetating areas to minimise visual impacts.	Pre-construction and construction.	Construction noise and vibration management plan. Air quality management plan. Erosion and sedimentation management plan.

Outcome	Ref #	Key action	Timing	Reference document
Minimising amenity impacts during operation.	S5	Noise barriers will be constructed in the vicinity of North Street and Huntingdale Park Road. Architectural treatments will be provided for 16 properties (subject to confirmation during detailed design). The management measures outlined in Section 7-6 and Appendix I will be implemented to minimise the visual impact of the project.	Operation.	Operational noise and vibration management plan. Urban and landscape design strategy.
Minimising impacts to recreational facilities during construction and operation.	S6	Access to recreational facilities will be maintained during construction and operation of the project, where practicable. Negotiations will be conducted with Berry Riding Club and Shoalhaven City Council to determine a new location for Berry Riding Club, and the two smaller riding clubs (where impact is likely), and if necessary to determine a temporary location during construction. Access to local creeks, including access to the existing Broughton Creek bridge will be maintained during construction and operation to provide access for recreational fishers.	Pre-construction, construction and operation.	Community Involvement and Communications. Draft: A resource manual for staff (RTA, June 2008). Community involvement plan. Traffic management plan.
Geology and soils				
Potential for erosion and sedimentation is minimised.	GS1	The area of soil exposure and disturbance will be restricted to the minimum amount necessary for construction.	Construction.	RMS QA Specification G40 Clearing and Grubbing.
	GS2	Detailed design will refine the requirements for construction erosion and sediment control, including the requirements for works within and adjacent to waterways.	Pre- construction and construction.	Section 8.1 of the environmental assessment. Erosion and Sedimentation Management Procedure (RTA, 2008).

Outcome	Ref #	Key action	Timing	Reference document
	GS3	Management measures will be designed and installed in consultation with a soil conservation specialist for areas of high risk of erosion and sedimentation.	Pre- construction and construction.	Section 8.1 of the environmental assessment. Erosion and Sedimentation Management Procedure (RTA, 2008). Managing Urban Stormwater – Soils and Construction Volume 1 (Landcom, 2004). Managing Urban Stormwater – Soils and Construction, Volume 2D – Main Road Construction (DECCW, 2008).
Effective erosion and sediment control measures	GS4	Monitoring of water quality upstream and downstream of the project site will be undertaken before and during construction, in accordance with the EPL. This monitoring will assess the effectiveness of impact mitigation and management strategies. Implementation of additional feasible and reasonable management measures will then occur, if found to be necessary.	Pre- construction and construction.	Section 8.1 of the environmental assessment. Erosion and Sedimentation Management Procedure (RTA, 2008). Managing Urban Stormwater – Soils and Construction Volume 1 (Landcom, 2004). Managing Urban Stormwater – Soils and Construction, Volume 2D – Main Road Construction (DECCW, 2008). RMS QA Specification G38 Soil and Water Management. RMS QA Specification G39 Soil and Water Management (Erosion and Sediment Control Plan).
Acid sulfate soils (ASS) to be avoided are protected.	GS5	Areas of ASS to be avoided will be fenced and signposted as exclusion zones before and during any works in the vicinity.	Pre- construction and construction.	Section 8.1 of the environmental assessment. Guidelines for the Management of Acid Sulfate materials: Acid Sulfate Soils, Acid Sulfate Rock and Monosulfidic Black Ooze (RTA 2005).

Outcome	Ref #	Key action	Timing	Reference document
Impact of exposing acid sulfate soils is minimised.	GS6	Exposed ASS will be neutralised and protected from surface run-on. Any acid runoff or acid material will be contained and treated.	Pre-construction and construction.	Section 8.1 of the environmental assessment. Guidelines for the Management of Acid Sulfate materials: Acid Sulfate Soils, Acid Sulfate Rock and Monosulfidic Black Ooze (RTA 2005). Protection of the Environment and Operations Act 1997.
Impact of exposing unforseen occurrences of contaminated soils is minimised.	GS7	Targeted soil contamination investigations will be undertaken during detailed design, if required. A Remedial Action Plan will be developed if contamination is found to pose unacceptable risks to the environment and human health.	Pre-construction and construction.	Section 8.1 of the environmental assessment. Contaminated Land Management Guideline (RTA 2005).
Air quality				
Dust generation and impact to sensitive receivers is minimised.	AQ1	Appropriate dust suppression measures including stabilising disturbed areas and watering unsealed roads and stockpiles, providing wind breaks, controlling truck speeds and movements on site to designated roadways and maintaining construction equipment will be implemented during construction. Dust generating activities will stop when and as required under the EPL.	Construction.	Section 8.2 of the environmental assessment.
Air quality environmental management measures are effective.	AQ2	Monitoring will be undertaken monthly to assess the effectiveness of the air quality environmental management measures. Where required, additional feasible and reasonable environmental management measures will be used.	Pre-construction and construction.	Section 8.2 of the environmental assessment. AS 3580.10.1-1991 Methods of Sampling Analysis of Ambient Air. DECC guideline Approved Methods for Modelling and Assessment of Air Pollutants in New South Wales (August 2005). AS 2922 Ambient Air Guide for Siting of Sampling Equipment.

Outcome	Ref #	Key action	Timing	Reference document
Hazard and risk				
Risk of an incident during construction is minimised.	HR1	During construction, bunds will isolate hazardous liquids and materials.	Pre-construction and construction.	Section 8.3 of the environmental assessment. AS 1940 The Storage and Handling of Flammable and Combustible Liquids.
	HR2	Appropriate controls will be put in place for all hazardous and potentially contaminating activities to prevent contamination of watercourses.	Construction.	Section 8.3 of the environmental assessment.
	HR3	All work health and safety measures will be in accordance with relevant legislation.	Construction.	Section 8.3 of the environmental assessment. *Work Health and Safety Act 2011.* Work Health and Safety Regulation.
Impacts to the eastern gas pipeline are to be avoided.	HR4	Protection measures for the eastern gas pipeline and suitable construction methods when working in the vicinity of the pipeline will be implemented in consultation with Jemena.	Pre-construction and construction.	Australian Standard AS 2885.1-2007 Pipelines – Gas and liquid petroleum – Design and Construction.
Hazards and risks during operation are minimised.	HR5	Permanent water quality basins will be designed during the detailed design phase to protect waterways from spills.	Operation.	Section 8.3 of the environmental assessment.

Outcome	Ref #	Key action	Timing	Reference document
Waste management				
Waste disposal is minimised.	WR1	Waste management will follow the waste hierarchy. The generation of waste will be avoided. Waste materials will be recovered and re-used on-site or alternative re-use arranged wherever feasible and reasonable. Disposal will be a last resort.	Construction.	*Waste Avoidance and Resource Recovery Act, 2001.* *Protection of the Environment and Operations Act, 1997.* Waste Avoidance and Resource Recovery Strategy (DECC 2006). NSW Government's Waste Reduction and Purchasing Policy. DECC (1999) Environmental guidelines – assessment, classification and management of liquid and non-liquid waste. RTA Stockpile Management Procedures 2001.
Greenhouse gas and climate change				
Minimise greenhouse gas emissions and energy consumption	GC1	Wherever feasible and reasonable, detailed design will consider whole of life reductions in greenhouse gas emissions and energy consumption.	Pre-construction and construction.	Section 8.5 of the environmental assessment. AS/NZS 1158:1.1.2005.
	GC2	Energy efficient work practices, including selection of materials and equipment, will be adopted to minimise energy use and greenhouse gas emissions associated with construction and ongoing maintenance where feasible and reasonable.	Pre-construction, construction and operation.	Section 8.5 of the environmental assessment.
	GC3	The use of renewable energy sources required to operate the Variable Message Signs would be investigated during detailed design phase.	Pre-construction and construction.	Section 8.5 of the environmental assessment.

Outcome	Ref #	Key action	Timing	Reference document
Ancillary facilities				
Impacts of ancillary facilities are minimised	AF1	Sites for ancillary facilities will satisfy the criteria provided in Chapter 4 of the environmental assessment unless otherwise approved through the CEMP.	Pre-construction and construction	Section 4.4.7 of the environmental assessment

11 Justification and conclusion

This chapter presents a justification of the project and a conclusion to the environmental assessment. It considers a range of issues including project benefits, protection of the environment, the objects of the EP&A Act, including ecologically sustainable development and community consultation. The Director-General's requirements (DGRs) for the project justification shown in the extract below are also addressed in this chapter.

Director-General's requirements	Where addressed
Project justification:	
Assess the alternatives considered (including an assessment of the environmental costs and benefits of the project relative to alternatives). and provide justification for the preferred project taking into consideration the objectives of the Environmental Planning and Assessment Act 1979 and the following:	Section 11.1 Chapter 3
The environmental, social and economic impacts of the project.	Section 11.1.1
The suitability of the site.	Section 11.1.1
Whether or not the project is in the public interest.	Section 11.1.1

11.1 Justification

11.1.1 Summary of strategic and project justification

The strategic need for the project stems from the importance of the Princes Highway in providing safe and efficient access, including freight access, to the NSW south coast. The project would form part of the Princes Highway upgrade goal of providing four lanes from Waterfall to the Jervis Bay Road Junction, Falls Creek.

The objectives of the project are consistent with the relevant strategic planning and policy frameworks, including the *National Road Safety Strategy for Australia 2011 – 2020* (Australian Transport Council, 2011), *NSW 2012 – A Plan to Make NSW Number One* (Department of Premier and Cabinet, 2011), the draft *NSW Long Term Transport Master Plan* (Transport for NSW, 2012), the *Illawarra Regional Strategy 2006-2031* (Department of Planning (DP&I), 2007a), the *South Coast Regional Strategy 2006-2031* (DP&I, 2007b) and *Shoalhaven – An Enterprising Alternative, an Economic Development Strategy* (Shoalhaven City Council et al, 2005). The project objectives are:

- *To improve road safety*

  The project would significantly improve road safety. Steep and winding sections of the existing highway would be eliminated. The provision of two lanes in each direction and climbing lanes on steeper sections would improve overtaking safety. The median barrier would eliminate the potential for head-on crashes. The provision of grade separated interchanges for main highway accesses and enhanced left-in left-out treatments on all other junctions would reduce the frequency of conflicting turning movements. The removal of highway traffic from within Berry would reduce conflict between pedestrians and vehicles and would facilitate turning movements on and off Queen Street.

  Improvements to regional road safety would also be expected as the project would reduce the volume of regional traffic using the Sandtrack as an alternative route. Decreased traffic volume on the Sandtrack would deliver safety benefits and amenity improvements to road users and the communities located alongside it.

- *To improve efficiency of the Princes Highway between Toolijooa Road and Schofields Lane*

  The improved horizontal and vertical alignments for the project would significantly improve road efficiency. Traffic would be able to maintain the posted speed limit, reversing the trend of falling average travel speeds associated with ongoing traffic growth. The provision of two lanes in each direction and climbing lanes on steeper sections significantly improves overtaking opportunities. The provision of grade separated interchanges for main highway accesses and enhanced left-in left-out treatments on all other junctions would improve the efficiency of all movements on and off the highway. A bypass of Berry would eliminate the need for a reduced speed zone.

- *To support regional and local economic development*

  The project would enhance potential business opportunities in the area by improving connectivity to the NSW south coast. It would facilitate improved access to the existing tourism industry at Jervis Bay, Batemans Bay and Ulladulla. Industries in the Nowra area would benefit from more reliable access to markets and raw materials in the Sydney and Wollongong areas.

  Without the project, longer travel times and congestion within Berry would have economic consequences on local businesses, industry and tourism. Increased commuting times would hinder employment growth in the region, and recreational travellers would become less inclined to accept the time and cost associated with travelling through the area.

  The impacts on high quality agricultural land would be minimised and the proximity of interchanges close to Berry would facilitate access to the central business district.

- *To provide value for money*

  The value management workshop undertaken for the project ensured that value for money was a key consideration when assessing the alignment and design of the project.

- *To enhance potential beneficial environmental effects and manage potential adverse environmental impacts*

- Key environmental benefits of the project include reduced noise levels, improved air quality and amenity within Berry, improved flood outcomes in Berry due to the diversion of Town Creek and improved fauna crossings along the length of the project.

  Potential adverse environmental impacts would be managed through the mitigation measures presented in **Chapter 7** and **Chapter 8**. Residual impacts remaining after the implementation of these mitigation measures, such as the unavoidable removal of an Endangered Ecological Community (EEC), would be offset in accordance with an agreed offset strategy.

- *To optimise the benefits and minimise adverse impacts on the local social environment*

  Benefits to the local social environment would include improved road safety and highway efficiency, reduced conflict between highway traffic and pedestrians within Berry, enhanced public space and pedestrian/cycle access within Berry, and improved and more reliable access to larger regional centres such as Wollongong.

  Adverse social impacts for the project, such as changed access, community cohesion impacts and impacts on recreational facilities, have been minimised through the design of the project and would be managed through the mitigation measures provided in **Chapter 7** and **Chapter 8**.

Environmental, social and economic impacts

Consideration of the environmental, social and economic impacts of the project has been fundamental to the design process. As far as possible, impacts have been avoided.

A detailed assessment of the impacts of the project is provided in **Chapter 7** and **Chapter 8**. An environmental risk assessment was prepared to ensure that all potential impacts were addressed. The environmental risk assessment is presented in **Chapter 9** and the key impacts are summarised below.

Traffic and transport

Construction activities would disrupt highway, regional and local flows, leading to travel time delays and decreased network performance as discussed in **Section 7.1**. To mitigate these impacts, a traffic management plan would be prepared and would include guidelines and procedures to ensure the continuous, safe and efficient movement of construction and non-construction traffic in and around the project area during construction.

Following construction, the project would reduce the length of the highway by around 1.5 kilometres between Toolijooa Road and Schofields Lane. The project would provide two lanes in each direction and would increase the safe operating speed of the Princes Highway in the project area. It would bypass the Foxground bends and remove conflicts between local traffic movements within Berry. It would result in the Princes Highway having an estimated seven minute shorter travel time for vehicles travelling between Toolijooa Road and Schofields Lane.

Local roads and accesses in rural areas would be restricted to left-in and left-out movements due to a central median and safety barrier fencing. This would provide substantial improvements in road safety, including the elimination of traffic turning to and from minor roads across fast-moving two-way traffic. However, there would be an additional travel time resulting from vehicles travelling to interchanges in order to complete a u-turn. The maximum additional travel time would be around four minutes.

Some local roads would also be modified as part of the project and this would result in some redistribution of local road traffic with associated minor increases in travel times for some vehicles wishing to access the highway.

Noise and vibration

During construction of the project, noise and vibration impacts would arise from construction plant, equipment, traffic and activities (refer to **Section 7.2**). Impacts, including sleep disturbance, would be expected from extended work hours and out-of-hours work. Vibration impacts on buildings and/or human comfort would also arise, especially as a result of blasting activities at Toolijooa Ridge. To mitigate these impacts, a Noise and Vibration Management Plan would be prepared and would include reasonable and feasible approaches to reduce noise and vibration impacts during construction. Notification and consultation procedures would also be implemented for extended work hours and out of hours work.

During operation, noise at a total of 164 receivers was found to exceed the applicable operational noise criteria (with some receivers experiencing exceedances during both the daytime and night-time periods). In total 18 receivers were considered to be acutely affected. In order to mitigate these impacts, noise barriers have been proposed along North Street and along the northbound off-ramp for the southern interchange for Berry. Additionally, a total of 20 isolated properties have been identified that would experience noise levels above the criteria and would qualify for the consideration of architectural treatment to dwellings.

Biodiversity

As discussed in **Section 7.3**, there would be 57.1 hectares of native vegetation potentially impacted directly or indirectly by the project. This includes an EEC and five different vegetation communities that provide potential habitats for threatened species. There would be 2.9 hectares of riparian vegetation, which is an EEC, removed and seven hectares would be subject to indirect impacts. Indirect impacts would include fragmentation and edge effects.

To mitigate these impacts, mitigation and management measures would be implemented relating to (but not limited to) vegetation clearance, edge effects, weed management, exclusion zones, fish passage and fauna management measures (such as fauna crossings). These would be undertaken in accordance with RMS Biodiversity Guidelines (RTA, 2011), detailed in a Fauna and Flora Management Plan and supported by monitoring during pre-construction, construction and operational phases of the project. A Vegetation Management Plan would also be prepared in consultation with local Landcare groups and the CMA. It would include details for the restoration, regeneration and rehabilitation of areas of native vegetation in the vicinity of the project.

The unavoidable loss of riparian vegetation would be a residual impact of the project. Offsetting would be required to meet the 'improve or maintain' outcomes required in the DGRs for the project. . A biodiversity offset package would be submitted within 12 months of approval and would include details of the final suite of measures to be implemented based on the biodiversity offset strategy. It would identify the timeline for implementation and the detail of measures, including ongoing management. A simulated BioBanking assessment undertaken for the project determined that native vegetation removed would need to be offset at an average ratio of 1:5.3 in order to achieve the 'improve or maintain' standard.

Surface water and groundwater

Potential impacts to surface water as a result of the construction of the project are discussed in **Section 7.4**. Impacts would include potential sedimentation and pollution of surface water from construction activities including site preparation, excavation, earthworks and drainage works. Impacts would also potentially arise from ancillary facilities and soil stockpiles. A soil and water management plan would be prepared prior to construction and would detail control measures for erosion, sedimentation and pollution.

During operation, surface water runoff would increase due to an increase in impervious surfaces and concentration of road runoff through drainage infrastructure. This in turn would increase the frequency, volume and velocity of flows in receiving waterways, potentially leading to or exacerbating erosion and increasing the risk of pollutants entering nearby waterways. The project may also cause permanent changes to drainage catchments for existing farm dams.

The diversion of Town Creek would alter the flow regimes in parts of Bundewallah Creek, Connolly's Creek, Broughton Mill Creek and Town Creek. The changed catchment area would have negligible impact on flow volumes of Bundewallah Creek, Connolly's Creek and Broughton Mill Creek. The reduction in flow volumes in Town Creek could lead to sediment accumulation. Given the existing degraded condition of Town Creek through Berry, sediment accumulation is not considered to have a significant adverse impact on water quality.

As discussed in **Section 7.4**, construction and operation of the project would have the potential to impact groundwater levels as a result of changes to groundwater flow patterns, recharge and discharge characteristics of the site. The decrease in recharge rates is expected to be minor given the small road surface of the project compared to the remainder of the catchment.

Flooding

As described in **Section 7.5**, construction ancillary facilities would be located outside the 1 in 100 year flood zone, where possible. Where storage in the floodplain is required, appropriate bunding and scour protection would be provided.

Following construction, culverts, bridges and embankments would potentially impact the existing flooding regime in Broughton Creek, Connollys Creek, Broughton Mill Creek, Bundewallah Creek, Town Creek and Hitchcocks Lane Creek. There is potential for an increase in the extent, level and velocity of flooding, although the impact is expected to be minor and manageable through the consideration of additional drainage measures during detailed design. The diversion of Town Creek would reduce flood levels in areas of Berry.

Landscape character and visual amenity

Changes to the visual landscape as a result of the project are discussed in **Section 7.6**. Project elements that would have a visual impact following the construction of the project would include bridges, cuttings, embankments, interchanges (including lighting), noise barriers and vegetation removal. The greatest visual impacts would occur in sections where offline construction is required. In these areas new infrastructure would be introduced into the visual landscape where there currently is none.

The project would have the greatest impact around Berry, especially in the vicinity of North Street. Interruptions to the views of ridges and the escarpment from Berry would result from the introduction of the new highway infrastructure and the noise attenuation measures in the vicinity of North Street. These impacts would be managed by landscaping and the urban design measures at key precincts in Berry, namely the bridge at Berry, the North Street precinct and the Kangaroo Valley Road and southern interchange for Berry precinct. The design of these elements would be in accordance with the Urban and Landscape Design Strategy and RMS urban design guidelines, with community feedback sought as the detailed design develops. The scale and rhythm of noise attenuation measures would also be determined in consultation with the local community and would have consideration to the town grid layout and view corridors of north-south streets. Consideration to a share path linking North Street with the southern interchange for Berry would also be given during detailed design.

Aboriginal cultural heritage

Eighteen Aboriginal heritage recordings would be partially impacted by the project and eight fully impacted. Of those fully impacted, all consist of archaeological deposits, with the exception of one fig tree. Partially and fully impacted sites, which include two ethno-historical recordings and one cultural landscape, are discussed in **Section 7.7**. To mitigate these impacts, a Heritage Management Plan would be prepared and would include training for construction staff and the Unexpected Finds Procedure that details procedures should there be any unanticipated discovery of Aboriginal objects, burial sites or human remains. Additional measures would also include archaeological salvage of Aboriginal objects, exclusion fencing to avoid impacts, and minimising the disturbance to the natural soil profile. A Heritage Interpretation Plan would be prepared in consultation with Aboriginal stakeholders, local Councils and landowners with the aim to identify options for the promotion of the cultural values of the project area.

Non-Aboriginal (historic) heritage

In total 40 non-Aboriginal heritage recordings were assessed. Of the 40 recordings, 21 would not be directly impacted, six would be partially impacted, and 13 wholly impacted. Of the 22 items not directly impacted, 13 would be subject to indirect impacts relating to their landscape contexts. A summary of items that would be impacted by the project is provided in **Section 7.8**. Impacts will be managed by the archival recording, archaeological and salvage programs, which would include monitoring. Exclusion zones would also be identified and protected (with fencing).

Land use and property

Potential impacts on property and land use by the project are discussed in **Section 7.9**. Impacts would include property acquisition, severance and sterilisation of land, changes in property access, impacts on future development potential of land within the project and adjoining areas and impacts on urban settlement patterns and future development potential of adjoining land.

Socio-economic

Potential positive and negative socio-economic impacts from construction and operation of the project are discussed in **Section 7.10**. During construction, socio-economic impacts would be the result of changes in amenity and changed traffic conditions and access arrangements. These changes would lead to impacts to amenity, economic impacts to agriculture, tourism sectors and businesses within Berry, impacts on traffic conditions, impacts to community cohesion and impacts to community facilities and recreation. These would be managed by the implementation of a Community Involvement Plan to inform the community regarding future work, changes to the road network and the general construction program. Measures to inform tourists, and signage to promote services and tourist attractions in Berry would be implemented to minimise impacts on tourism in the area. Landscape, noise, traffic and air quality mitigation and management measures would also minimise impacts on amenity.

Following construction, both positive and negative socio-economic impacts would result from the bypass of Berry town centre, improved amenity in town improved pedestrian and local traffic safety in Berry, changes to the local and regional road network, property acquisition as well as severance of rural properties. These changes would lead to amenity impacts, economic impacts, such as impacts to the agriculture and tourism sectors and to highway reliant and non-highway reliant businesses, impacts on community cohesion and social character and impacts on recreational activities and community assets. RMS would continue discussions with Shoalhaven City Council to assist in develop strategies to encourage the ongoing viability of businesses in the town of Berry and to encourage new businesses. This could include signage, and programs to enhance community areas and streetscapes. With Berry, consultation with the community would continue in developing a plan to provide pedestrian access and cycle links over the proposed highway and determining potential uses in the buffer zone between North Street and the edge of the project. A temporary and permanent solution of the Berry Riding Club would also be determined during detailed design. Consultation with agricultural businesses owners would also be continued to address the impacts of land acquisition on the viability of farm operations.

Suitability of the site

Environmental, social and economic impacts of different sites were assessed through the evaluation of route options in value management workshops. The preferred option was selected as it best met the project objectives as well as the functional, socio-economic and environmental criteria established through the value management workshop (refer to **Chapter 3** for further details).

The preferred option is considered to be the most suitable site for the project as:

- It provides the best value for money by optimising the cut/fill balance and providing the most cost effective design solution through Toolijooa Ridge.
- It minimises the environmental impact of the project by lessening the disturbance to threatened species and EECs, reducing flood impacts within Berry and responding to the natural landscape by following existing contours and utilising the existing highway alignment where possible.
- It minimises the social and economic impacts of the project by avoiding direct impacts to the heritage precinct at Pullman Street and community sporting and recreational facilities, minimising property acquisition, amenity and heritage impacts, reducing impacts on high quality agricultural land and supporting local and regional economic development.

The public interest

The project is considered to be in the public interest as it would improve road safety, traffic efficiency and access on the NSW south coast. It would also improve safety and amenity within the township of Berry.

As a result of the project, the following crash reductions are predicted to occur along the highway between Toolijooa Road and Schofields Lane (refer to **Section 7.1**):

- 100 per cent reduction in crashes between vehicles travelling in opposing directions.
- 74 per cent reduction in off-path crashes on curves.
- 50 per cent reduction in crash frequency between vehicles travelling in the same direction.
- 64 per cent total reduction in crashes in the project area.

The project would improve traffic efficiency and access, including for freight, on the NSW south coast. It would result in the Princes Highway having an estimated seven minute shorter travel time for vehicles travelling between Toolijooa Road and Schofields Lane.

The removal of heavy vehicles from the Berry town centre would improve both safety within the town and amenity. The existing conflict between pedestrians and vehicles would be reduced and there would be amenity improvements such as reduced noise levels and improved air quality.

11.1.2 Objects of the EP&A Act

The objects of the *Environmental Planning and Assessment Act 1979* (EP&A Act) provide a framework within which the justification of the project can be considered. A summary of this assessment is provided in **Table 11-1**.

Table 11-1 Objects of the EP&A Act and relevance to the project

EP&A Act objective	Comment
To encourage the proper management, development and conservation of natural and artificial resources, including agricultural land, natural areas, forests, minerals, waters, cities, towns and villages for the purpose of promoting the social and economic welfare of the community and a better environment.	Where possible the design of the project has been developed to manage and conserve natural and artificial resources. Mitigation and management measures detailed in **Chapter 7** and **Chapter 8** would be implemented in instances where impacts to resources cannot be avoided. The actions provided in the biodiversity offset strategy would be undertaken in order to maintain the availability of natural resources in the project area. The main objectives of the project are to improve road safety and efficiency on the NSW south coast and measures would be implemented to ensure the impact of this development on the natural and built environment is minimised. There would be significant amenity and safety improvements within the township of Berry. It is recognised that there would be some impact on agricultural land in the project area but this would not be significant on a regional scale.
To encourage the promotion and co-ordination of the orderly and economic use and development of land.	The project would form part of the Princes Highway upgrade program to upgrade the highway to four lanes from Waterfall to the Jervis Bay Road junction, Falls Creek. It would provide improved access to and encourage the orderly and economic use of land on the NSW south cast.
To encourage the protection, provision and co-ordination of communication and utility services.	Utilities affected by the project are described in Section 4.2.11. Affected utilities would be protected or relocated.
To encourage the provision of land for public purposes.	The project would be used for public purposes. If possible residual land between North Street and the project would be utilised as public open space.
To encourage the provision and co-ordination of community services and facilities.	The project has been designed to minimise impacts to community facilities. The project would improve access between towns and regional centres in the project area. Access to community services on the South Coast would be improved.
To encourage the protection of the environment, including the protection and conservation of native animals and plants, including threatened species, populations and ecological communities, and their habitats.	The project has been designed to minimise impacts on the environment, including impacts to native flora and fauna, threatened species, populations and ecological communities and their habitats. Impacts to endangered ecological communities (EECs) as a result of the project would be offset as discussed in Section 7.3.

EP&A Act objective	Comment
To encourage ecologically sustainable development.	Ecologically sustainable development (ESD) is considered below in Section 11.1.3.
To encourage the provision and maintenance of affordable housing.	Not relevant to the project.
To promote the sharing of the responsibility for environmental planning between different levels of government in the State.	Throughout the project consultation has been undertaken with relevant levels of government.
To provide increased opportunity for public involvement and participation in environmental planning and assessment.	Community consultation has been undertaken throughout all stages of the project and would continue through the detailed design phase, construction and following the opening of the project. Details of community involvement are provided in **Chapter 6**.

11.1.3 Ecologically sustainable development

Development that improves the total quality of life, both now and in the future, in a way that maintains the ecological processes on which life depends is referred to as ESD. The principles of ESD have been an integral consideration for the Foxground and Berry bypass and throughout the development of the project. This includes the effective integration of social, economic and environmental considerations in all decision-making processes, as defined by Section 6(2) of the *Protection of the Environment Administration Act 1991*.

ESD requires the effective integration of social, economic and environmental considerations in decision-making processes. The four main principles supporting the achievement of ESD are discussed below in the context of the project. **Table 11-2** summarises how the Foxground and Berry bypass project is consistent with the principles of ESD.

In NSW, the commitment to the concept of environmental sustainability is expressed in current legislation. It is an object of the EP&A Act to encourage ESD (Section 5(vii)).

The four principles of ESD are defined as follows:

The precautionary principle – if there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation. In the application of the precautionary principle, public and private decisions should be guided by:

(i) Careful evaluation to avoid, wherever practicable, serious or irreversible damage to the environment.

(ii) An assessment of the risk-weighted consequences of various options.

Inter-generational equity – the present generation should ensure that the health, diversity and productivity of the environment are maintained or enhanced for the benefit of future generations.

Conservation of biological diversity and ecological integrity – that conservation of biological diversity and ecological integrity should be a fundamental consideration.

Improved valuation, pricing and incentive mechanisms – that environmental factors should be included in the valuation of assets and services, such as:

(i) Polluter pays - those who generate pollution and waste should bear the cost of containment, avoidance or abatement.

(ii) The users of goods and services should pay prices based on the full life cycle of costs of providing goods and services, including the use of natural resources and assets and the ultimate disposal of any waste.

(iii) Environmental goals, having been established, should be pursued in the most cost effective way, by establishing incentive structures, including market mechanisms that enable those best placed to maximise benefits or minimise costs, to develop their own solutions and responses to environmental problems.

Table 11-2 considers all four principles of ESD in the light of the project.

Table 11-2 Application of the principles of ESD to the project

ESD principle	Foxground to Berry bypass	Project application
Precautionary principle	The project environmental assessment has included a strategic approach to ensure that environmental risks are considered early and time is afforded for detailed specialist reports in key risk areas. All information has utilised best available technical information and environmental standards, goals and measures to minimise potential environmental risks. In addition 'do nothing' scenarios used for assessment have been adopted to take into account the precautionary principle.	A number of environmental impacts are difficult to quantify or define. In order to alleviate this, the precautionary principle was applied early in the Project through the risk process and early mitigation measures identified. An environmental risk analysis was completed for the project development and environmental assessment. The risk analysis included an evaluation of whether the project poses any risk of serious or irreversible environmental harm. Specialist investigations that were of particular importance in applying a precautionary approach to the project included flora and fauna, climate change and flood management. As a precautionary approach, all worse case potential environmental impacts have been assessed and mitigation measures have been developed to manage those worse case impacts. Flora and Fauna field investigations have enabled important ecological features to be avoided during the initial route selection stage, where possible. The Biodiversity Offset Strategy (**Appendix E**) addresses residual impacts that cannot be mitigated, such as the unavoidable loss of Riverbank forest (River-flat eucalypt forest EEC).

ESD principle	Foxground to Berry bypass	Project application
Inter-generational equity	The project has included a number of specialist reports to assess social equity both in terms of environmental, social and economic costs and benefits to the current community and future generations.	A number of potential socio-economic impacts in both construction and operational phases of the project have been assessed, including impacts to amenity, community cohesion, business, recreation and the agricultural sector. Overall, the social and economic benefit of the proposal is expected to outweigh any negative impacts that cannot be satisfactorily mitigated. Impacts resulting from climate change such as the frequency and intensity of flooding events, storm surges and sea level rises have also been considered including an allowance for a 6% increase in rainfall intensity, the majority of which are not considered to carry a high likelihood or severity. The outcomes of the climate risk assessment and the flood management study have been considered in the design (particularly culvert and bridge design).
Conservation of biological diversity and ecological integrity	Potential impacts resulting from the project on ecological values include the following: • Vegetation clearance and habitat loss. • Increased fragmentation including edge effects. • Increased mortality. • Weed invasion.	The route selection and the development of the concept design have sought to avoid and minimize biodiversity impacts as much as possible. This includes the design of appropriate fauna connectivity structures and the consideration of appropriate revegetation strategies to maintain fauna movement patterns and habitat. The Biodiversity Offset Strategy (**Appendix F**) addresses residual impacts that cannot be mitigated, such as the unavoidable loss of Riverbank forest (River-flat eucalypt forest EEC). Climate change impacts have also been considered but the assessment indicates that the likelihood of direct impact on biodiversity in the project area is low.

ESD principle	Foxground to Berry bypass	Project application
Improved valuation and pricing of environmental resources	The pricing of environmental resources is considered throughout the assessment and is best demonstrated through the socio-economic assessment, the greenhouse gas report and the Biodiversity Offset Strategy. In addition the costs associated with the planning and design of mitigation measures to minimise adverse environmental impacts and the cost to implement them have been built into the overall project costs	Overall, the social and economic benefit of the proposal is expected to outweigh any negative impacts that cannot be satisfactorily mitigated. In addition the greenhouse gas assessment considered the impact of the Clean Energy Future legislative Package 2011 (including the carbon price).

11.2 Conclusion

This environmental assessment has addressed the key issues identified in the DGRs issued under Part 3A of the EP&A Act. A checklist showing where the DGRs are addressed in this environmental assessment is provided in **Appendix A**. The assessment has also addressed the additional key issues identified in the environmental risk analysis in **Chapter 9**. The key issues identified include:

- Implications for traffic and transport.
- Noise and vibration impacts.
- Impacts on flora and fauna.
- Surface and groundwater impacts.
- Flooding impacts.
- Landscape and visual amenity changes.
- Impacts to Aboriginal heritage.
- Impacts to non-Aboriginal (historic) heritage.
- Property and land use issues.
- Socio-economic impacts.

Where possible, these impacts have been avoided through the design of the project. Unavoidable impacts would be managed through the mitigation measures detailed in **Chapter 7, Chapter 8** and the Statement of Commitments in **Chapter 10**. Consultation has been undertaken with affected stakeholders to provide early notification of potential impacts. Where appropriate, consultation has included identification and agreement on appropriate mitigation measures (refer to **Chapter 6** for further details).

The project would provide beneficial outcomes on a local and regional scale. These would include:

- Improved road safety on the Princes Highway and the ‘Sandtrack’.
- Improved road efficiency on the Princes Highway.
- Removed conflicts between highway and local traffic movements within Berry.
- Improved safety and amenity within Berry due to the removal of heavy vehicles.
- Improved access to the existing tourism industry on the South Coast.
- Greater reliability of access to markets and raw materials in Sydney and the Wollongong-Kiama area for industries in the Nowra area.
- Increased turnover for non-highway reliant businesses.
- Reduced flooding in Berry due to the diversion of Town Creek.

These benefits as well as the mitigation of impacts mean that the project would meet its objectives (as discussed in **Section 12.1**). It would also satisfy key government strategies and plans, including the *Illawarra Regional Strategy* and *Shoalhaven – An Enterprising Alternative, an Economic Development Strategy*. These plans identify improvements to the Princes Highway as a priority to support the economy of the NSW south coast.

The project has been designed in accordance with current RMS road design guidelines, safety and traffic efficiency requirements to address the existing high crash history, and aims to deliver immediate safety benefits.

The project achieves acceptable environmental, social and economic outcomes, and delivers substantial road safety and wider economic and road-user benefits. The project is considered justified.

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