Appendix H

Water quality technical paper

Mount Victoria Village Safety Upgrade

TECHNICAL PAPER – WATER QUALITY

- Final 2
- November 2013

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Prepared by
Sinclair Knight Merz
ABN: 37 001 024 095

710 Hunter Street
Newcastle West NSW 2302
Australia
PO Box 2147 Dangar NSW 2309 Australia

Tel: +61 2 4979 2600
Fax: +61 2 4979 2666
www.skmconsulting.com

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Terms and abbreviations

Term	Definition
ANZECC / ARMCANZ	Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand
CMA	Catchment Management Authority
Conductivity	Measure of the amount of dissolved salts in the water and its ability to conduct an electrical current. Units are mS.cm-1
Dissolved Oxygen	Measure of the amount of oxygen dissolved in water
EPA	NSW Environmental Protection Agency
DECC	Former NSW Department of Environment and Climate Change. Now OEH.
DECCW	Former NSW Department of Environment and Climate Change and Water. Now OEH.
HRC	Healthy Rivers Commission
NorBE	Neutral or Beneficial
NTU	Measure of turbidity in water
OEH	Office of Environment and Heritage (formerly Department of Environment, Climate Change and Water)
pH	Measure of acidity or alkalinity of water.
REF	Review of environmental factors
Roads and Maritime	NSW Roads and Maritime Services
RTA	Former NSW Road and Traffic Authority. Now RMS
SCA	Sydney Catchment Authority
SEPP	State environmental planning policy
TN	Total nitrogen
TP	Total phosphorus
TSS	Total suspended solids
Turbidity	Measure of the "muddiness" of the water

Executive summary

The Mount Victoria Village Safety Upgrade is located across the Grose River and Coxs River catchments. The Grose River's catchment forms part of the Great Blue Mountains World Heritage Area and the river itself is classified as a 'wild river' This indicates it has high conservation value and is in in near-pristine condition in terms of animal and plant life and water flow. The Coxs River catchment forms part of Sydney's drinking water supply catchment, managed by the Sydney Catchment Authority (SCA). The proposal is located in the extreme upper reaches of both catchments.

Limited available data indicates that nearby waterways are generally in good condition. Given that the current highway does not include any water quality treatment, this data suggests that the waterways are resilient to water quality impacts from the highway.

The scope of the proposal includes widening of the existing highway shoulders and a number of intersection works. In relation to the existing highway, the proposal does not present significant changes. This is in contrast to other nearby proposals or completed project on the Great Western Highway, where the design involves full widening.

During construction, there is potential for the works to increase the levels of sediments and pollutants to downstream waterways, particularly through activities such as vegetation clearance, topsoil stripping and cut and fill earthworks. During operation, increased impervious areas have the potential to increase levels of pollutants discharging to downstream waterways. There are three discharge points that would generate proportionately high pollutants in comparison to the existing location. The assessment deemed that mitigation measures for both construction and operation would be required.

Mitigation of construction impacts would be in line with the strategies recommended in the Blue Book (Landcom 2004 and DECC 2008b). Lyall & Associates Consulting Engineers (Lyall & Associates) have produced a conceptual erosion and sediment control strategy (RMS, 2013c) that would include sediment sumps and other localised erosion and sediment controls. Sediment basins would also be included in locations where permanent operational controls would be located. These controls would be part of a multi-faceted approach that would also include procedural controls, site management controls and monitoring.

The operational water quality strategy is to prevent or reduce water quality impacts to downstream waterways as a result of operation of the new sections of the road that would be developed as part of the proposal. Mitigation would apply to new sections of the highway where traffic flow is high and would be focused on locations where increased impervious areas would results in an increase in pollutant runoff compared to the existing situation. Two biofiltration basins and one water quality ponds are proposed. Indicative sizes and locations are provided and include a pond of 250m3 at chainage 15590, a biofiltration basin of 500 square metres at chainage 16490, and biofiltration basin at the northern end of Fairy Dell Road of 200 square metres in size.

The size, type and location of the water quality mitigation measures would be further investigated, calculated and modelled using appropriate tools during detailed design, in accordance with the criteria detailed in this Review of Environmental Factors (REF) and following liaison with Roads and Maritime Services (RMS) and the SCA.

If these measures are correctly designed and then adequately implemented, managed and maintained on site, it is expected that the proposal would have a neutral or beneficial impact on water quality in the SCA catchment, in comparison to existing conditions.

1. Introduction

1.1 Project background

The Katoomba to Lithgow Great Western Highway upgrade (previously known as the Mount Victoria to Lithgow Upgrade) is part of the NSW and Australian Governments' commitment to improve road safety and accessibility to communities in the Blue Mountains and central west of NSW. Investigations for the upgrade started in May 2008 to determine the preferred route corridor. The preferred route alignment was announced in May 2010, followed by corridor investigations in 2011.

In July 2012, the NSW and Australian governments announced a $250 million revised investment program for the upgrade of the Great Western Highway between Katoomba and Lithgow. This decision addressed recommendations from an independent review of the proposed upgrades of the Great Western Highway west of Katoomba.

The revised package of upgrades will enhance safety outcomes and maximise benefits to the community by targeting specific deficiencies. Roads and Maritime Services (Roads and Maritime) will manage and deliver the following:

- Upgrading the highway at Forty Bends, east of Lithgow to three lanes on the current alignment ($120 million).
- A number of enhanced safety upgrades between Mount Victoria and Lithgow. These include Forty Bends, River Lett Hill, Hartley Valley and Mount Victoria village Safety Upgrades ($83 million).
- Finalising the concept design and road boundaries for upgrading the highway from Mount Victoria to Lithgow and requesting councils to adopt these in their future planning.
- Using the remaining funds from the joint $250 million Australian and NSW government commitment for upgrades of the Great Western Highway between Katoomba and Mount Victoria.

The Forty Bends design and review of environmental factors (REF) were completed in April 2013. The design and REFs for the remaining safety upgrades are currently being prepared.

1.2 Mount Victoria village safety upgrade

Roads and Maritime proposes to upgrade a section of the highway through Mount Victoria village in the Blue Mountains, New South Wales. The upgrade extends about 2.3 kilometres and is comprised of three sections, from 400 metres west of Browntown Oval (east of Mount Victoria village) to just west of Mount York Road (in this report, this is referred to as 'the proposal'). Key features of the proposal are outlined in **Table 1-1** and illustrated in **Appendix A**.

Table 1-1 Key elements of the proposal

Section	Proposed safety improvements
Section 1: Between 400 m west of Browntown Oval and	• Widen the road shoulders up to about 2.5 m on both sides of the road. • Provide a basic right turn into Victoria Falls Road.

Section	Proposed safety improvements
240 m west of Victoria Falls Road (chainage 15400 to chainage 15880)	• Provide a concrete safety barrier, new pedestrian footpath (about 80 m long) and pedestrian fence next to the Gatekeepers Cottage. • Provide a pedestrian pathway about 160 m long next to the westbound lane between about chainage 15400 and 15600 • Upgrade drainage, with kerb and guttering along the length of Section 1, including underground pipes to convey stormwater. • Water quality treatment next to the eastbound lane, near Victoria Falls Road. • Incorporation of underground utilities within the proposed pedestrian pathway between chainage 15490 and 15560.
Section 2: Between 200 m east of Harley Avenue and 20 m east of Station Street (chainage 16130 to chainage 16660)	• Widen the road shoulders up to about 3 m on both sides of the road. • Build a 6 m wide and 230 m long two-way service road. This road would provide safe access to private properties on the southern side of the highway between Cecil Road and Mount Piddington Road. This service road would have shared vehicle and pedestrian use. • Provide a pathway about 170 m long between Mount Piddington Road and Hooper Street, next to the westbound lane. • Provide dedicated right-turn bays into Harley Avenue and Mount Piddington Road. • Provide a left-in and left-out turning control at Hooper Street with signposting and line marking. • Moving the road about 20 m to the north between Mount Piddington Road and Hooper Street to improve the road alignment by easing the sharp curve. • Upgrade drainage, with kerb and guttering along the length of Section 2, including underground pipes to convey stormwater. • Provide 4 retaining walls to minimise environmental and property impacts. • Build a water quality and detention basin next to the eastbound lane, opposite Mount Piddington Road. • Relocation of underground utilities within the new service road.
All sections	• Design speed would remain at 60 km/h. • Highway would remain a two-laned road (one lane in each direction). • Partial acquisition of 18 properties. • Install kerb and guttering south of the highway in all

Section	Proposed safety improvements
	sections. • Improve the road surface by providing new pavement to tie-in to the vertical levels of the existing highway.

1.3 Purpose of this report

This report details a review of the impacts on surface water quality as a result of the construction and operation of the Mount Victoria village Safety Upgrade. It recommends mitigation measures to address these impacts. A qualitative Neutral or Beneficial (NorBE) assessment has also been undertaken for the area of the proposal located within the Sydney Drinking Water catchment.

The purpose of this report is to provide a detailed analysis for input into the Review of Environmental Factors (REF), as required under Part 5 of the *Environmental Planning and Assessment Act 1979* (EP&A Act). This report builds on environmental corridor studies undertaken for the preferred route corridor and concept design for the Mount Victoria to Lithgow upgrade.

1.4 Report structure

This report is structured as follows:

- Section 1: Introduction.
- Section 2: Methodology and relevant legislation framework.
- Section 3: Water quality objectives.
- Section 4: Existing environment.
- Section 5: Potential impacts.
- Section 6: Safeguards and mitigation measures.
- Section 7: Drinking water catchment and NorBE.
- Section 8: Conclusion.
- Section 9: References.

2. Methodology

2.1 Approach to this study

The primary objective of this study is to assess and manage potential impacts to surface water quality and identify measures to avoid or minimise potential impacts from surface runoff on downstream waterways during construction and operation phases.

A hydrology and drainage investigation of the Mount Victoria village Safety Upgrade was undertaken by Lyall & Associates Consulting Water Engineers (Lyall & Associates) in early 2013 on behalf of Roads and Maritime to assess drainage and water quality requirements and related construction and operational phase impacts (the Lyall report) (RMS, 2013c). This REF technical paper is a desktop study which summarises and expands on the findings of that report. Additional information reviewed included:

This assessment has included a review of the following Roads and Maritime documents:

- Preliminary concept road design provided as CAD files by Roads and Maritime in June 2013
- Updated concept road design provided by Roads and Maritime as drawings in mid July 2013
- Great Western Highway Upgrade, Mount Victoria Safety Upgrade, Civil Concept Design Report, December 2012.

The assessment has also included a review of a number of documents from the following authorities, as listed in the references in **Section 9**:

- Sydney Catchment Authority (SCA).
- NSW Office of Environment and Heritage (OEH).
- Hawkesbury Nepean Catchment Management Authority (CMA).
- Healthy Rivers Commission (HRC) of NSW.
- Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand (ANZECC/ARMCANZ).
- Landcom.

2.2 Legislative review

The following NSW legislation and statutory requirements are considered in the water quality assessment work:

- ***Protection of the Environment Operations Act 1997 (POEO Act)***, which sets the framework for environment protection during the construction and operation of a development or undertaking of an activity. The POEO Act consolidates key pollution statutes relating to air, water and noise pollution and environmental offences, and establishes a duty to notify either the Environmental Protection Authority (EPA) or the local council where incidents are likely to cause material harm to the environment. As the proposal would not result in a main road of four or more traffic lanes for greater than three to five kilometres (Clause 35 of Schedule 1 (Road construction)), the proposed works are not classified as a scheduled activity under the POEO Act. The proposal would therefore not involve undertaking any scheduled activities and would not require an environmental protection licence (EPL).
- ***Protection of the Environment Administration Act 1991***.The Act establishes the Environment Protection Authority (now part of the Office of Environment and Heritage) to

provide integrated administration for environment protection, and perform particular tasks in relation to the quality of the environment, environmental audit and reports on the state of the environment (SCA, 2011c).

- **NSW *Fisheries Management Act 1994* (FM Act),** which provides for the protection of threatened fish and marine vegetation and is administered by the Department of Primary Industries. The FM Act, in conjunction with the *Threatened Species Conservation Act 1995*, aims to conserve, develop and share fishery resources and conserve marine species, habitats and diversity. The alignment of the existing highway crosses River Lett. Waterway crossings would be designed where possible according to NSW Fisheries (part of NSW Department of Primary Industries – DPI guidelines (Why do Fish Need to Cross the Road? Fish Passage Requirements for Waterway Crossings, DPI, 2003) and in consultation with NSW Fisheries staff to ensure minimal impact on aquatic habitats and species protected under the Act.
- ***Water Management Act 2000***. The Act provides for the protection of river and lakeside land in NSW and aims to provide for the sustainable management of the water resources throughout NSW. It identifies provisions relating to 'controlled activities' which includes (among other definitions) the carrying out of any activity that affects the quantity or flow of water in a water source' or affects land fronting a waterway. However, in accordance with clause 39A(1) of the Water Management (General) Regulation 2004,Roads and Maritime is permitted to undertake works within 40 metres of a watercourse without obtaining a permit under the Water Management Act 2000.
- **The *State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011* (the Drinking Water SEPP)**. The SEPP commenced on 1 March 2011 and lies under the EP&A Act. This policy replaced the Drinking Water Catchments Regional Environmental Plan No 1. The SEPP states that a proposed development within the Sydney Catchment Authority (SCA) drinking water catchment must have a neutral or beneficial effect on water quality (NorBE).

2.3 Guidelines

The following design guidelines and management procedures are relevant in determining the appropriate water quality management and mitigation measures to be implemented during the construction and operational phases of the proposed upgrade.

2.3.1 Construction phase

The following guidelines seek to minimise land degradation and water pollution from road construction sites in New South Wales. The guidelines have been used to identify appropriate management procedures during construction works and physical controls to minimise erosion and to prevent sediment moving off site during the construction phase of development.

- Soils and Construction Management Urban Stormwater series (herein referred to as the Blue Book):
- NSW Department of Environment, Climate Change and Water (DECCW) 2008, Managing Urban Stormwater-Volume 2D Main Road Construction.
- Landcom 2004, Managing Urban Stormwater- Soils and Construction, Volume 1, 4th Edition.
- Roads and Traffic Authority (RTA) 1999, Code of Practice for Water Management - Road Development and Management.
- RTA 2001, Stockpile Site Management Procedures.
- RTA 2003, Road Design Guideline: Section 8 Erosion and Sediment.
- RTA 2003, Guideline for Construction Water Quality Monitoring.
- RTA 2009, Erosion and Sediment Management Procedures.

- Roads and Maritime Services (RMS) 2011, Technical Guideline: Temporary Stormwater Drainage for Road Construction.
- RMS 2011, Technical Guideline – Environmental Management of Construction Site Dewatering.
- RMS 2012, Environmental Direction: Management of Tannins from Vegetation Mulch.

2.3.2 Operational phase

The following documents provide guidance on water management and conservation practices related to the design, operation and maintenance of the roads and traffic system in order to protect waterways and water quality where practicable and feasible. In addition they provide guidance on designing permanent water quality treatment in a consistent and practicable manner. The design for the proposal would address the sensitivity of receiving waters and local environment along the highway.

- Austroads 2001, Road Runoff and Drainage: Environmental Impacts and Management Options, Austroads AP-R180.
- Austroads 2003, Guidelines for Treatment of Stormwater Runoff from the Road Infrastructure, Austroads AP-R232.
- Austroads 2010, Guide to Road Design, Part 5: Drainage Design.
- RTA 1997, Water Policy.
- RTA 1999, Code of Practice for Water Management - Road Development and Management.
- RTA 2003, Procedures for Selecting Treatment Strategies to Control Road Runoff.
- SCA 2011, Neutral or Beneficial Effect on Water Quality Assessment Guideline.
- VicRoads 2011, Integrated Water Management Guidelines.

3. Water quality objectives

The key water quality objective is to minimise potential impacts on downstream waterways from surface runoff generated from the proposal during the construction and operational phases.

As the proposal falls within SCA's drinking water catchments, all of the SCA's objectives would need to be met. These would be identified during detailed design through liaison with the SCA.

4. Existing environment

4.1 Catchment context

The proposal is located within the urban development of the township of Mount Victoria. This ridge-top village is bounded by steep and densely forested areas. The site location is shown in **Figure 4-1**. **Figure 4-2** provides a wider context of the location.

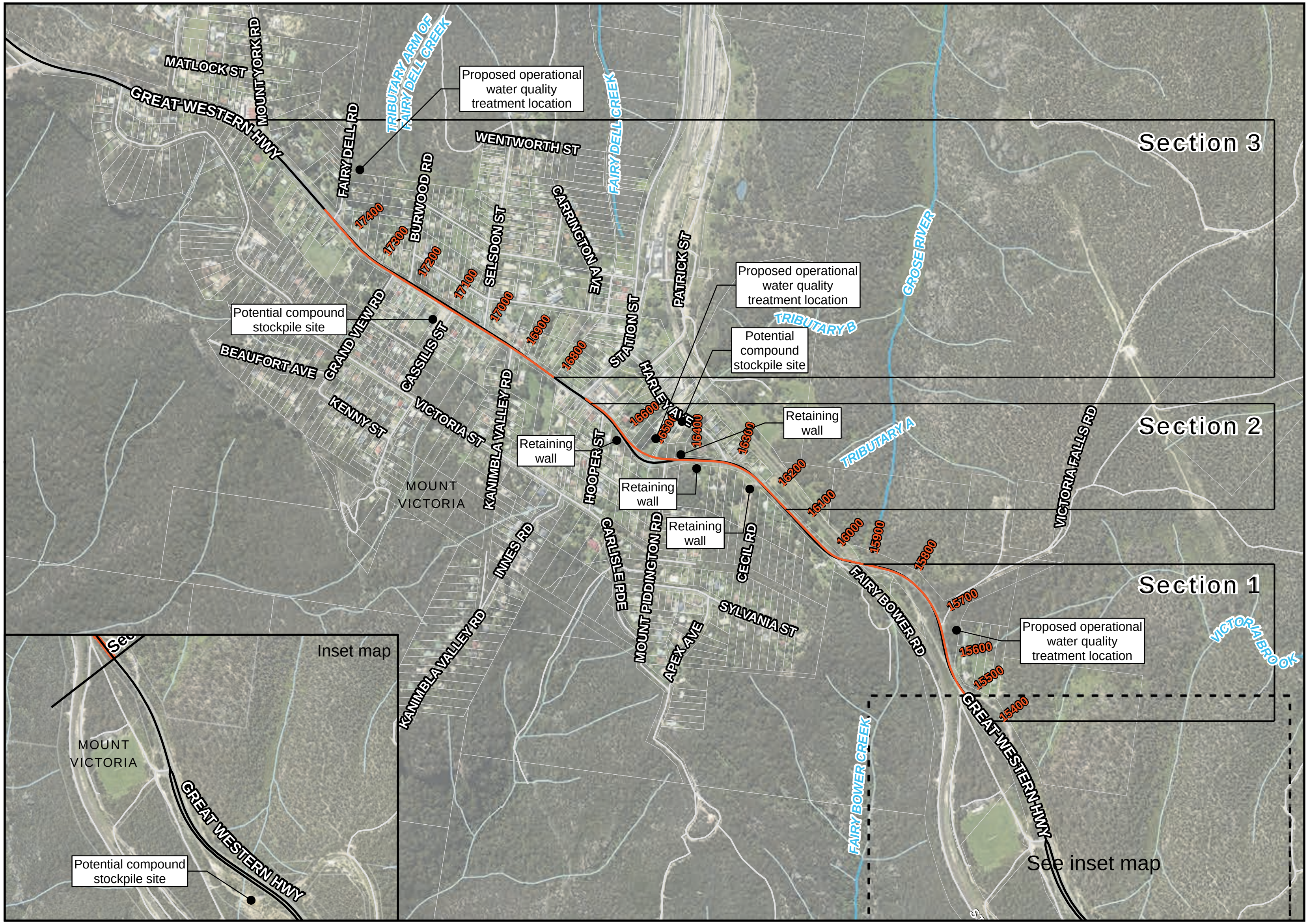
The length of highway runs through the catchment headwaters of two major river systems, namely the Grose River and Coxs River, both of which form part of the larger Hawkesbury-Nepean River system. A ridge that runs generally north-south along Station Street, extending north along the Darling Causeway, forms the catchment divide between these two systems. There are no major creek crossings along this section of the GWH as it is located relatively high in the headwaters of the two catchments.

To the east of the ridge, the highway corridor is located within the headwaters of the Grose River catchment. Section 1 and 2 of the proposal are located in this area. Section 1 of the highway upgrade works drain generally to the north-east toward an unnamed tributary arm of Boyce Gully, which ultimately feeds into the Grose River via Victoria Brook and Victoria River. Section 2 of the upgrade works drain generally to the north-east toward two unnamed tributary arms of the Grose River in the very upper reaches of its catchment. The receiving watercourses for both Sections 1 and 2 are located within the Blue Mountains National Park.

To the west of the ridge, the highway corridor is located within the headwaters of the Mid Coxs River catchment, which forms part of the larger catchment of Lake Burragorang that is impounded by Warragamba Dam. The catchment is managed by the Sydney Catchment Authority (SCA) and is subject to specific drinking water regulations. Section 3 of the highway upgrade works drain generally to the north towards the main arm and an unnamed tributary of Fairy Dell Creek, which ultimately feed into the Coxs River via Kerosene Creek and the River Lett.

The prevailing terrain is relatively steep through Sections 1 and 2, with typical grades in the order of 10 to 20 per cent for land adjoining the highway corridor. West of Station Street (i.e. through Section 3) the terrain flattens out to some extent, with typical grades less than five per cent for areas both upslope and along the highway corridor. However, the terrain falls away steeply to the north (i.e. downstream) of the highway.

FIGURE 4-1 PROPOSAL SITE LOCATION



LEGEND
- The proposal
- Section boundary
- Existing highway
- Road
- Primary waterway
- Minor waterway
- Property boundary

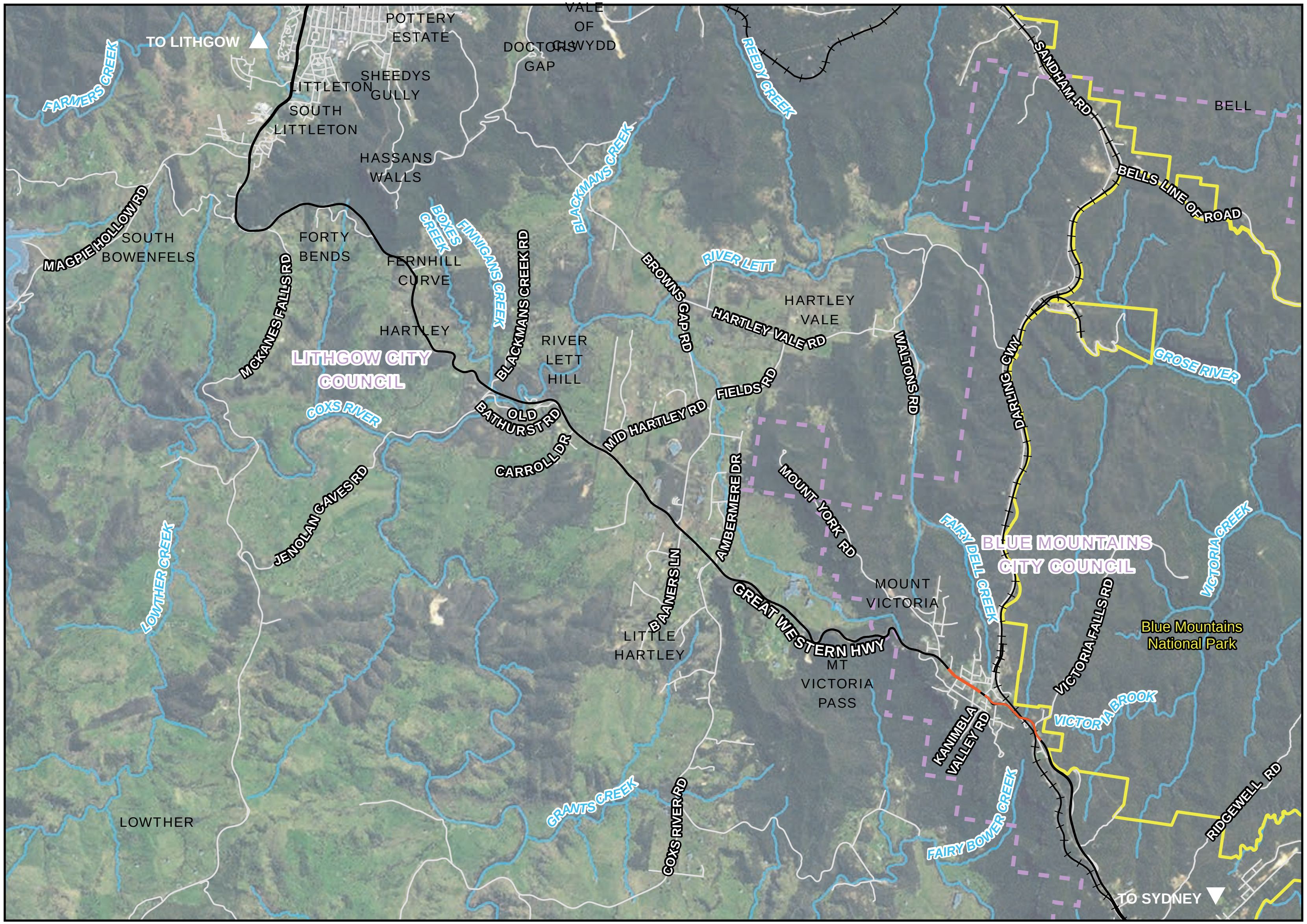
Sinclair Knight Merz does not warrant that this document is definitive nor free of error and does not accept liability for any loss caused or arising from information provided herein.

DATA SOURCES
Roads and Maritime Services 2013, LPMA 2010, STREETWORKS 2001

0 500
Metres

SKM

FIGURE 4-2 LOCALITY OF PROPOSAL



LEGEND

- The proposal
- Existing highway
- Railway
- Primary waterway
- Road
- Blue Mountains National Park
- LGA boundary

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DATA SOURCES
ESRI Online 2013, Roads and Maritime Services 2013, LPMA 2010, STREETWORKS 2001

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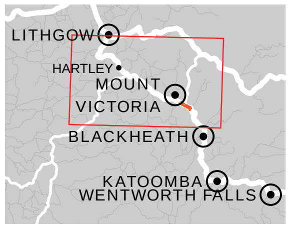

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Newcastle Spatial Team - Prepared by : KO
Checked by : VC

4.2 Existing environmental values and conditions

The Mid Coxs River subcatchment is highly valued for its recreational values by local and regional communities (Hawkesbury Nepean CMA, 2008b).

Over 80 per cent of the Grose River sub-catchment is reserved land as part of the Greater Blue Mountains World Heritage Area. The catchment is generally characterised by spectacular views of tall cliffs, plateaus of exposed sandstone and densely forested areas.

The Grose River and its tributaries have been assessed as meeting the criteria for wild rivers laid out in the National Parks and Wildlife Act 1974. This indicates it has high conservation value and is in in near-pristine condition in terms of animal and plant life and water flow, and is free of the unnatural rates of siltation or bank erosion that affect many of Australia's waterways (OEH, 2011).

Within this catchment there are a number of hanging swamps, (Blue Mountains Swamps) that are listed as a vulnerable/endangered ecological community under the *NSW Threatened Species Conservation Act, 1995* (and endangered ecological community under the *Environmental Protection and Biodiversity Conservation Act 1999*). These swamps are also listed in the directory of important wetlands. The greatest density of Blue Mountains Swamps in the region occurs in the Upper Mountains between Mt Victoria and Lawson.

Due to the Grose River sub-catchment’s national park status, existing impacts to the catchment have been confined to the ridges bordering the catchment, which is where the proposal is largely located. According to the SCA (2007), water quality downstream of Mt Victoria is heavily affected by stormwater runoff from ridge top urban areas.

Until 2008 the Mt Victoria Sewage Treatment Plant effluent discharged into Fairy Dell Creek which joins the Coxs River via Hartley. Decommissioning of the plant has improved downstream water quality. However, there may be some existing on-site sewer systems on private properties in the study area which may impact on water quality, particularly if they are not maintained properly by the private owner (SCA, 2007).

4.3 Existing waterways and culvert crossings

There are six main drainage lines along the route of the proposed safety upgrade, and each has an existing minor culvert crossing. There are no major creek crossings along this section of the Great Western Highway as it is located relatively high in the headwaters of the two catchments.

The existing highway drainage system in the proposal area combines runoff from upslope catchments with runoff generated within the highway corridor.

4.4 Existing water quality treatment

There is currently no treatment for stormwater runoff from the existing highway in the proposal area and no spill containment infrastructure. The existing drainage network includes a mix of open channels and swales with some pit and pipe systems that discharge untreated to the Grose River and Coxs River catchments.

4.5 Existing water quality data

4.5.1 Water quality indicators

Recommended water quality indicators, based on concentration, applicable to waterways in the study area have been established by ANZECC/ARMCANZ (2000). The ANZECC/ARMCANZ guidelines provide benchmarks for assessing existing water quality according to the established environmental values.

In accordance with the ANZECC/ARMCANZ guidelines, the assessment of existing water quality in this report is made in accordance with default trigger values for chemical and physical stressors for south-east Australia for slightly disturbed upland river aquatic ecosystems. The ANZECC/ARMCANZ guideline trigger values for water quality parameters that have been used are shown in **Table 4-1**.

Table 4-1 Recommended water quality objectives for the proposal

Indicators	Trigger value for aquatic ecosystems
Temperature (°C)	N/A
Turbidity (NTU)	2-25 NTU
Dissolved oxygen (% saturation)	90–110 per cent saturation
Electrical conductivity (µS/cm)	30–350
pH	6.5–8
Ammonium (mg/L)	<0.013 mg.L-1
Oxidised nitrogen (mg/L)	<0.015 mg. L-1
Total nitrogen (mg/L)	<0.25mg.L L-1
Orthophosphate (mg/L)	0.015 mg. L-1
Total phosphorus (mg/L)	0.02 mg. L-1

Water quality indicators used in this assessment and their relevance include:

- Turbidity (NTU) is a measure of the "muddiness" of the water and is important because the turbidity of water is an indication of the amount of suspended colloidal and particulate matter in the water and how much light can penetrate for important biochemical processes such as photosynthesis. Elevated levels of particulate matter can also impact on dissolved oxygen concentrations and pH.
- Conductivity (mS.cm-1) is a measure of the amount of dissolved salts in the water and its ability to conduct an electrical current. It is important as some plant and animal species are salt sensitive whilst others require higher salt concentrations.
- Temperature (°C) is a measure of the degree of hotness or coldness of water. It is a form of pollution and can impact on riverine biota and associated biological and chemical processes.
- pH is a measure of acidity or alkalinity of water. Most freshwater and estuarine biota have a range of tolerances between 6.5 and 8.
- Dissolved oxygen (% saturation and mg.L-1) is a measure of the amount of oxygen dissolved in water. Dissolved oxygen is vital for many forms of riverine and estuarine biota including native fish and is also vital for the functioning of healthy aquatic ecosystems.
- Nutrients (nitrogen (N) and phosphorus (P)) are essential nutrients for life on earth. Nutrient pollution can lead to excessive growth of aquatic plants such as phytoplankton, cyanobacteria, Macrophytes and algae. High levels of nutrients can be a contributor to eutrophication. Phosphorus is found in waterbodies in dissolved and particulate forms. Dissolved phosphorus (measured as FRP) is found in the form of phosphate ions and may be readily taken up by aquatic plants and micro-organisms. Nitrogen exists in water both as inorganic and organic

species, and in dissolved and particulate forms. Inorganic nitrogen is found both as oxidised species (e.g. nitrate and nitrite) and reduced species (e.g. ammonia). In non-saline waters phosphorus tends to be the limiting nutrient that restricts the growth of algae.

4.5.2 Data

Existing water quality data is limited in the study area. Blue Mountains City Council (BMCC) undertakes annual macroinvertebrate monitoring at a number of sites within the local government area to audit the health of the creeks. During the macroinvertebrate surveys, water quality data is collected for a range of chemical and physical indicators. This data is indicative of ambient water quality on the day of sampling. Of the sites monitored by BMCC, two sites fall within the project area. These sites, Fairy Dell Creek and Grose River tributary at Mt Victoria, have generally been monitored annually since 2000, the results of which are contained in **Appendix B**.

According to the results of the macroinvertebrate surveys, Fairy Dell Creek is mildly impacted and the Grose River is near pristine. Swamps are located within the catchment of both sites, and therefore it is assumed that the creeks are groundwater fed. Both sites contain a good diversity of species, inferring that the creek and water quality are in good condition. Over the years, the water quality at the time of sampling has supported this, with low conductivity and turbidity that fell within the recommended limits. pH levels were slightly lower in the Grose River tributary than Fairy Dell Creek; however both fell within the recommended limit of 6.5 to 8. Dissolved oxygen levels at the time of sampling over the years generally fell below the recommended lower limit of 90 per cent saturation.

Prior to 2009, the water quality of Fairy Dell Creek was impacted by the Mt Victoria Sewage Treatment Plant (STP) which discharged tertiary treated effluent into the waterway, resulting nutrient concentrations that exceeded the recommended limits. However following the decommissioning of the STP, nutrient concentrations have reduced and at the time of sampling were low and complied with the ANZECC/ARMCANZ (2000) guidelines. Nutrient concentrations in the Grose River tributary were low and compliant.

Overall the limited data indicates that the water quality of both Fairy Dell Creek and Grose River tributary appears good and complies with the ANZECC/ARMCANZ (2000) guidelines for the protection of slightly disturbed upland river aquatic ecosystems, with the exception of dissolved oxygen which fell below the recommended lower limit of 90 per cent saturation.

4.6 Sensitivity of receiving waters

Due to the classification of the proximity of the Mt Victoria proposal to the Greater Blue Mountains National Park and the ‘wild river’ status of the Grose River, all downstream waters on the proposal will be treated as sensitive receiving waters.

5. Potential water quality impacts

In this section, the potential impacts of construction and operation of the proposal are explored.

5.1 Construction phase impacts

The construction phase of the proposal presents risk to downstream water quality if management measures are not implemented, monitored and maintained throughout the construction process.

5.1.1 Construction activities

If unmitigated, the highest risk to water quality would occur through the following construction activities:

- Construction upstream of waterways such as Fairy Dell Creek, or within minor watercourses.
- Construction of in-stream structures in watercourses, such as extensions to culverts and other drainage works.
- General earthworks, including stripping of topsoil, excavation or filling, particularly larger cuts and fills.
- Removal of vegetation.
- Stockpiling of topsoil and vegetation.
- Transportation of cut and/or fill materials.
- Movement of heavy vehicles across exposed earth.

5.1.2 Surface water quality

The potential impact of unmitigated construction activities on receiving surface waters include:

- Increased sedimentation and elevated turbidity levels of nearby creeks from exposed soil during site disturbance and movement of construction vehicles, particularly following rainfall events.
- Increased sedimentation of downstream watercourses smothering aquatic life and affecting the ecosystems of downstream sensitive waterways, wetlands and floodplains.
- Increased levels of nutrients, metals and other pollutants, transported via sediment to downstream water courses.
- Chemical, heavy metal, oil and grease, and petroleum hydrocarbon spills from construction machinery directly contaminating downstream waterways.
- Increased levels of litter from construction activities polluting downstream watercourses.
- Tannin leachate from clearing and mulching.

Sediment is generated when rain or runoff comes into contact with exposed areas and stockpiles, becomes suspended and transported to receiving waters located downstream. Once sediment enters waterways, it can directly and indirectly impact on the aquatic environment. Direct impacts include reducing light penetration (limiting the growth of macrophytes), clogging fish gills, altering stream geomorphology, smothering benthic organisms and reducing visibility for fish. Indirect impacts of increased sediments occur over the longer term and include accumulation and the release of attached pollutants such as nutrients and heavy metals.

5.1.3 Extent of works in relation to construction impacts

Section 1.2 outlines the scope of the proposal. In relation to the existing highway, the proposal does not present significant changes. This is in contrast to other nearby proposals or completed project on the Greater Western Highway, where the design involves full widening. Therefore, the impacts of this proposal would be less significant than for a full widening project.

Lyall & Associates (RMS, 2013e) determined that estimated average annual soil losses from the highway corridor during construction would not be sufficient to warrant large scale sediment retention basins. This was based on dividing the construction works into discrete areas that would be disturbed during construction and then calculating the soil losses based on Revised Universal Soil Loss Equation (RUSLE). The assessment found that no discrete area would annually result in more than 150 cubic metres of soil losses to downstream waterways. This 150 cubic metre value is the threshold set by the Blue Book (Landcom 2004 and DECC 2008b) above which large-scale sediment treatment devices are needed.

Generally the scope includes widening of the existing highway shoulders. The proposal follows the existing highway alignment with some minor changes to the longitudinal and transverse alignment at defined locations. The proposal would require general earthworks along the length of the highway, with some limited areas of larger cuts and fill batters. Traffic management would be used during construction to maintain traffic flow along the existing road. Therefore, construction would not occur across the full width of the highway at any one time, minimising exposed construction areas.

Table 5-1 provides a summary of the scope of roadwork and then breaks down the works further in relation to construction activities that may impact water quality.

Table 5-1 Scope of roadworks and significance to water quality impacts

Section	Scope of works	Works in relation to water quality
1	Shoulder widening, including provision of a basic right turn at Victoria Falls Road and shallow v-shaped drains (SO drainage)	• General widening including a new footpath along westbound carriageway. Overall increase in pavement areas. • Some very small fill batters (located at chainage 15490 – 15590. • Some very small cuts located at chainage 15670 – 15730. • Small amount of vegetation removal, topsoil stripping and minor earthworks required.
2	Alignment and intersection improvements west of the rail bridge including protected right turns at Harley Avenue and Mount Piddington Road.	• Additional turning lanes and general widening between chainage 16210 – 16460. Overall increase in pavement areas. • Widening would require vegetation clearance, topsoil removal and earthworks.
2	Introduction of a service road between Cecil Road and Mount Piddington Road to facilitate property access adjacent to the westbound carriageway.	• Vegetation clearance, topsoil stripping and earthworks between chainage 16230 and chainage 16460, which will include a small fill batter.
2	Alignment improvements between Mount Piddington Road and Hooper Street, including any necessary retaining wall structures.	• Larger fill batter required from chainage 16480 to 16540, generally overlying the current paved area, thus minimal vegetation clearance required. • Larger widening on the northern side between chainage 16460 and 16560 requiring vegetation clearance, topsoil

Section	Scope of works	Works in relation to water quality
		removal and large earthworks.
2	Left in /left out only at Hooper Street by introducing a raised median island.	• Minor works only – no significant change to the extent of paved area, and no significant earthworks.
3	Shoulder widening east of Kanimbla Valley Road to Fairy Dell Creek.	• General widening and increase to pavement area, with some cut and fill areas. Some vegetation clearance, topsoil stripping and earthworks would be required.
3	Protected right turns at Kanimbla Valley Road and Selsdon Street.	• Widening at would require cut areas on the southern side of the highway and a small fill area on the northern side of the highway. Vegetation clearance, topsoil stripping and earthworks would be required.
3	Removal of the eastbound road safety barrier west of Grandview Road and subsequent relocation of three electrical poles and pole mounted transformer.	• Minor works only.
3	Introduction of a raised splitter island in Fairy Dell Road.	• Minor works only.
3	Widening of the existing raised median and introduction of a kerb blister on the Great Western Highway immediately west of Mount York Road.	• Minor works only.
All	Possible construction of water quality basins (operational).	• Would require vegetation clearance, topsoil stripping and earthworks.
All	Additional kerb and guttering to be added and tied into the existing pavement drainage south of the existing highway, where this is required.	• Minor works but would involve working within drainage paths.
All	Retaining structures to minimise environmental and property impacts, as required.	• Would require earthworks.

5.1.4 Location of works within the drinking water catchment

The location of part of the proposal within Sydney's drinking water supply catchment means there is potential for the water quality within the catchment to be adversely impacted. However, it is likely that any changes in water quality at the proposal would be negligible by the point of drinking water collection due to the long distance between the two locations and the likely assimilation of pollutants into the existing environment.

5.1.5 Significance of construction impacts

The likelihood of watercourses within the study area being impacted by the construction of the proposal is low as they are not directly crossed by the proposal. The creeks would be relatively resilient to the potential impacts on water quality caused by of construction, particularly as they are well vegetated which would provide a buffer to runoff from the surrounding area and are located a reasonable distance from the proposed works. The consequences, however, would be high, given the location of the proposal within the drinking water catchment. Therefore, appropriate mitigation measures should be implemented along the length of the proposal during construction to minimise the impacts. Construction phase mitigation measures are outlined in **Section 6.1**.

5.2 Operational phase impacts

During the operational phase of the proposal, the roads would be sealed and the embankments would be vegetated and stabilised. It is assumed that there would be no exposed topsoil along the highway. Hence, risks are no longer due to sediment loading but are instead due to pollutants from atmospheric deposition, vehicles and motorists.

5.2.1 Surface water quality

Once the proposal is complete and the highway is operational, the main risk to water quality is surface runoff from impervious surfaces and concentration of runoff by drains and kerbs. This can result in the build-up of contaminants on road surfaces, median areas, rest areas and roadside corridors in dry weather which, during rainfall events, can be transported to surrounding watercourses or infiltrate into the groundwater system.

The contaminants of most concern relating to road runoff are:

- Suspended sediment from the paved surface and landscaped batters during the establishment period.
- Heavy metals attached to particles washed off the paved surface.
- Oil, grease and other hydrocarbon products.
- Litter from the road corridor.
- Nutrients from biological matter.

In addition, nutrients such as nitrogen and phosphorus are also found in road runoff due to natural atmospheric deposition of fine soil particles.

The water quality of nearby creeks and streams during the operation of the highway has the potential to be affected by the larger road pavement footprint and its associated pollutants. This could result in:

- Increased suspended solids due to atmospheric deposition on paved surfaces. This can lead to increased turbidity, thereby reducing light penetration through the water column, impacting aquatic flora and fauna.
- Decay of organic matter and some hydrocarbons which can decrease dissolved oxygen levels affecting fish and aquatic life.
- Increased nutrients (nitrogen and phosphorus) from deposition of atmospheric soil particles on paved surfaces. This may stimulate the excessive growth of algae and aquatic plants. The excessive growth of plants and algae contributes a high organic load to the waterway which may deprive the water column of oxygen during night time respiration and through decomposition of decaying material. Some forms of algae may also release toxins into the water column, making it unsuitable for recreation and possibly lead to fish kills.
- Excessive biochemical oxygen demand as a result of the oxidation of hydrocarbons and ammonia and the reduction of metals leading to the depletion of dissolved oxygen in the water. This may cause the death of aquatic organisms and result in the release of nutrients and metals from bed sediments due to anoxic or anaerobic conditions.

- Increased levels of heavy metals (including aluminium and iron) either directly or attached to sediments which are toxic to aquatic biota and fish.
- Silting of waterways and associated smothering of aquatic flora and fauna.
- Increased levels of litter, oils and grease reducing the visual amenity of the waterways.

Given the scope of the proposal and the limited extent of the additional paved surface that would result from the safety upgrade, these impacts are likely to be negligible.

Other potential effects of the operational road on water quality include:

- Increased volume of highway runoff associated with the introduction of additional impervious surfaces, which would potential increase scouring and therefore impacting water quality.
- Alteration of the water table and changes to local hydrology, potentially leading to stagnation of a waterway or changes in levels of turbidity, nitrogen and phosphorus.
- Those associated with maintenance practices such as herbicide use, mowing, road surface cleaning and reparation.

5.2.2 Accidental spills

There is currently no spill containment in the area of the proposal. If no mitigation was provided in the design, the potential impacts from accidental spillage of hazardous materials during the operational stage of the proposal would remain the same as the current situation. These may include contaminants in the spill passing rapidly into the drainage system and impacting the ecology of downstream waterways and terrestrial ecosystems.

The proposed safety works would implement higher road design standards that seek to reduce accidents in the area. Therefore the likelihood of a potential spill of hazardous substances would be lessened as a result of the proposal.

It is likely that any negative impacts to water quality of the drinking water catchment would be negligible at the point of offtake due to the considerable distance of the proposal from the drinking water source.

5.2.3 Proposed design in relation to operational impacts

As stated in Section 5.1.3, the proposal does not present significant changes in relation to the existing highway. This is in contrast to other nearby proposals or completed project on the Greater Western Highway, where the design involves full widening. The impacts of this proposal would therefore be less significant than for a full widening project. In addition, the existing highway does not provide any water quality mitigation. Thus, the impact of the proposal needs to be considered relative to the existing situation.

The operational phase would, however, present two changes that may impact on water quality:

1. Changes to the discharge locations of the operational drainage system.
2. Increased impervious areas due to widening of the shoulders or creation of turning lanes.

The proposed operational drainage strategy is shown in **Appendix C** (RMS, 2013c). It would retain the locations of the existing six cross drainage culverts. **Table 5-2** describes each of the cross drainage outlets and the associated receiving environment. The outlets of these drainage structures generally flow to well vegetated drainage paths.

Table 5-2 Proposed drainage design and receiving environments

Ref ID	Design Chainage	Sec.	Description of receiving environment	Catchment
X1	15530	1	Discharge joins flows from a second minor piped drainage line and is then piped before discharging to a tributary arm of Boyce Gully.	Grose
X2	15590	1	Discharges into informal vegetated drainage line that drains to tributary arm of Boyce Gully.	Grose
X3	16170	2	Discharges to informal vegetated drainage line that is piped under the rail line. Drains to tributary arm of the Grose River.	Grose
X4	16490	2	Discharges to vegetated drainage line and then piped through to and under Harley Ave. Flows are discharged and flow through a vegetated channel towards the railway culvert before discharging into a tributary arm of the Grose River.	Grose
X5	16780	3	Discharges to piped drainage system that runs through Mount Victoria Memorial Park. Drains to Fairy Dell Creek.	Coxs
X6	17370	3	Discharges to piped drainage system that outlets to a well vegetated drainage line and drops of steeply into bushland. The drainage line ultimately discharges into Fairy Dell Creek.	Coxs

Lyall and Associates (RMS, 2013c) undertook an assessment of the impact of the proposal on total catchment area and catchment imperviousness for each of the six cross drainage lines. The results are shown in **Table 5-3**. It can be seen that the overall increase in catchment areas due to the proposal is not significant. However there are large increases in impervious area within the catchments at X2, X3, X4 and X6. Increased impervious area general translates to an increase in the volume of pollutants generated.

Table 5-3 Scope of roadworks and impact on impervious area

Ref ID	Present conditions		Post –proposal conditions					
	Total area	Impervious area	Total area	Difference in total area		Impervious area	Difference in impervious area	
X1	1.7	0.55	1.7	0.00	0%	0.57	0.02	4%
X2	0.66	0.22	0.66	0.00	0%	0.27	0.05	25%
X3	7.07	1.06	7.23	0.16	2%	1.61	0.55	52%
X4	7.76	2.23	7.99	0.23	3%	2.56	0.33	15%
X5	5.53	1.49	5.53	0.00	0%	1.53	0.04	3%
X6	2.87	1.15	2.91	0.04	1%	1.48	0.33	28%

It can be seen that the most significant increase in impervious area occurs at X3. However this increase is mostly due to the introduction of a new service road that would access a small number of properties. Traffic loads on this road would be low, therefore it is not anticipated that the increased impervious area would relate to a notable increase in generation of pollutants to X3.

The change to impervious areas at X1 and X5 are not considered large enough to warrant mitigation during operation.

5.2.4 Significance of operational impacts

Under current conditions, no water quality treatment or spill containment is provided for runoff from the highway. The downstream waterways appear relatively resilient as they are potentially already receiving runoff from the existing highway and limited data infers the water quality and health of Fairy Dell Creek and the Grose River is good.

The scope of the proposal includes widened of impervious areas and an increase in formalised drainage systems. This may increase pollutant loads into nearby watercourses. This impact may be considerable at the discharge points of the X2, X4 and X6 culverts, where the impervious area of the catchments has increased by between 15 and 52 per cent. It is therefore recommended that operational water quality mitigation measures are provided in these locations.

In general, the likelihood of a potential spill of hazardous substances would be lessened as a result of the highway upgrade and the higher road design standards proposed. As the waterways appear resilient under current conditions, and the proposal is a considerable distance upstream of the drinking water offtake point, no standalone spill containment is proposed. However, where water quality mitigation is being implemented, it is proposed to include an additional volume within the design to capture spills.

Operational phase mitigation measures are outlined in **Section 5.2.**

Since the proposal is located within the SCA drinking water catchment, a NorBE assessment has been undertaken and is included in Chapter 7.

6. Water quality management measures

6.1 Construction phase mitigation

6.1.1 Strategy

A strategy aimed at mitigating the adverse impacts of the construction phase of the safety upgrade on water quality in receiving drainage lines and watercourses was developed as part of the Lyall report (RMS, 2013c).

The strategy addresses the increase in potential for both erosion and sediment mobilisation within the construction corridor, and transport of this sediment into downstream watercourses via sediment-laden runoff leaving areas disturbed by the road works.

A preliminary assessment was undertaken by Lyall & Associates to determine the average annual volume of sediment which could be “washed off” the highway corridor if appropriate measures are not implemented by the Contractor during the construction phase of the project. Based on the findings of this assessment, it was concluded that large scale sediment basins would not be necessary for the proposal to meet the standards set out in the Blue Book (Landcom 2004 and DECC 2008b)).

Lyall & Associates (RMS, 2013c) proposed the provision of a series of smaller temporary sediment sumps positioned at key locations along the highway corridor. These would manage runoff from disturbed areas during construction. Lyall & Associates also identified an opportunity to utilise at least one permanent stormwater basin as a temporary sediment basin during the construction phase of the safety upgrade works.

The proposed strategy, produced by Lyall & Associates, is included in **Appendix D**.

It should be noted that the ultimate requirements for controlling erosion and sediment during construction will be dictated by final design of the proposal, the proposed construction methods, the staging and site management practices, all of which are yet to be finalised.

6.1.2 Key principles

The erosion and sediment control measures that would be implemented during construction are based on five principles:

- Controlling the occurrence of erosion.
- Controlling the movement of sediment.
- Diverting offsite “clean” water away from construction areas.
- Diverting onsite “dirty” water towards a sediment basin.
- Capturing sediments that are transported.

To achieve these principles, water quality during construction would be managed using:

- Procedural controls.
- Site managed erosion controls measures.
- Physical sediment control measures.
- Treatment with sediment basins.

This strategy would use the principles outlined in the Blue Book (Landcom 2004 and DECC 2008b).

6.1.3 Procedural controls

A Soil and Water Management Plan (SWMP) would be developed to manage disturbed excavated and imported materials and prevent erosion and sediment impact throughout construction. It would be applicable to all activities during the construction phases of the proposal. Its key objective is to ensure that impacts to soils and water quality are minimised.

A soil conservationist from the Roads and Maritime Erosion, Sediment and Soil Conservation Consultancy Services Register would be engaged during detailed design to develop an Erosion and Sediment Management Report which would inform the SWMP and would regularly inspect works throughout the construction phase.

The SWMP would be prepared and implemented in consultation with relevant government departments and councils as part of the Contractor Environmental Management Plan (CEMP).

The SWMP would be prepared, in consultation with the SCA, as part of the CEMP for the proposal prior to the commencement of construction in accordance with RTA specification G38. The SWMP would address the RTA's *Code of Practice for Water Management* (1999) and incorporate specifications outlined in the *Soil Conservation Service Technical Handbook No. 2: Urban Erosion and Sediment Control* (Quilty et al, 1978). It would be reviewed by Roads and Maritime's Environmental Officer, Western Region, prior to commencement of works.

The plan would include the following items relevant to water quality:

- Erosion and Sediment Control Plans (ESCPs) for all progressive stages of construction.
- Consideration of the impacts soil erodibility.
- Construction and management of sediment control devices, including maintenance regimes for all controls.
- Protection of waterways.
- Acid sulfate soil issues.
- Management of stockpiles.
- Tannin leachate management control.
- Chemical water quality controls.
- Maintenance regimes for all controls.
- Water quality monitoring and checklists.

Environmental management during construction would also be undertaken in line with Roads and Maritime specifications. Those relevant to water quality include:

- RMS QA Specification G36 – Environmental Protection (Management System).
- RMS QA Specification G38 – Soil and Water Management (Soil and Water Management Plan).
- RMS QA Specification G40 – Clearing and Grubbing.

Construction activities would be sequenced and managed to minimise potential water quality degradation due to erosion. Management would include:

- Early installation of physical controls, including cross drainage to convey clean water around or through the site.
- Staging of works to minimise the duration of exposed topsoil by retaining topsoil cover, grassed drainage lines and shrub cover on the soil surface for as long as possible.
- Separation of clean and dirty water wherever possible, and the diversion of clean water from

upslope areas through the construction site.

- Minimising stockpiling.
- Minimising the lengths of slopes through limiting the extent of excavations and the use of diversion drains to reduce water velocity over disturbed areas.
- Where possible, constructing working platforms from rock fill so that bare earth is not exposed.
- Conservation of existing topsoil for later site rehabilitation
- Temporary stabilisation using batter blanketing, surface mulching or vegetation
- Progressive site rehabilitation or sealing of works areas.
- Appropriate location and treatment of site access and stockpile sites.

6.1.4 Physical controls

Whilst the installation of appropriate erosion control measures would greatly reduce the quantity of soil eroded from a construction site, some erosion would inevitably occur, and measures are therefore required to ensure that eroded material is trapped and retained. Such measures include:

- Offsite diversion drains to collect clean runoff from upstream of the construction area and divert it around or through the site without it mixing with construction runoff.
- Scour protection along drainage lines and through the site other concentrated flowpaths. At outlet points, scour protection devices such as energy dissipaters to reduce flow velocity and potential scouring, erosion and sedimentation of existing natural channels and vegetation, where required. Hard scour protection measures would be avoided wherever possible
- Sediment fences and filters to intercept and filter small volumes of construction runoff.
- Rock check dams that are built across a swale or diversion channel to reduce the velocity of flow in the channel and thus reduce erosion of the channel bed, as well as trapping sediment.
- Vegetated buffer strips
- Level spreaders to convert erosive, concentrated flow into sheet flow.
- Onsite diversion drains that collect construction runoff and direct it to treatment facilities.
- Treatment systems to capture sediment and associated pollutants in construction runoff (further information on the location and sizes of sediment basins is provided in Section 6.1.5).
- Specific measures and procedures for works within waterways such as the use of silt barriers and temporary creek diversions. Details of some of these measures are covered in Roads and Maritime': *Technical Guideline - Temporary Stormwater Drainage for Main Road Construction* (2011e).

These physical controls would be installed in line with the principles of the Blue Book (Landcom 2004 and DECC 2008b) and Roads and Maritime's standard drawings.

6.1.5 Treatment

As stated in **Section 5.1.3**, Lyall & Associates determined that the extent of soil losses is not sufficient to warrant the use of sediment basins (full details of the calculations and parameters adopted are available in that report). Instead, sediment sumps are proposed.

The locations of the sumps were determined by Lyall & Associates (RMS, 2013c) based on a review of the available contour data and an assessment of the likely location where runoff from the highway corridor will discharge to receiving drainage lines during the construction phase of the project. The locations are shown in **Appendix D**. Ultimate requirements for temporary sediment sumps along the length of highway corridor will be dictated by final design of the road upgrade, proposed construction methods and staging plans, and site management practices.

Where water quality treatment devices are installed for the operational stage it is proposed to use these as sediment basins during the construction stage. **Section 6.2** details the operational phase mitigation measures and includes three locations where sediment basins would be incorporated.

These are:

- Downstream of X2 at approximate chainage 15600 in Section 1.
- Downstream of X4 at approximate chainage 16500 in Section 2.
- Downstream of X6 at the northern end of Fairy Dell Road in Section 3.

6.1.6 Maintenance

The following management and maintenance procedures would be adopted to ensure effective functioning of sediment control measures:

- A soil conservationist from the Roads and Maritime Erosion, Sediment and Soil Conservation Consultancy Services Register would regularly inspect works throughout the construction phase in line with the requirements of the SWMP.
- Inspections would be undertaken at regular intervals and following significant rainfall events to assess available water storage capacity, water quality, structural integrity and debris levels.
- Where appropriate, an approved flocculent would be applied to sediment basins as early as possible so that early mixing of flocculants occurs. Water quality would be tested prior to discharge in accordance with any EPL requirements.
- Where excessive sediment has built up in basin or sump to a point where greater than 30 per cent of the total capacity has been utilised, sediment would be removed and adequately disposed of.
- Water from sediment basins would be utilised for construction purposes such as dust suppression where feasible.
- When sediment basins require pumping out rather than discharge via a flow outlet, a float would be attached to the hose suction or located inside a bucket to ensure that sediment from the basin floor is not discharged.
- Records regarding water quality and functionality or erosion and sediment control devices would be kept, including details of rain events, use of flocculants, discharge, sediment removal and dewatering activities in accordance with reporting procedures and licence conditions.
- A checklist would be completed when treated water is to be discharged from the basin in accordance with the CEMP.

6.2 Operational phase mitigation

6.2.1 Strategy

The ANZECC/ARMCANZ (2000) Guidelines indicate that several physical-chemical and toxicant parameters need to be controlled to maintain the required protection level for aquatic ecosystems. Some of these parameters include nutrients (total phosphorus and total nitrogen), suspended solids, oils and greases, petroleum hydrocarbons and several heavy metals including copper, lead, zinc, cadmium and chromium which are commonly found in stormwater runoff from roads.

The operational water quality strategy is to prevent or reduce surface water quality impacts to downstream waterways as a result of operation of the new sections of the road that would be developed as part of the proposal. Mitigation would not need to be provided to unchanged sections of the highway, as these areas are not currently treated. Also, mitigation would not need to be provided to areas of low traffic loads, such as on local side roads or new access roads, as the level of pollutant loading would be low.

Again, the management strategy would involve a multi-faceted approach for the operation phase, including treatment through physical water quality devices where possible and procedural controls.

6.2.2 Physical water quality controls

Section 5.2.3 identified the locations where the proposal would cause large increases to the proportion of impervious areas within a catchment and where this subsequently would result in increased pollutant loads. These were at the outlets to culverts X2, X4 and X6.

In these locations, a treatment device would be designed to meet the proposal's water quality objectives and load-based design criteria approved by Roads and Maritime and the SCA (for X6 which is within the drinking water catchment). The recommended load-based water quality objectives (refer to **Table 6-1**) and design criteria are based on the NSW EPA recommendations (EPA, 1997). Any design requirements set by the SCA would also need to be met for X6.

While the proposed safety works are generally minor to minimal in nature, there are no existing water quality measures in place addressing existing background water quality impacts from the roadway. It is therefore noted that the proposed water quality measures outlined in this section address the cumulative water quality requirements of the site, rather than just the incremental changes to water quality introduced by the proposed safety measures.

The design life of the water quality treatment systems would be between 20 and 50 years before renewal is needed.

Table 6-1 Operational water quality control treatment target guidelines

Pollutant	Minimum reduction of the annual average load
Total suspended solids (TSS)	80%
Total nitrogen (TN)	45%
Total phosphorous (TP)	45%
Oil and grease	None visible

In order to balance competing environmental objectives, the locations and types of water quality devices describe here would need further consideration of the total footprint and its impact on property boundaries, designated heritage and environmental exclusion zones, and existing trees and vegetation.

Mitigation at X2

A small water quality pond is proposed downstream of X2 at approximate chainage 15600. The pond would provide an effective and efficient water quality treatment prior to runoff discharging into the Sydney drinking water catchment. A spill containment provision of 20,000L would be incorporated into the pond through an underflow baffle arrangement at the outlet side of the basin.

MUSIC modelling was used to estimate a required water quality pond volume of approximately 250 cubic metres. A pond of this size would reduce the develop levels of TSS by 80 per cent, TP by 73 per cent and TN by 55 per cent. Refer to **Appendix E** for further details on the calculations and assumptions.

Mitigation at X4

The proposed drainage design incorporates a stormwater detention basin immediately downstream of X4. This lies within the upper reaches of the Grose River catchment but outside SCA's drinking water catchment. It is proposed to incorporate capacity to provide stormwater treatment in the detention basin. Spill containment would be provided by the inclusion of an emergency gate valve at the drainage collection pit located at the downstream end of the basin.

The water quality treatment would be provided by a biofiltration layer. Modelling identified a basin with a biofiltration layer approximately 500 square metres in size. A biofiltration basin of this size would reduce the develop levels of TSS by 92 per cent, TP by 77 per cent and TN by 45 per cent. Refer to **Appendix E** for further details on the calculations and assumptions.

Mitigation at X6

The Lyall report (RMS, 2013c) identified a site at the northern end of Fairy Dell Road as being the best location for a system capable of treating runoff from a substantial length of highway corridor. The potential site is located on the western portion of Lot 8 in DP 2028 and south-eastern corner of Lot 3 in DP 1140103. A biofiltration basin with an inline gross pollutant trap also required on the incoming piped drainage line for pre-treatment of stormwater to remove litter, debris and coarse sediments. Spill containment would be provided by the inclusion of an emergency gate valve at the drainage collection pit located at the downstream end of the basin.

MUSIC modelling was used to estimate a required biofiltration basin area of approximately 200 square metres. A biofiltration basin of this size would reduce the develop levels of TSS by 92 per cent, TP by 77 per cent and TN by 46 per cent. Refer to **Appendix E** for further details on the calculations and assumptions.

The locations of the proposed pond and biofiltration basins are shown on **Figure 6-1**.

Scour protection devices

Scour mitigation devices would be included in the drainage design where scour may occur. These devices would be designed to sufficiently dissipate the energy in flow in order to avoid scour. Where changes to the cross drainage design may cause scour, scour mitigation devices would be designed for the downstream end of the cross drainage culvert.

Maintenance requirements

Maintenance during operation would be undertaken by the Roads and Maritime maintenance team in line with the SWMP, which would detail a maintenance and inspection program for operational controls.

As a minimum, the maintenance requirements for the vegetated swales and water quality ponds would include:

- Regular inspections.
- Removal of rubbish and debris from the swales and the basin trash racks.
- Mowing and replanting of the swale vegetation as required.
- Removal of sediment from the swales and ponds at 5 to 10 year intervals.
- Emptying of spills from the ponds by emergency response team.

6.2.3 Procedural water quality controls

An SWMP would be prepared and implemented as part of the CEMP. The plan would include operational water management controls and a maintenance and inspection program for operational controls.

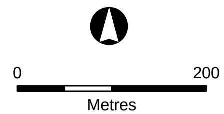
FIGURE 6-1 | PROPOSED OPERATIONAL WATER QUALITY TREATMENT LOCATIONS

LEGEND

- The proposal
- Construction footprint (5 m buffer)
- Proposed operational water quality treatment location
- Primary waterway
- Minor waterway
- Property boundary

Sinclair Knight Merz does not warrant that this document is definitive nor free of error and does not accept liability for any loss caused or arising from reliance upon information provided herein.

DATA SOURCES
Roads and Maritime 2013,
LPMA 2010, STREETWORKS 2001



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Newcastle Spatial Team - Prepared by : KO
Checked by : VC

7. Drinking water catchment and NorBE

As stated in **Section 2.3**, under the SEPP, a proposed development within the SCA drinking water catchment must have a neutral or beneficial effect on water quality. A NorBE assessment on water quality has been undertaken on the following page using the *Part 5 NorBE Assessment Template* (SCA, 2011b).

Section 3 of the proposal is located within the SCA catchment. Therefore this section of the proposal is subject to the NorBE criteria. Sections 1 and 2 have not been assessed for NorBE.

As allowed by Note 4 of the *Part 5 NorBE Explanatory Note* (SCA, 2011c), the answers to some of the assessment questions are simplified by referring to the relevant sections in this report.

Neutral or Beneficial Effect Assessment for proposed activities by public authorities that will be assessed under Part 5 of the Environmental Planning and Assessment Act 1979, as specified in Clause 12 of the State Environmental Planning Policy (Sydney Drinking Water Catchment) 2011

NorBE assessment – will there be a neutral or beneficial effect on water quality? *(Assessment must consider surface and ground waters and must consider construction and operation stages)*		
1)	Are there any identifiable potential impacts on water quality? What **pollutants** are likely? *Major potential pollutants are* ***sediments*** *(fine and coarse),* ***nitrogen, phosphorus, pathogens*** *and* ***hazardous chemicals and contaminants*** *such as oil/fuel.* During construction and/or post construction?	Impacts on water quality are possible from the construction and operation of the proposal. Impacts on water quality during construction are identified in **Section 5.1** and during operation are identified in **Section 5.2.** Pollutants likely during construction are identified in **Section 5.1.2** and during operation are identified in **Section 5.2.1**.
2)	For each pollutant list the **safeguards** needed to prevent or mitigate potential impacts on water quality *(these may be SCA endorsed current recommended practices and/or equally effective other practices*)?	Mitigation measures for the construction impacts are identified in **Section 6.1** and for the operation impacts in **6.2**. The construction phase mitigation measures are based on the Blue Book (Landcom 2004 and DECC 2008b) which are endorsed by the SCA as ‘current recommended practice’ (CRP).
3)	Will the safeguards be adequate for the time required? How will they need to be maintained?	Construction phase controls would be designed for an anticipated duration of less than 24 months, using Blue Book (Landcom 2004 and DECC 2008b) parameters for the design of sediment basins selected for this time frame. Maintenance of construction phase controls is detailed in **Section 6.1.5**. The design life of the biofiltration basin and water quality ponds would be between 20 and 50 years. Maintenance of operational phase controls is detailed in **Section 6.2.2**.
4)	Will all **impacts** on water quality be effectively **contained on the site** by the identified **safeguards** (above) and not reach any watercourse, waterbody or drainage depression? Or will **impacts** on water quality be **transferred outside the site** for treatment? How? Why?	All potential impacts as a result of both construction and operation of the proposal would be treated prior to discharge to the surrounding environment or receiving water bodies.

NorBE assessment – will there be a neutral or beneficial effect on water quality? *(Assessment must consider surface and ground waters and must consider construction and operation stages)*	
5) Is it likely that a **neutral or beneficial effect** on water quality will occur? Why?	From the qualitative assessment undertaken, the proposal is likely to have a neutral or beneficial effect on water quality. Explanation is provided in **Section 8.** Further detailed assessment including water quality modelling using MUSIC would be undertaken during development of the detailed design
Prepared by/date	Sinclair Knight Merz 14 August 2012

8. Conclusion

The Mount Victoria Safety Upgrade is located across the Grose River and Coxs River Catchment. The Grose River catchment forms part of the Great Blue Mountains World Heritage Area and the river itself is classified as a ‘wild river’ This indicates it has high conservation value and is in in near-pristine condition in terms of animal and plant life and water flow. The Coxs River catchment forms part of Sydney’s drinking water supply catchment, managed by the SCA. The proposal is located in the extreme upper reaches of both catchments.

Limited available data indicates that nearby waterways are generally in good condition. Given that the current highway does not include any water quality treatment, this data suggests that the waterways are resilient to water quality impacts from the highway.

The scope of the proposal includes widening of the existing highway shoulders and a number of intersection works. In relation to the existing highway, the proposal does not present significant changes. This is in contrast to other nearby proposals or completed project on the Greater Western Highway, where the design involves full widening.

During construction, there is potential for the works to increase the levels of sediments and pollutants to downstream waterways, particularly through activities such as vegetation clearance, topsoil stripping and cut and fill earthworks. During operation, increased impervious areas have the potential to increase levels of pollutants discharging to downstream waterways. There are three discharge points that would generate proportionately high pollutants in comparison to the existing location. The assessment deemed that mitigation measures for both construction and operation would be required.

Mitigation of construction impacts would be in line with the strategies recommended in the Blue Book (Landcom 2004 and DECC 2008b). Lyall and Associates have produced a conceptual erosion and sediment control strategy (RMS, 2013c) that would include sediment sumps and other localised erosion and sediment controls. Sediment basins would also be included in locations where permanent operational controls would be located. These controls would be part of a multi-faceted approach that would also include procedural controls, site management controls and monitoring.

The operational water quality strategy is to prevent or reduce water quality impacts to downstream waterways as a result of operation of the new sections of the road that would be developed as part of the proposal. Mitigation would apply to new sections of the highway where traffic flow is high and would be focused on locations where increased impervious areas would results in an increase in pollutant runoff compared to the existing situation. Two biofiltration basins and one water quality ponds are proposed. Indicative sizes and locations are provided and include a pond of 250 square metres at chainage 15590, a biofiltration basin of 500 square metres at chainage 16490, and biofiltration basin at the northern end of Fairy Dell Road of 200 square metres.

The size, type and location of the water quality mitigation measures would be further investigated, calculated and modelled using appropriate tools during detailed design, in accordance with the criteria detailed in this REF and following liaison with Roads and Maritime and the SCA.

If these measures are correctly designed and then adequately implemented, managed and maintained on site, it is expected that the proposal would have a neutral or beneficial impact on water quality in the SCA catchment, in comparison to existing conditions.

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Appendix A Proposed design

Figure A. 1 Proposed Section 1 design

Figure A. 2 Proposed Section 2 design

Figure A. 3 Proposed Section 3 design

Appendix B Water quality data

Table B. 1 Water quality results (2006/2010) River Lett at Jenolan Caves Road (Source: Streamwatch/Lithgow Environment Group).

Date	Temperature (°C)	Conductivity (ms/cm)	DO (mg/L)	pH	Salinity (PSS)	DO (%sat)	Turbidity NTU	Available Phosphorus (mg/L)	Nitrate-nitrogen (mg/L)
FAIRY DELL CREEK									
May 2012 (rep 1)	11.21	0.066	8.53	7.49	0.030	76.7	7.9	0	0.13
May 2012 (rep 2)	11.20	0.067	8.35	7.41	0.030	75.5	6.9	0	0.05
May 2012 (rep 3)	11.19	0.067	8.4	7.42	0.030	75.7	6.5		
February 2011	15.08	0.089	7.92	7.67	0.040	77.5	9.7		
February 2010	17.32	0.089	8.14	7.13	0.04	84.8	7.9	0	0.09
February 2009	14.29	0.115	8.64	6.7	0.06	85.1	19.5	0.03	0.14
March 2007	13.25	0.378	8	7	0.18	76	16.4	0	0.15
April 2006	11.28	0.55	9.95	7.96	0.026	90.8	18.3	0.17	1.14
2005	14.23	0.261	8.94	6.42	0.12	95	9.6	0.49^	1.95
2003	13.6		5.4	6.4			13	0.03	
2001	16.52	0.056	9.59	6.85		98.2	21.4		
2000	13.81	0.0307	7.25	7.25		79.3			
GROSE RIVER TRIBUTARY									
April 2012 (rep 1)	10.41	0.047	8.3	7.30	0.020	73.3	7.5	0	0.02
April 2012 (rep 2)	10.41	0.047	8.22	7.22	0.020	72.4	6.7	0	0.07
April 2012 (rep 3)	10.42	0.047	8.11	7.17	0.020	71.8	6.1		
March 2011	13.77	0.055	7.72	6.93	0.030	73.8	15.2	0.13	0.07
January 2010	14.77	0.045	6.49	5.8	0.02	63.7	4.3	0.05	0.12
February 2009	15.07	0.057	6.55	5.81	0.030	64.2	30.3	0.005	0.005
May 2007	12.75	0.050	8.25	5.80	0.030	78.9	12.75	0	0.16
April 2006	10.90	0.042	9.5	7.54	0.020	85	35	0.24^	0.2
2005	14.23	0.047	8.01	5.98	0.030	84.3	6.7		
2004	14.18		5	4.57		47.3	7.2		

Date	Temperature (°C)	Conductivity (ms/cm)	DO (mg/L)	pH	Salinity (PSS)	DO (%sat)	Turbidity NTU	Available Phosphorus (mg/L)	Nitrate-nitrogen (mg/L)
2002	15.00	0.034	7.68	6.74		76	3	0.02	
2000	14.74	0.036	5.97	6.44		59.4			

^ measured as Total Phosphorus

Appendix C Conceptual drainage design

Figure C. 1 Proposed Section 1 drainage design strategy (RMS, 2013c)

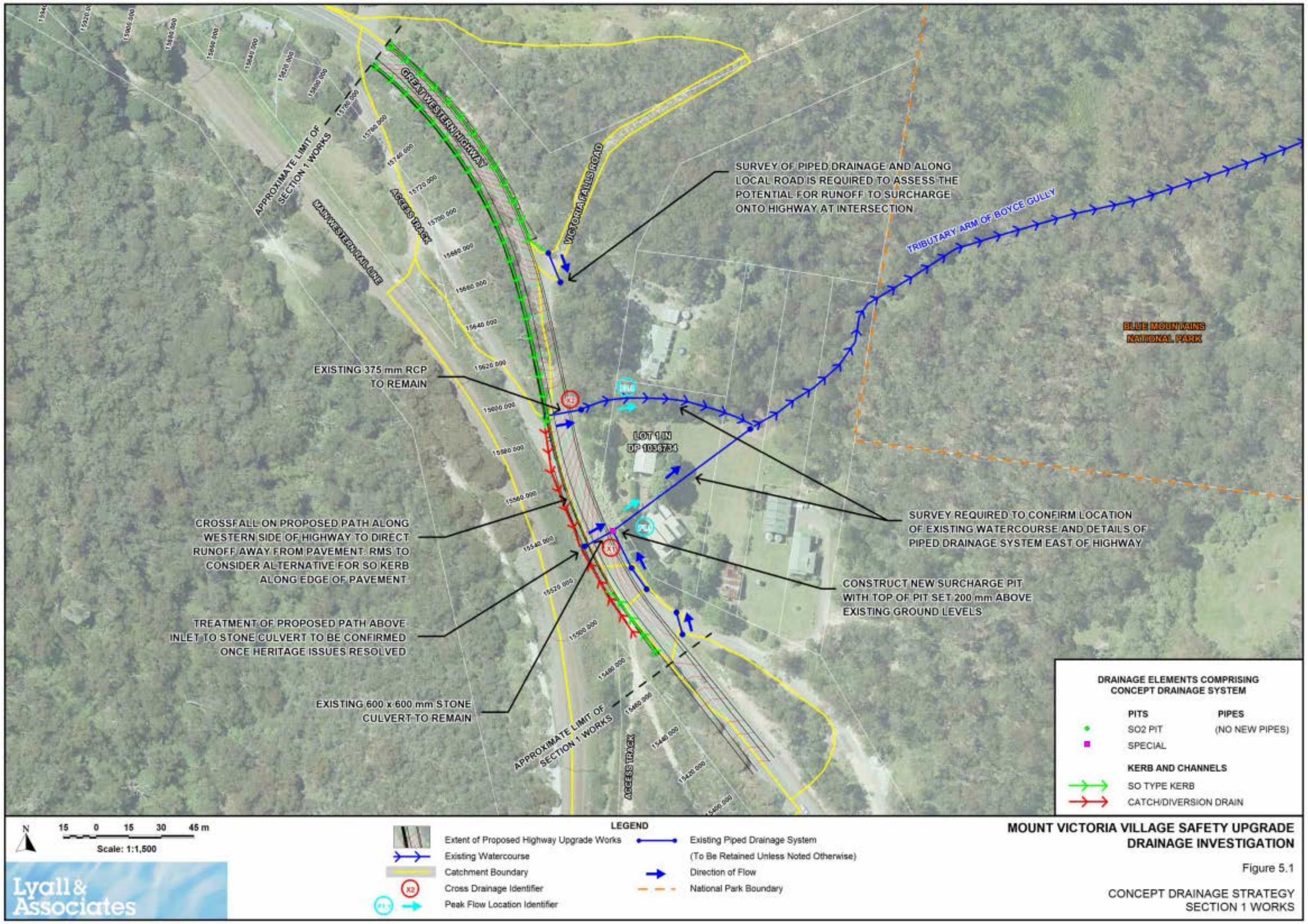


Figure C. 2 Proposed Section 2 drainage design strategy (RMS, 2013c)

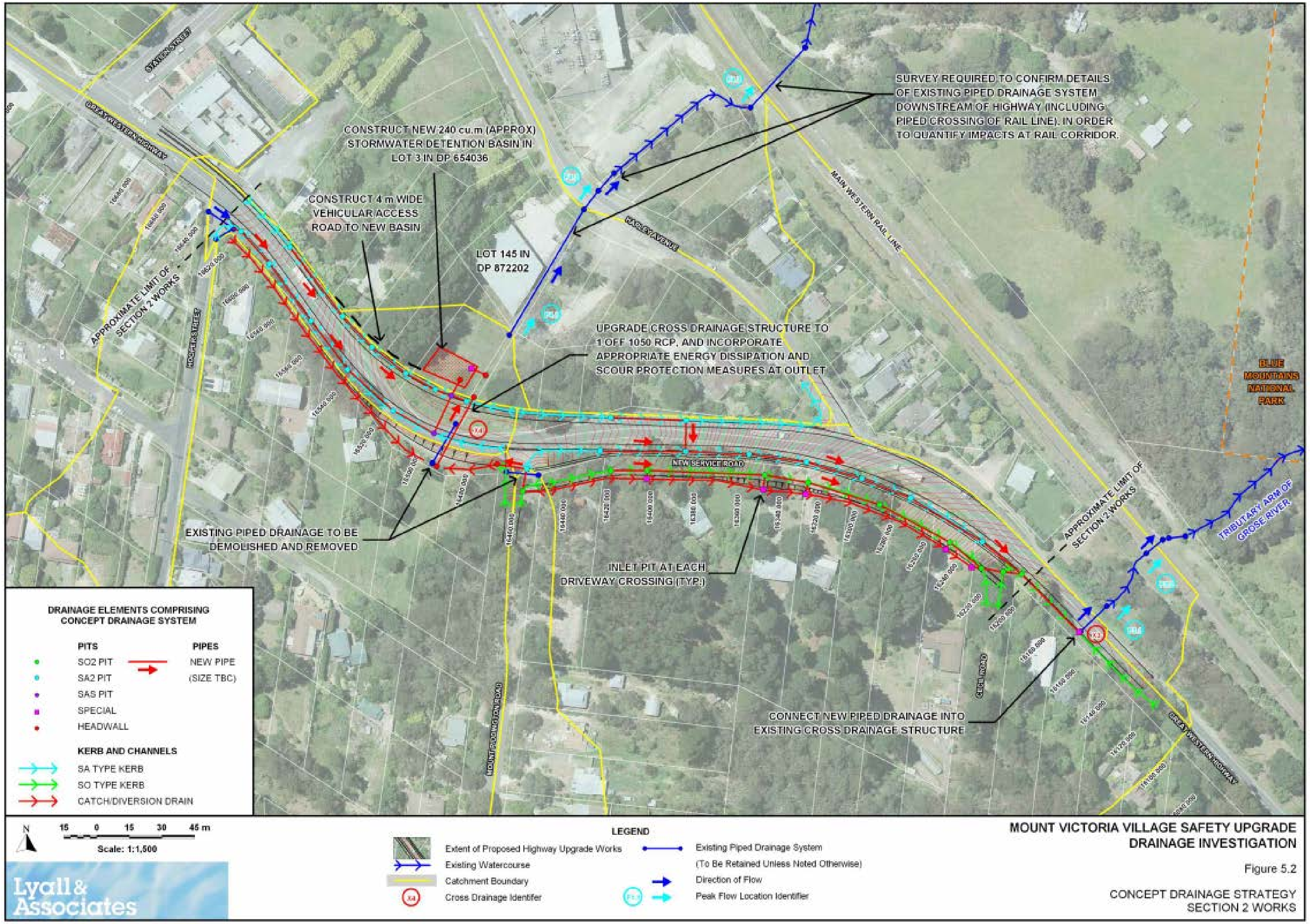


Figure C. 3 Proposed Section 3 drainage design strategy (Sheet 1 of 2) (RMS, 2013c)

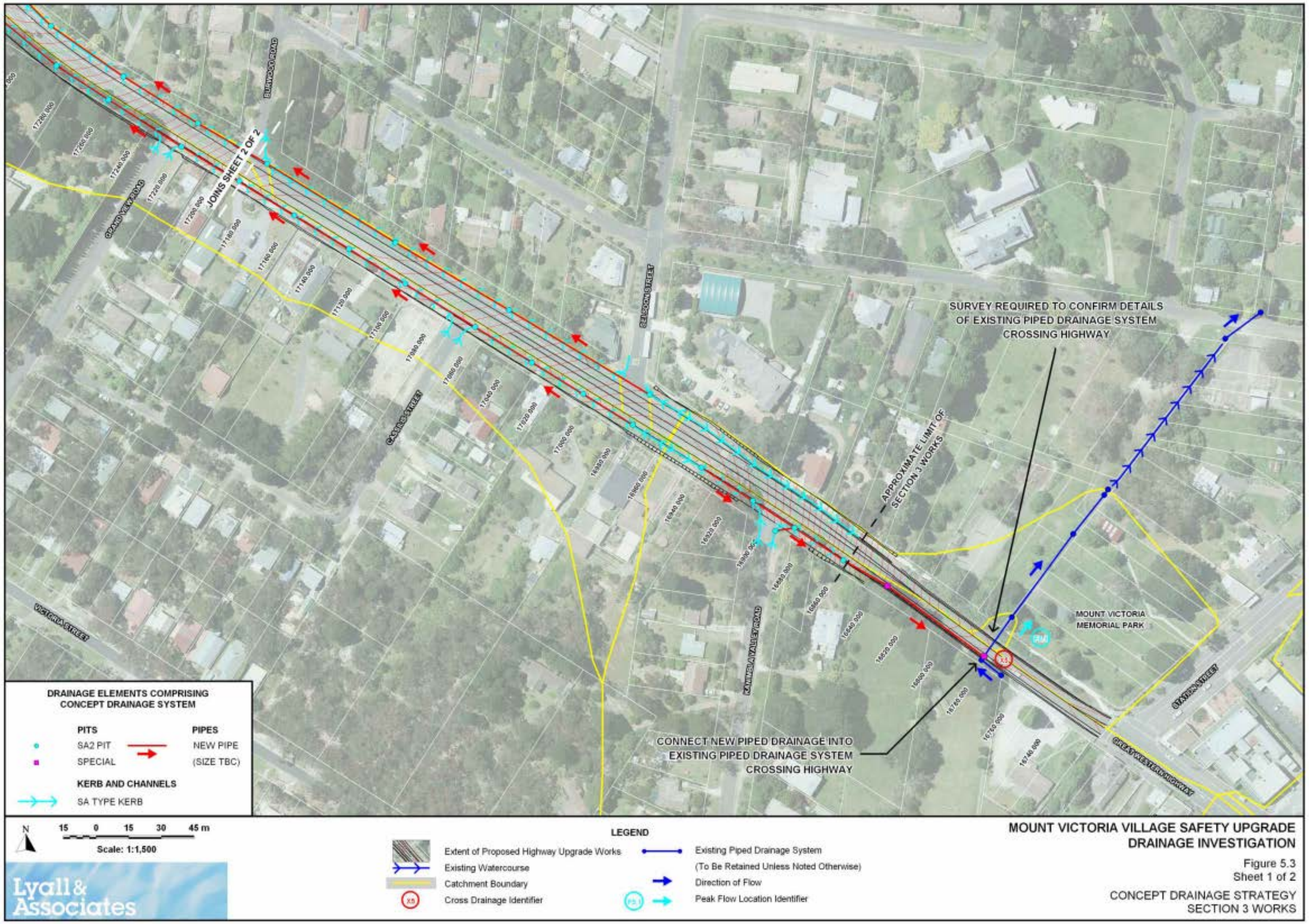
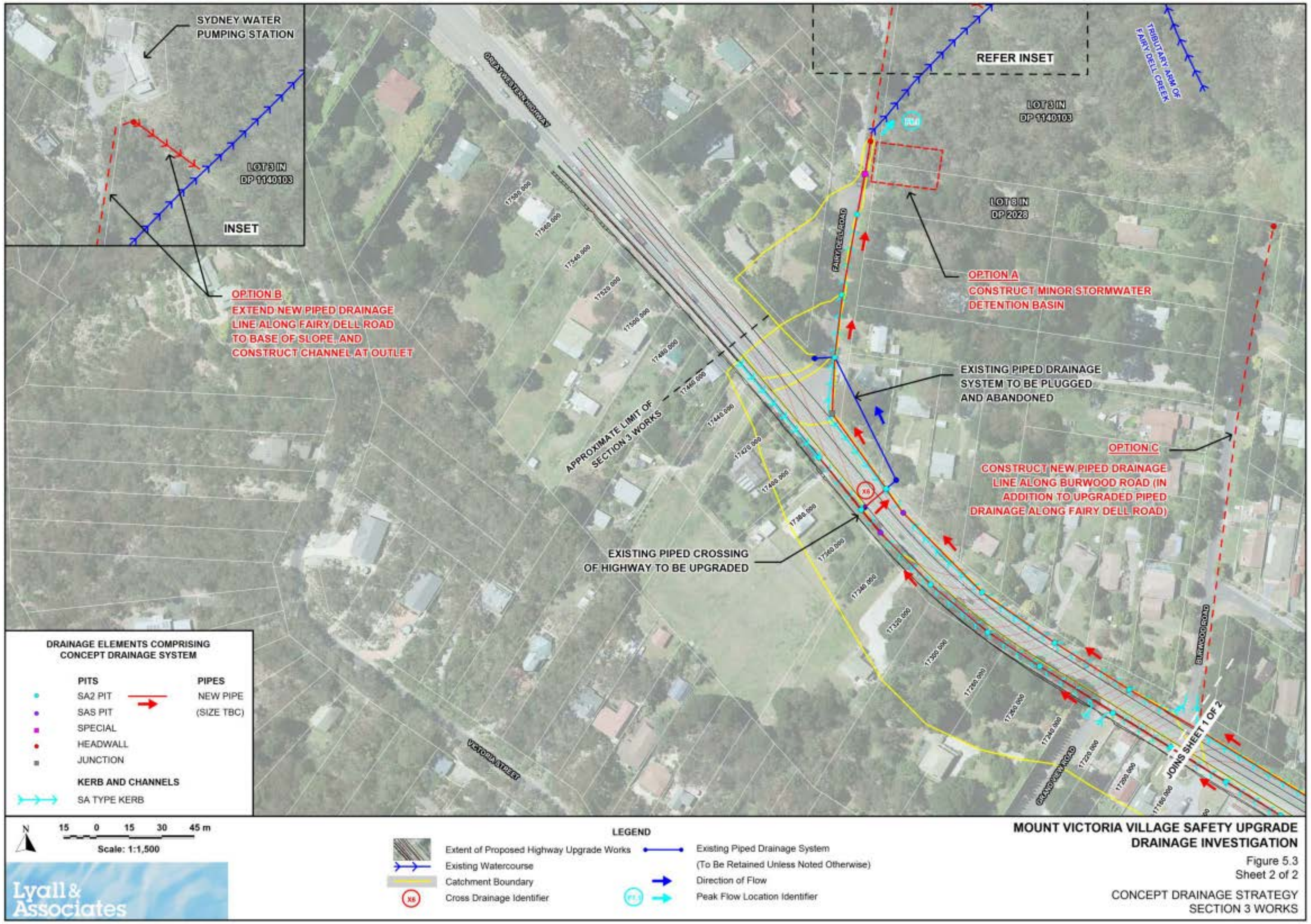


Figure C. 4 Proposed Section 3 drainage design strategy (Sheet 2 of 2) (RMS, 2013c)



Appendix D Conceptual erosion and sediment control strategy

Figure C. 5 Section 1 erosion and sediment control strategy (RMS, 2013c)

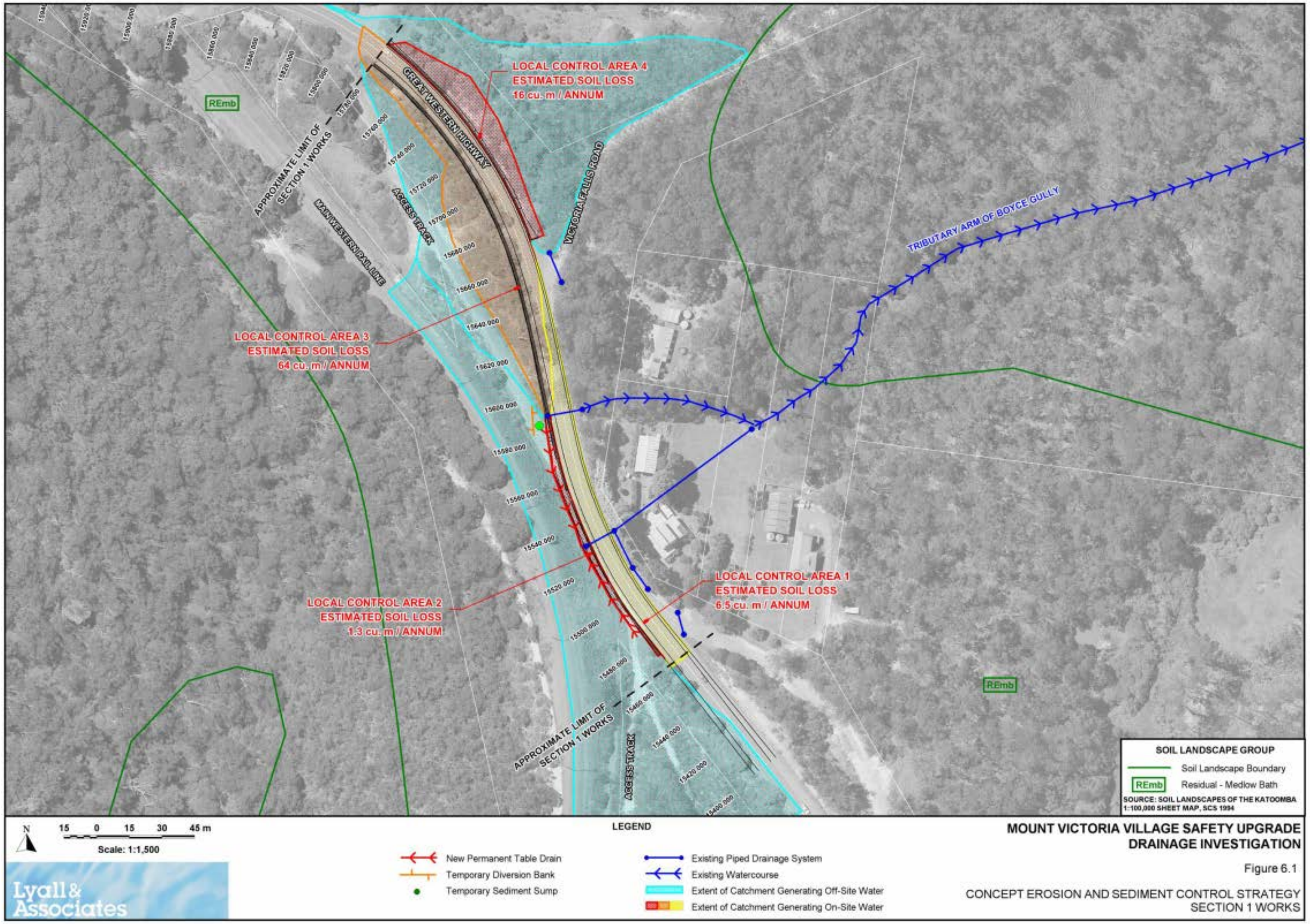


Figure C. 6 Section 2 erosion and sediment control strategy (RMS, 2013c)

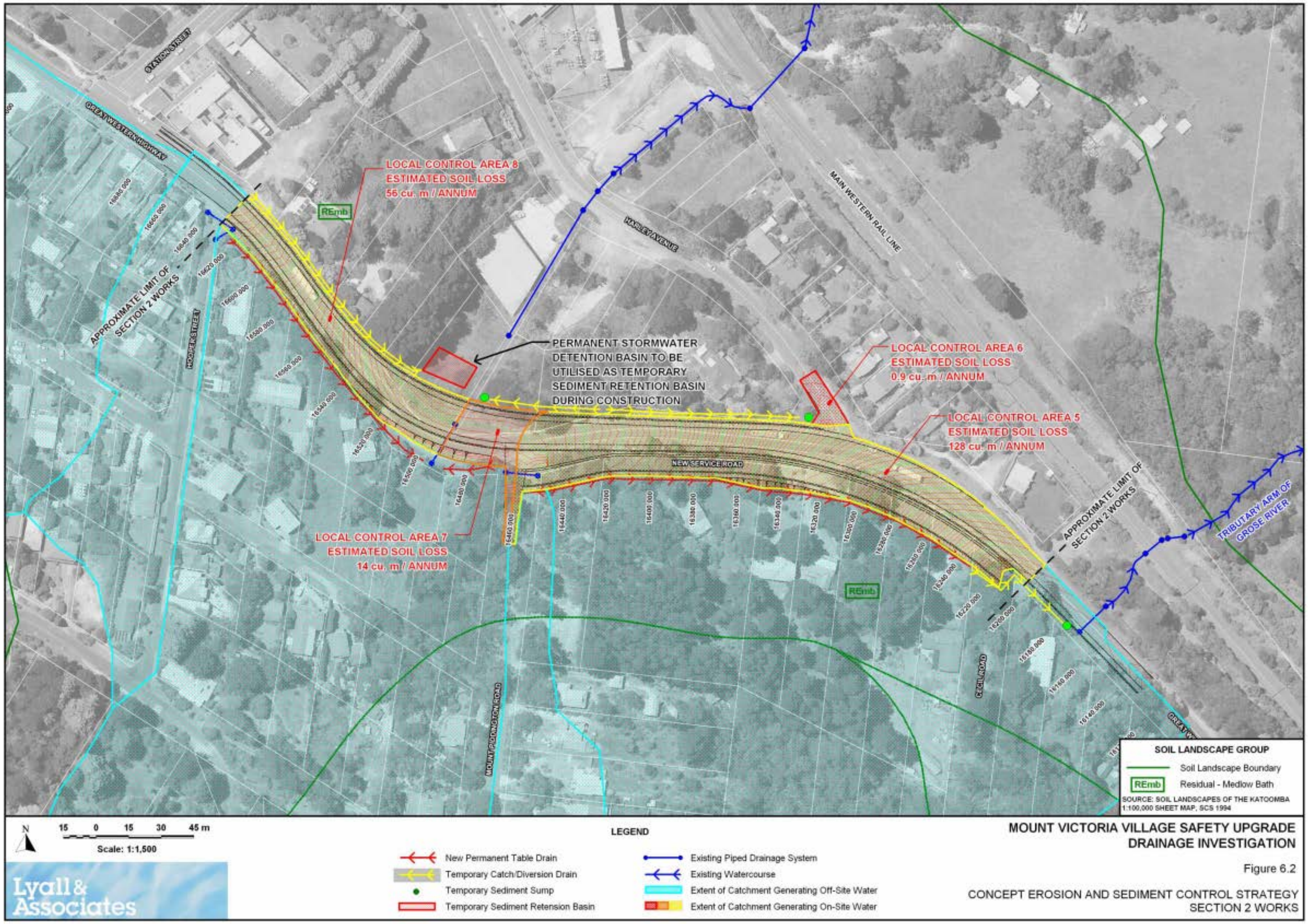


Figure C. 7 Section 3 erosion and sediment control strategy (Sheet 1 of 2) (RMS, 2013c)

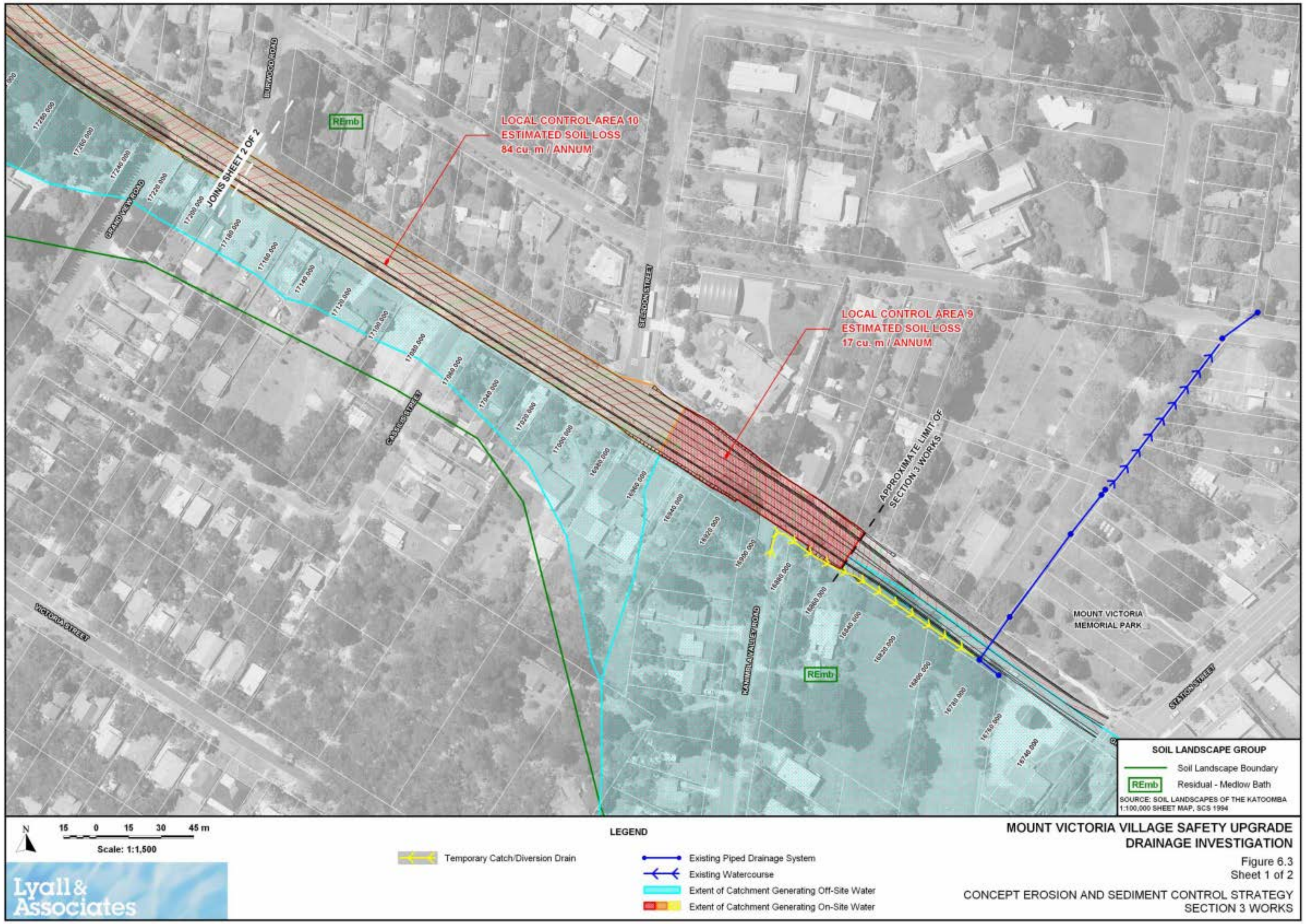
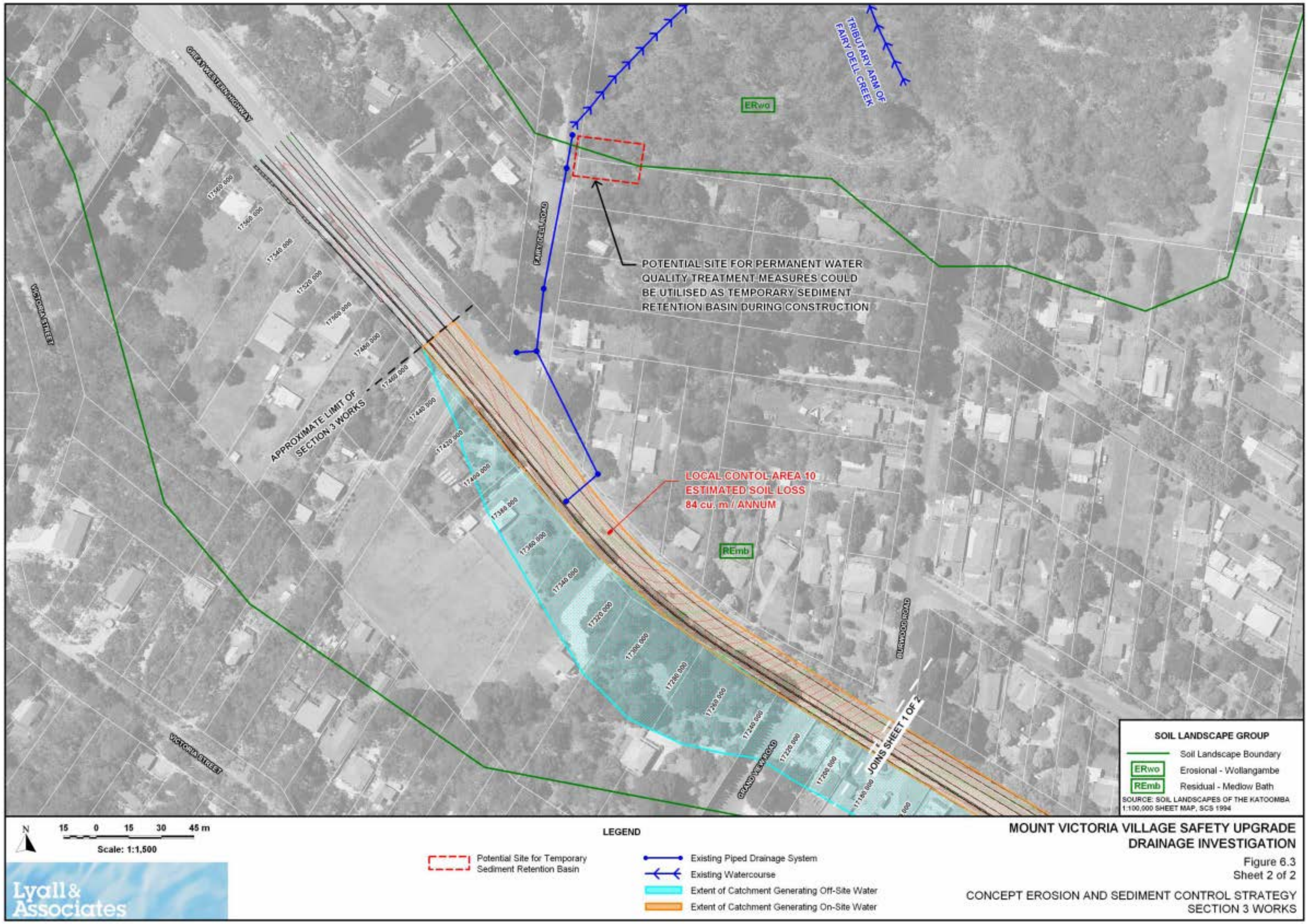


Figure C. 8 Section 3 erosion and sediment control strategy (Sheet 2 of 2) (RMS, 2013c)



Appendix E Operational water quality sizing

A water quality assessment was undertaken to attain water quality treatment volume. The tool used for this was the eWater *Model for Urban Stormwater Improvement Conceptualisation* (MUSIC). An iterative process was used to find the treatment device size needed to achieve the required water quality design criteria for the catchment. The pollutants modelled in MUSIC are Total Suspended Solids (TSS), Total Nitrogen (TN) and Total Phosphorus (TP), and the reduction criteria are shown in

Table E.1 Water quality design criteria

Pollutant	Minimum reduction of the annual average load
Total suspended solids (TSS)	80%
Total nitrogen (TN)	45%
Total phosphorous (TP)	45%
Oil and grease	None visible

The model was set up using rainfall data from a pluviograph at Katoomba (station number 06039), which was the closest available weather station. The models were run for observed rainfall data from 1980 to 2010 at daily time steps. Evaporation data was taken from the Silo Data Drill (QLD Government, 2009) for available data at Katoomba.

Catchment areas were taken from the Lyall report (RMS, 2013c) and are shown in **Table E.2.**

Table E.2 Catchment areas

	Total area (ha)	Impervious area (ha)		Proposed treatment method
X2	0.66	0.27	41%	Pond
X4	7.99	2.56	32%	Biofiltration basin
X6	2.91	1.48	51%	Biofiltration basin

The design parameters that have been assumed are shown in **Table E.3** and **Table E.4**. It should be noted that soil conditions are unknown and soil testing would need to be undertaken to determine the correct values.

Table E.3 Water quality pond assumed design parameters

Design parameter	Value
Pond depth	1.5m
Exfiltration rate	2mm/hr
Notional detention time	72 hours

Table E.4 Biofiltration basin assumed design parameters

Design parameter	Value
Extended detention depth	0.3m
Exfiltration rate	2mm/hr
Filter depth	0.9
Filter Medan particle diameter	0.45mm

Design parameter	Value
Saturated hydraulic conductivity	100mm/hr
Overflow weir width	2m

The results of the analysis are shown in **Table E.5**. It should be noted that these values are estimates only and further detailed analysis would be required during detailed design.

Table E.5 Treatment results

Location	Type	Size	Pollutant reduction (%)		
			TSS	TP	TN
X2	Pond	250m3	80	73	55
X4	Biofiltration basin	500m2	92	77	45
X6	Biofiltration basin	200m2	92	77	46