New Richmond Bridge and traffic improvements Stage 2

Soils, Surface Water and Groundwater Working Paper

Transport for New South Wales

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Contents

Executive Summary i

1 Introduction 1

1.1 Proposal identification 1

1.1.1 Proposal Background 1

1.1.2 Proposal Overview 2

1.2 Proposal location and setting 7

1.3 Scope of Work 7

1.4 Limitations 8

2 Methodology 9

2.1 Report Scope 9

2.2 Overview of approach 9

2.3 Desktop review 10

2.3.1 Study area 10

2.3.2 Data sources 12

2.4 Impact Assessment 13

3 Relevant legislation, policy and guidelines 16

3.1 Legislation 16

3.2 Policy and Guidelines 17

3.2.1 National policy and guidelines 17

3.2.2 State-wide and local policy and guidelines 19

4 Existing environment 37

4.1 Land use 37

4.2 Climate 39

4.3 Topography 40

4.4 Surface Water 42

4.4.1 Catchment and local water features 42

4.4.2 Surface water quality 45

4.4.3 Geomorphology 49

4.5 Soils 51

4.5.1 Soil landscapes 51

4.5.2 Erosion hazard 53

4.5.3 Acid sulfate soils 53

4.5.4 Soil salinity 56

4.5.5 Hydrologic soil properties 58

4.5.6 Naturally occurring asbestos 58

4.6 Geology 60

4.7 Hydrogeology 62

4.7.1 Hydrogeological landscapes 62

4.7.2 Aquifers 65

4.7.3 Groundwater users 67

4.8 Surface water and groundwater interaction 78

4.9 Sensitive receiving environments 79

4.9.1 GDEs 79

4.9.2 Wetlands 84

4.9.3 Key Fish Habitats 86

5 Construction Methodology 87

5.1 Early Works 87
5.2 Main Construction Works 87
5.2.1 Site establishment 88
5.2.2 Earthworks 88
5.2.3 Roadworks 88
5.2.4 Bridgeworks 89
5.2.5 Drainage work 90
5.2.6 Finishing work 90
5.3 Construction Zoning 91
5.3.1 Area 1 – New Hawkesbury River Bridge (Stage 2A only) 91
5.3.2 Area 2 – North Richmond (Stage 2A and Stage 2B) 91
5.3.3 Area 3 – Kurrajong Road between Old Kurrajong Road and Chapel Street (Stage 2A only) 91
5.3.4 Area 4 – Bypass between Kurrajong Road and Londonderry Road (Stage 2A and Stage 2B) 92
5.3.5 Area 5 – Bypass between Drift Road and Castlereagh Road (Stage 2A only) 92
5.3.6 Area 6 – Bypass / Londonderry Road Intersection (Stage 2B only) 92

6 Impact Assessment 94
6.1 Potential Construction Impacts 94
6.1.1 Ancillary facilities and stockpiles 94
6.1.2 Concrete/asphalt activities 95
6.1.3 Vegetation removal and earthworks 95
6.1.4 Works on waterfront land 96
6.1.5 Spills and incidents 96
6.1.6 Earthworks 96
6.1.7 Acid Sulfate Soils 97
6.1.8 Groundwater risks and dewatering 97
6.1.9 Surface water discharges 102
6.1.10 Water use 102
6.1.11 Summary of potential construction impacts 102
6.2 Potential Operational Impacts 107
6.2.1 Groundwater recharge and quality 107
6.2.2 Scour and erosion 107
6.2.3 Water quality 107
6.2.4 Salinity 111
6.2.5 Soil properties 111
6.2.6 Summary of potential operational impacts 111
6.3 Cumulative Impacts 114

7 Management of impacts 117
7.1 Overview of mitigation measures 117
7.2 Mitigation measures 117

8 Conclusion 125
9 References 126

Appendices

Glossary
Appendix A – Aquifer Interference Policy Guidelines
Appendix B – Erosion and Sedimentation Management Report

Figures

Figure 1-1 The proposal
Figure 2-1 Soil, surface water and groundwater study area
Figure 3-1 Water Sharing Plan groundwater source boundaries
Figure 4-1 Land uses surrounding the proposal area
Figure 4-2 Topography
Figure 4-3 Local water features
Figure 4-4 Surface water sample locations as part of the Stage 2 DSI
Figure 4-5 Geomorphic stream conditions
Figure 4-6 Soil landscapes
Figure 4-7 Acid sulfate soils
Figure 4-8 Salinity hazard
Figure 4-9 Hydrologic soil properties
Figure 4-10 Regional seamless geology
Figure 4-11 Hydrogeologic landscapes
Figure 4-12 Groundwater productivity
Figure 4-13 Relevant registered groundwater bores
Figure 4-14 Groundwater monitoring wells
Figure 4-15 Groundwater bores and water depths
Figure 4-16 Aquatic groundwater dependent ecosystems
Figure 4-17 Terrestrial groundwater dependent ecosystems
Figure 4-18 Mapped coastal wetlands
Figure 5-1 Construction stage zoning

Tables

Table 2-1 Data sources
Table 2-2 Risk matrix – likelihood descriptor
Table 2-3 Qualitative risk assessment
Table 2-4 Qualitative risk assessment
Table 3-1 Key legislation relevant to the proposal
Table 3-2 National policy and guidelines
Table 3-3 NSW and local policy and guidelines
Table 3-4 Aquatic ecosystem guideline values
Table 3-5 Other environmental values and associated guidelines
Table 3-6 Contaminant of Potential Concern Guidelines
Table 4-1 Climate monthly data
Table 4-2 Surface water quality data from the Stage 2 DSI (2023)
Table 4-3 Soil landscapes across the proposal area
Table 4-4 Soil landscape summary
Table 4-5 Summary of hydrogeologic conditions in registered groundwater bores
Table 4-6 Monitoring wells deployed
Table 4-7 Registered groundwater bores salinity data
Table 4-8 Physiochemical groundwater quality criteria
Table 4-9 Registered groundwater bores with standing water levels
Table 4-10 Groundwater strike results from geotechnical investigations
Table 4-11 Installed groundwater wells recorded standing water levels
Table 4-12 Aquatic Groundwater Dependent Ecosystems in and around the proposal area
Table 4-13 Terrestrial Groundwater Dependent Ecosystems
Table 6-1 Proposed basin dimensions and adjacent groundwater levels
Table 6-2 Proposal area excavation locations
Table 6-3 Summary of potential construction impacts for soils, surface water and groundwater
Table 6-4 Comparison of imperviousness pre and post development
Table 6-5 MUSIC Modelling – Preliminary Results
Table 6-6 Summary of potential operational impacts for soils, surface water and groundwater
Table 6-7 Summary of relevant key proposals and potential cumulative impacts
Table 7-1 Mitigation measures for proposal construction and operation
Table 9-1 Minimal impact considerations for a highly productive aquifer
Table 9-2 Minimal impact considerations for a low productivity aquifer

Glossary

Acronym	Definition
AHD	Australian Height Datum
AIP	NSW Aquifer Interference Policy
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand Guidelines
ASS	Acid Sulfate Soils
BaP	Benzo(a)pyrene
bgl	Below ground level
BoM	Bureau of Meteorology
BTEX	Benzene, Toluene, Ethylbenzene, Total Xylenes
CBD	Central Business District
CEMP	Construction Environmental Management Plan
cm	centimetre
CSWMP	Construction Soil and Water Management Plan
COPC	Contaminants of Potential Concern
CRC	Cooperative Research Centre
CRS	Chromium reducible sulphur
DGVs	Default guideline values
DMP	Dewatering Management Plan
DO	Dissolved oxygen
DPE	Department of Planning and Environment (nee Department of Planning, Industry and Environment)
NSW DCCEEW	NSW Department of Climate Change, Energy, the Environment and Water
DSI	Detailed Site Investigation
EC	Electrical conductivity
EILs	Ecological investigation levels
EP&A Act	Environmental Planning and Assessment Act 1979
EPA	Environment Protection Authority
ESCP	Erosion and sediment control plan
ESL	Ecological screening levels
ESMR	Erosion and Sedimentation Management Report
GDEs	Groundwater Dependant Ecosystems
GILs	Groundwater investigation levels
GMP	Groundwater Management Plan
GSW	General solid waste es
HCC	Hawkesbury City Council
HES	High efficiency sediment (basins)
HGL	Hydrogeological Landscape
HIL	Health-based investigation level
HRC	Health Rivers Commission
HSL	Health screening levels
H-N	Hawkesbury-Nepean
IDE	Inflow dependent ecosystem
KFH	Key fish habitat
km	kilometre

Acronym	Definition
km^2	Square kilometre
LGA	Local Government Area
L/s	Litres per second
m	meter
M	million
mL/year	Millilitres per year
MSDS	Material safety data sheet
mm	millimetre
m AHD	Meters Australian Height Datum
m bgl	Meters below ground level
mg/L	milligrams per litre
ML	Megalitres
mV	Millivolt
ND	Non-detect
NEPM	National Environment Protection Measures
NGIS	National Groundwater Information System
NHMRC	National Health and Medical Research Council
NorBE	Neutral or Beneficial Effects
NRAR	Natural Resource Access Regulator (NSW)
NSW	New South Wales
NTU	Nephelometric turbidity units
NWQMS	National Water Quality Management Strategy
OCPs/OPPs	Organochlorine and organophosphorus pesticides
OEMP	Operational Environment Management Plan
PAHs	Polycyclic aromatic hydrocarbons
PASS	Potential acid sulfate soil
PCBs	Polychlorinated biphenyl
PFAS	Per- and Poly-Fluoroalkyl Substances
PFOS	Perfluorooctanesulfonic acid
pH	Potential hydrogen
POEO	Protection of the Environment Operations Act 1997
RAAF	Royal Australian Air Force
RAP	Remediation Action Plan
RCI	River Condition Index
REF	Review of Environmental Factors
RFOs	River flow objectives
RTA	Roads and Traffic Authority (NSW)
SEARs	Secretary's Environmental Assessment Requirements
SEED	Sharing and Enabling Environmental Data
SEPP	State Environment Planning Policy
SMP	Spoil Management Plan
SSWGW	Soil, Surface Water and Groundwater
SSWMP	Soil and Surface Water Management Plan
TCS	Traffic control signal
TDS	Total dissolved solids
TfNSW	Transport for NSW

Acronym	Definition
TN	Total nitrogen
TP	Total phosphorous
TRH	Total Petroleum/Recoverable Hydrocarbons C6-C40
TSS	Total suspended solids
ug/L	Micrograms per litre
µS/cm	MicroSiemens per centimetre
UWS	University of Western Sydney
VENM	Virgin excavated natural material
WAL	Water access licence
WHS	Work, health and safety
WMP	Waste Management Plan
WMA	Water Management Act 2000
WQO	Water Quality Objective
WSP	Water Sharing Plans
WSWA	Water Supply Work Approval
˚C	Degrees Celsius

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Executive Summary

Transport for New South Wales proposes to upgrade Bells Line of Road and Kurrajong Road, between North Richmond and Richmond, as well as to construct a new bypass south of Richmond town centre. This has been proposed as the New Richmond Bridge and Traffic Improvements – Stage 2 (the proposal). Richmond Bridge is currently operating at capacity during peak periods and future traffic demand in the area would increase, driven by residential development west of the Hawkesbury River and background traffic growth. This is expected to further increase congestion and travel times along this arterial corridor. Hence, this proposal seeks to improve traffic, flood resilience and road safety within the Hawkesbury City Council local government area.

This report details constraints relevant to soils, surface water and groundwater, that may impact the construction and ongoing operation of the proposal. Further, this report assesses limitations associated with existing environmental conditions and how the proposal has the potential to impact local, sensitive receiving environments. This report has been prepared to support the Review of Environmental Factors for the proposal.

Key impact considerations have been outlined and partnered with site-specific mitigation measures. A review of the key soil considerations include: soil contamination, salinity, acid sulfate soils and erosion risks. Surface water considerations include water quality, geomorphology, sedimentation impacts, water supply and disposal. Key groundwater considerations include resource assessments, local users, water quality and dependent ecosystems. This assessment is a combination of a desktop review, supported by Aurecon's Stage 2 Geotechnical Investigation and Detailed Site Investigation (DSI), conducted in 2023 as part of the proposal's concept design.

Relevant national, state-based, and local legislation, policy and guidelines governing the management of soils, surface water and groundwater have been reviewed, with actions for construction and operational approvals recommended. Particularly, the NSW Aquifer Interference Policy, Water Management Act 2000, NSW Contaminated Land Management Act (1997) and NSW Acid Sulfate Soil Manual (1998), have been referenced to govern the scope of works.

The proposal is largely encompassed by an alluvial floodplain. This region is divided into numerous agricultural lots, typically bounded by a local road network. The floodplain is primarily used for rural or farming purposes and is covered by market gardens, turf farms, horse studs and nurseries. Flooding is a key concern of the proposal. Severe storm events have caused the Hawkesbury River floodplain to experience recent major flooding. Floods from late March 2021 to early July 2022 resulted in the damage to turf farms and other low-lying industries, as well as significant road closures and local access issues. Hence, the proposal's design seeks to improve access during floods, setting the design primarily above the nominal flood level, prioritising flood mitigation and safe means of traffic access during these flood events.

The proposal area is situated within the Hawkesbury-Nepean catchment, one of the largest coastal basins in NSW. The basin is considered unregulated river flow, with five major dams, as well as a range of weirs that control and retain river flows. The catchment faces significant water quality challenges due to localised, intensive urban and industrial development. The proposal area intersects a range of first, second, third, fourth and fifth-order streams, feeding minor lakes, waterbodies, wetlands and ultimately the Hawkesbury River. Hence, surface water quality within the Hawkesbury River is largely impacted by the severity and extent of floods, as well as local land uses. Coastal wetlands have been recognised as key sensitive receiving environments within the study area and subsequently a priority of design and management.

Surface water quality sampling undertaken as part of the Detailed Site Investigation for New Richmond Bridge Stage 2 indicated good water quality within the Hawkesbury River during ambient conditions at the time of sampling. Water quality within Pughs Lagoon, one of the coastal wetlands was shown to be moderately disturbed, likely the result of agriculture and urbanisation within its catchment. Water quality of other waterways within the floodplain are likely to be similar.

Soil hydrologic landscapes identified throughout the proposal area included Kurrajong, Richmond Lowlands and Londonderry. These soil groups are characterised by unconsolidated alluvial gravels, sands, silts and clays. A review of environmental databases further concluded four high risk areas within the Hawkesbury River floodplain for the presence of acid sulfate soils in sediments. The analysis of chromium reducible

sulfur, as part of the Detailed Site Investigation, at ten locations, concluded low sulfidic content. However, net acidity was exceeded in a range of samples. Acid sulfate soils are considered to be a potential risk for construction and operation and would need to be managed through the Construction Environmental Management Plan (CEMP).

The hydrogeologic landscape across the proposal area comprises of unconfined, colluvial and alluvial aquifers, with deeper bedrock aquifers within the Wianamatta Shale. Groundwater within the Hawkesbury alluvium is typically of good to moderate quality, and is a valuable water resource used predominately for stock and domestic agriculture and irrigation purposes. Database searches identified39 registered bores within 700 meters of the alignment (the proposal area).

Groundwater within the proposal area and from the alluvial aquifer is generally defined as fresh. The DSI introduced two monitoring bores (with an additional eight monitoring bores being installed as part of the geotechnical ground investigation) that found concentrations of metals, except zinc, nickel and copper, were detected in groundwater samples below the limit of reporting. These concentrations were attributed to naturally occurring elevated metal that are found in soils derived from the Wianamatta Shale. Additionally, samples collected were analysed for a suite of chemical contaminants of concern, including per- and polyfluoroalkyl substances (PFAS), of which, all were recorded below the laboratory limit of reporting (LoR) and adopted human health and ecological assessment criteria.

Groundwater levels across the floodplain were identified to range from very shallow to moderately deep, due to the proximity of and hydraulic connectivity with the Hawkesbury River. Historical database reviews concluded that levels ranged from 1.4 - 24.5 meters below ground level across the floodplain, taken between 1966 and 2023. During construction temporary dewatering may be required to provide dry conditions should excavations intersect the water-table (which is considered unlikely), such as bridge footings, retention basins, swales and utility trenches. Dewatering would be managed through a dewatering assessment prior to construction, and mitigations considered in the CEMP and a proposal wide risk register, based on concept design presented and assessed in this report groundwater dewatering is considered to be unlikely other than at the cofferdam locations (subject to confirmation of the final construction methodology and their final design during detailed design). Preference should be placed on methodologies that limit the time and volume of dewatering required.

A range of construction and operational risks have been identified, with examples of mitigation measures to be introduced as part of the Construction Environmental Management Plan. A range of recommendations have been provided as considerations, to further accompany ongoing development designs, inform the development of construction and operational phase management plans and uphold environmental due diligence.

1 Introduction

1.1 Proposal identification

Transport for NSW (Transport) proposes to upgrade Bells Line of Road / Kurrajong Road between Crooked Lane, North Richmond and Old Kurrajong Road, Richmond and construct a new bypass south of Richmond town centre. This is known as New Richmond Bridge and traffic improvements – Stage 2 (the proposal). The new route between Richmond and North Richmond would provide a minimum five per cent annual exceedance probability (AEP) flood resilience (equivalent to the 1 in 20 chance per year flood event). The proposal is about 50 kilometres north-west of the Sydney Central Business District (CBD) and about 33 kilometres north-west of Parramatta. It is in the Hawkesbury City Council local government area (LGA).

The proposal would be delivered in two stages, known as Stage 2A and Stage 2B. Should this REF be determined, and the already committed funding by the Australian Government and NSW Government released, Stage 2A would be constructed. This is expected to be complete by 2029. The timing of Stage 2B would be subject to available funding and Transport will continue to seek funding in upcoming State and Federal budgets to deliver the rest of the upgrades.

Stage 2A of the proposal includes a new four-lane bridge over the Hawkesbury River about 30 metres downstream of the existing Richmond Bridge, widening of Bells Line of Road through North Richmond to provide two lanes in each direction between the new bridge and the Terrace Road / Grose Vale Road intersection and a new bypass to the south of the Richmond town centre. The bypass would extend about 1.7 kilometres across the floodplain between the Kurrajong Road / Old Kurrajong Road intersection and Castlereagh Road / Inalls Lane / Southee Road intersection. Stage 2A of the proposal would also provide an active transport corridor between North Richmond and Richmond. This would include a new shared path on the southern side of Kurrajong Road between Old Kurrajong Road and Chapel Street and the conversion of the existing Richmond Bridge into an active transport connection across the Hawkesbury River.

Stage 2B of the proposal includes widening of Bells Line of Road between the Terrace Road / Grose Vale Road intersection and west of Charles Street and at its intersection with Crooked Lane. The bypass would also be extended 1.3 kilometres east from Castlereagh Road to Londonderry Road and would be a new road alignment to the south of Southee Road. Southee Road would connect to the bypass opposite Valder Place. The Londonderry Road / bypass / Vines Drive intersection would also be upgraded.

1.1.1 Proposal Background

Richmond Bridge is currently operating at capacity during peak periods and future traffic demand in the area will increase, driven by residential development west of the Hawkesbury River and background traffic growth. This is expected to further increase congestion and travel times along this arterial corridor.

Richmond Bridge is closed in moderate flood events when flood levels reach about eight metres Australian Height Datum (AHD), which is at about the 50 percent AEP flood level. Since 2020, Richmond Bridge has closed multiple times due to flooding. The closure of this bridge results in disruption to travel between North Richmond and Richmond and disrupts regional traffic using the Bells Line of Road corridor.

The Australian Government and NSW Government are funding traffic improvements between North Richmond and Richmond including a new bridge over the Hawkesbury River. This initiative is part of a wider program of traffic improvements between North Richmond and Richmond which includes previous intersection improvements at three key intersections on the approach to the existing Richmond Bridge, including Bells Line of Road / Grose Vale Road intersection in North Richmond as well as Kurrajong Road / Old Kurrajong Road intersection and March Street / Bosworth Street intersection in Richmond. The proposal builds on the previous intersection improvements and is being carried out as part of a wider program of traffic improvements between Richmond and North Richmond which is being delivered in two stages (Stage 1 and Stage 2). They are:

- **Stage 1** involves upgrading The Driftway between Londonderry Road and Blacktown Road to improve safety and flood resilience. This proposal has been separately determined by Transport and is being delivered separately to the proposal.
- **Stage 2** is the proposal and it aims to improve traffic efficiency, flood resilience, active transport connections and safety of the road network between Richmond and North Richmond.

1.1.2 Proposal Overview

The key features of Stage 2A of the proposal would include:

- a new four-lane bridge over the Hawkesbury River (about 360 metres long) about 30 metres downstream of the existing bridge, with two eastbound and two westbound lanes and the road level at a height to provide a five per cent AEP flood immunity
- widening of Bells Line of Road and Kurrajong Road to two lanes in each direction from the Terrace Road / Grose Vale Road intersection in North Richmond to just east of the Kurrajong Road / Old Kurrajong Road intersection in Richmond
- a new two-lane bypass south of Richmond town centre (one lane in each direction) between the Kurrajong Road / Old Kurrajong Road intersection and just east of the Castlereagh Road / Inalls Lane / Southee Road intersection, including:
  - a three-way signalised intersection connecting Kurrajong Road and the new bypass, including closure of the existing northern and southern legs of Old Kurrajong Road at Kurrajong Road
  - a two-way gated emergency driveway access connecting the northern leg of Old Kurrajong Road and Kurrajong Road, to be opened during flood evacuation events
  - a 150-metre-long bridge over a tributary to Mareh-Mareh Lagoon (near Inalls Lane)
  - a 120-metre-long bridge over the floodplain parallel to Inalls Lane
  - a roundabout at the Castlereagh Road / Inalls Lane / bypass intersection, with a local road connection to Southee Road
  - local road connections to Yarramundi Lane and Victoria Place from the bypass
  - truncation of Inalls Lane near Mareh-Mareh Lagoon, with local road connections to Inalls Lane from the bypass via Yarramundi Lane and near Drift Road
  - closure of the existing Drift Road intersection with Inalls Lane, with a new local road connection to Drift Road from the bypass
  - footpaths along the southern side of the of the bypass between Drift Road and Castlereagh Road and on each side of the roundabout
- an upgraded active transport network between Richmond and North Richmond, including:
  - a new shared path along the southern side of Kurrajong Road between the existing Richmond Bridge and Chapel Street, Richmond, a distance of about two kilometres, connecting to existing paths along March Street, Richmond
  - conversion of the existing Richmond Bridge and approaches into an active transport only connection
  - active transport connections from the existing Richmond Bridge through Hanna Park to an upgraded shared path on the northern side of Bells Line of Road until east of the Bells Line of Road / Terrace Road / Grose Vale Road intersection
- retention of bus stops along Bells Line of Road and Kurrajong Road
- new drainage infrastructure, including swales and water quality basins
- utilities connections and upgrades (including electrical, gas, water and telecommunications)
- new intelligent transport systems including closed-circuit television (CCTV) cameras to monitor traffic flow and assist with emergency management
- new maintenance access to the three new bridge structures

- permanent retaining walls near the approach to the new four-lane bridge in North Richmond and along Kurrajong Road near the new shared path
- driveway adjustments and tie-ins, including along Bells Line of Road, Beaumont Avenue, Kurrajong Road, Old Kurrajong Road, Inalls Lane, Drift Road and Castlereagh Road
- eight new parking spaces on the northern side of Beaumont Avenue, near its intersection with Terrace Road to replace parking spaces removed on Bells Line of Road
- finishing works, including kerb and gutters, signs, landscaping, lighting and line marking
- construction activities, including:
  - early work, including the establishment of a new compliant handrail on the existing Richmond Bridge
  - geotechnical, contamination and utility investigations which may be carried out as early work
  - a temporary roundabout at the Kurrajong Road / Chapel Street intersection
  - civil earthworks, bridge structural works, retaining walls, drainage work, utilities relocations and tie-in work and adjustments to adjoining sections of road
  - establishment of temporary ancillary facilities to support construction, including compound sites, site offices, stockpile and laydown locations, temporary access tracks and water quality devices
  - demolition work for structures and property features that fall in the proposal area.

The key features of Stage 2B of the proposal would include:

- localised widening of Bells Line of Road to provide a dedicated right-turn lane into Crooked Lane
- widening of Bells Line of Road to two lanes in each direction from west of Charles Street to the Terrace Road / Grose Vale Road intersection in North Richmond
- additional capacity improvements to the Bells Line of Road / Terrace Road / Grose Vale Road intersection, including an additional eastbound through lane at the intersection
- an upgraded shared path on the northern side of Bells Line of Road from west of Charles Street to the Terrace Road / Grose Vale Road intersection in North Richmond
- extension of the bypass (one lane in each direction) between the Castlereagh Road roundabout and just south of the Londonderry Road / Southee Road intersection, including:
  - a new signalised intersection at the junction of Londonderry Road, the new bypass and Vines Drive
  - closure of the Southee Road local road connection from Castlereagh Road and closure of Southee Road at Londonderry Road
  - a new local road connection to Southee Road opposite Valder Place, with left and right turn lanes provided at this intersection.
  - two new bus stops along the bypass near Hill Avenue (one eastbound and one westbound), with a footpath connection to Southee Road
- retention of bus stops along Bells Line of Road and Londonderry Road
- new drainage infrastructure, including swales and a water quality basin on Londonderry Road
- noise screening mounds, walls and/or additional attenuation between the bypass and Southee Road along the extended section of the bypass between Castlereagh Road and Londonderry Road
- utilities connections and upgrades (including electrical, gas, water and telecommunications)
- new intelligent transport systems at the Londonderry Road / bypass / Vines Drive intersection including closed-circuit television (CCTV) cameras to monitor traffic flow and assist with emergency management
- driveway adjustments and tie-ins, including along Bells Line of Road, the bypass and Londonderry Road
- finishing works, including kerb and gutters, signs, landscaping, lighting and line marking
- construction activities, including:

- geotechnical, contamination and utility investigations which may be carried out as early work
- civil earthworks, retaining walls, drainage work, utilities relocations and tie-in work and adjustments to adjoining sections of road
- establishment of temporary ancillary facilities to support construction, including compound sites, site offices, stockpile and laydown locations, temporary access tracks and water quality devices
- demolition work for structures and property features that fall in the proposal area.

An overview of the proposal (Stage 2A and 2B) is provided in Figure 1-1a-b.

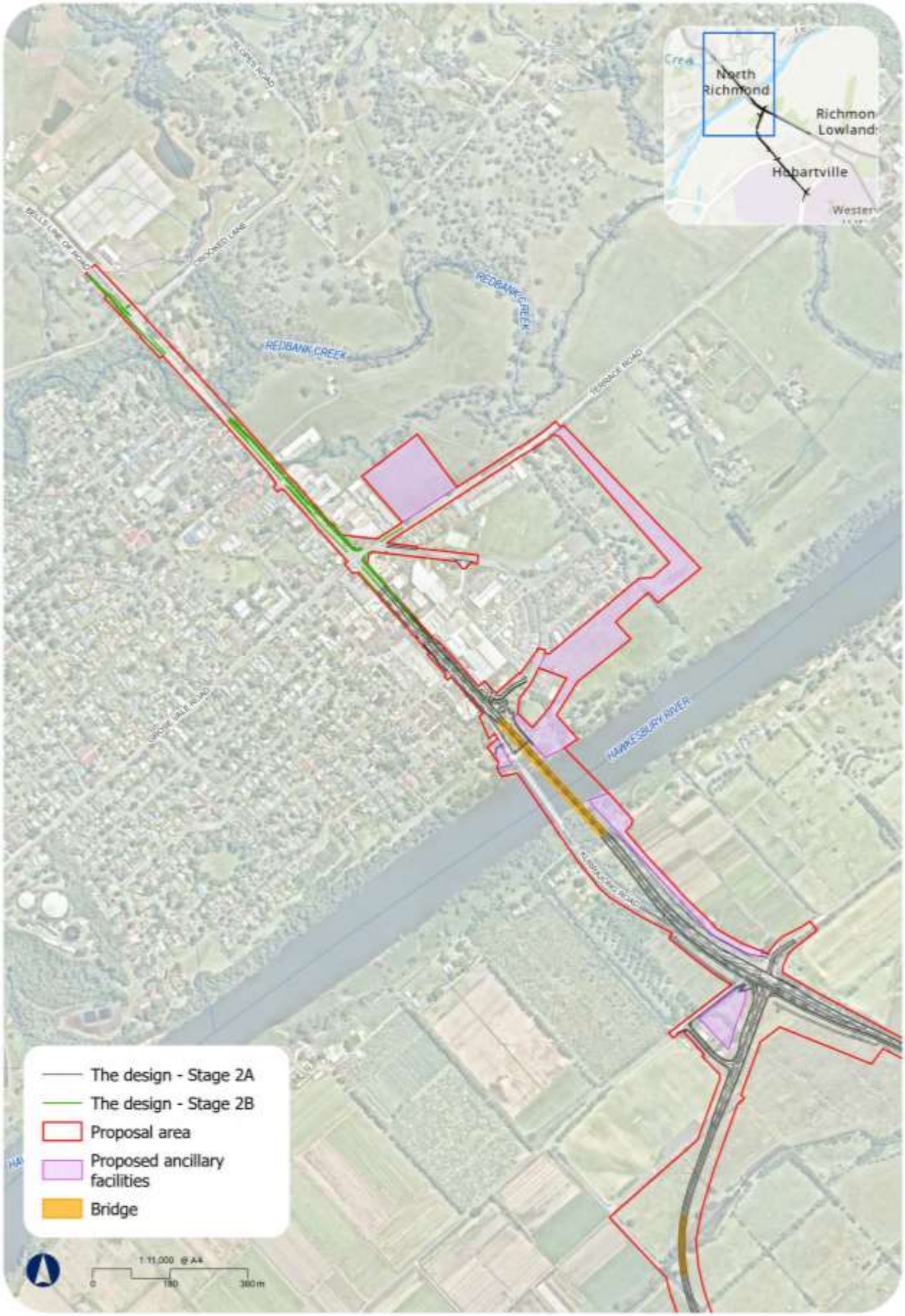

Figure 1-1a The proposal

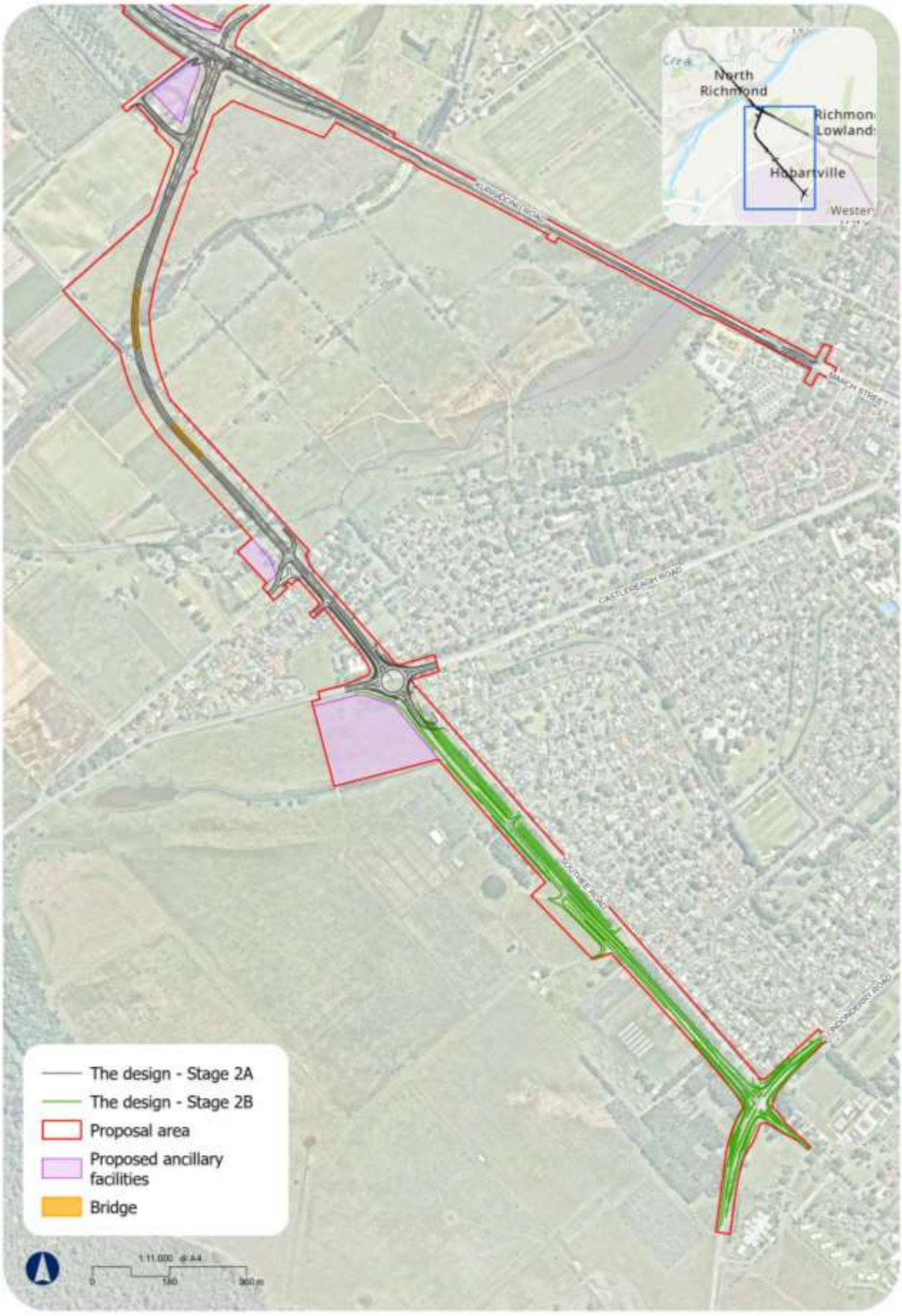

Figure 1-1b The proposal

1.2 Proposal location and setting

Richmond has a rich heritage and is one of five original Macquarie Towns. Along Southee Road and Inalls Lane, the proposal area is immediately south of the Hobartville residential area. Between Inalls Lane and the Hawkesbury River, the proposal area passes through large rural landholdings, of agricultural, horse stud farms and recreational uses. On the western side of the Hawkesbury River, the proposal crosses Hanna Park, before continuing through the North Richmond town centre, of commercial, industrial and residential zones.

The existing Richmond Bridge forms part of the Bells Line of Road and Kurrajong Road corridor, connecting Richmond and North Richmond. This corridor allows motorists to access the Bells Line of Road crossing of the Blue Mountains, one of two routes connecting the Blue Mountains and Central West to Sydney.

1.3 Scope of Work

This report has been prepared to support the Review of Environmental Factors (REF) for the proposal.

The following scope of work was completed to prepare the Soil, Surface Water and Groundwater (SSWGW) Assessment Working Paper for the REF proposal area:

- A proposal overview and summary,
- assess the relevant legislation, policy and guidelines applicable to the scope of works for construction and operational approvals,
- understand the existing environment and implications for construction and operation. This includes assessing:
  - catchment and surface water conditions,
  - soil and contamination conditions,
  - regional and site-specific geology,
  - hydrogeology and groundwater conditions,
  - sensitive receiving environments,
- characterise the soils, surface water and groundwater of the proposal area,
- assess potential impacts of the proposal during the construction and operational phases,
- recommend management or mitigation measures to eliminate or reduce identified potential impacts.

1.4 Limitations

This report has been prepared by Aurecon for Transport, for the purpose agreed between Aurecon and Transport, as set out in this report. The services undertaken by Aurecon in preparation of this report are limited to those specifically detailed in the report and are subject to the scope of limitations set out in the report.

The opinions, conclusions and any recommendations in this report are based on:

- conditions encountered and information reviewed at the date of preparation of the report. Aurecon has no responsibility or obligation to update this report to account for events or changes arising post completion,
- assumptions made by Aurecon described in this report. Aurecon disclaims liability arising from any of the assumptions being incorrect,
- information obtained from testing undertaken at, or in connection with specific sample points. Site conditions at other parts of the site may differ from specific site conditions found at specific sample points.

Site conditions (including the presence of hazardous substances and/or site contamination) may change following completion of this report. Aurecon does not accept responsibility arising from, or in connection with, any changes to site conditions.

2 Methodology

2.1 Report Scope

This report provides a Soil, Surface Water and Groundwater assessment prepared by Aurecon to support the New Richmond Bridge Stage 2 Proposal REF. The purpose of this working paper is to assess the impacts of the proposal area on soils, surface water and groundwater.

Key considerations for soils include:

- soil contamination,
- salinity,
- acid sulfate soils,
- erosion risks.

Key considerations for surface water include:

- surface water quality and surface water quantity,
- geomorphology,
- water supply and disposal.
- sensitive surface water environments (e.g. coastal wetlands).

Key considerations for groundwater include:

- groundwater resource (e.g., aquifer conditions, resource potential, vulnerability, recharge, levels),
- groundwater users (e.g., irrigation, stock and domestic, commercial/industrial, potable water supply),
- groundwater quality (physical parameters and chemistry),
- groundwater dependent ecosystems (GDEs) (e.g., watercourses, wetlands).

2.2 Overview of approach

The following tasks were undertaken as part of the assessment:

- desktop review of available information and data collation,
- field verification: general regional walkover and targeted waterway geomorphological survey to define:
  - existing environment,
  - potential construction and operational impacts,
  - construction and operational mitigation measures.
- Detailed Site Investigation (DSI) undertaken from June – November of 2023 studying site specific geotechnical, hydrogeologic, hydraulic and contaminant implications for the design,
- an assessment of the relevant requirements and waterway objectives, evaluated on a qualitative basis,
- report the impact assessment findings and identification of any appropriate management measures to be implemented during construction and operation.

2.3 Desktop review

A desktop review was conducted to gain an understanding of the existing conditions of the area. The defined study area is defined in Section 2.3.1, and sources of data detailed in Section 2.3.2.

2.3.1 Study area

For the purpose of this assessment, the proposal is broken down into the proposal area and the proposal study area. The proposal area has been proposed as the immediate zone that would undergo earthwork activities, with a five-metre buffer from the edge of the design to account for vegetative clearance boundaries. This footprint includes all construction activity areas, including laydown areas for ancillary facilities or the storage of equipment and machinery.

The proposal area includes a buffer zone of approximately 700 m, either side of the alignment. This is relevant to groundwater and surface water assessments. The fluidity of these components expands the study area beyond the proposal area. The study area for surface water includes the Hawkesbury River, Redbank Creek, Rickabys Creek range of Coastal Wetlands inclusive of Pughs lagoon and Mareh-Mareh lagoon and their connecting tributaries extending down gradient across an alluvial floodplain to the Hawkesbury River, as the ultimate surface water receptor.

The proposal area and proposal study area (assessment boundary) is shown in Figure 2-1.

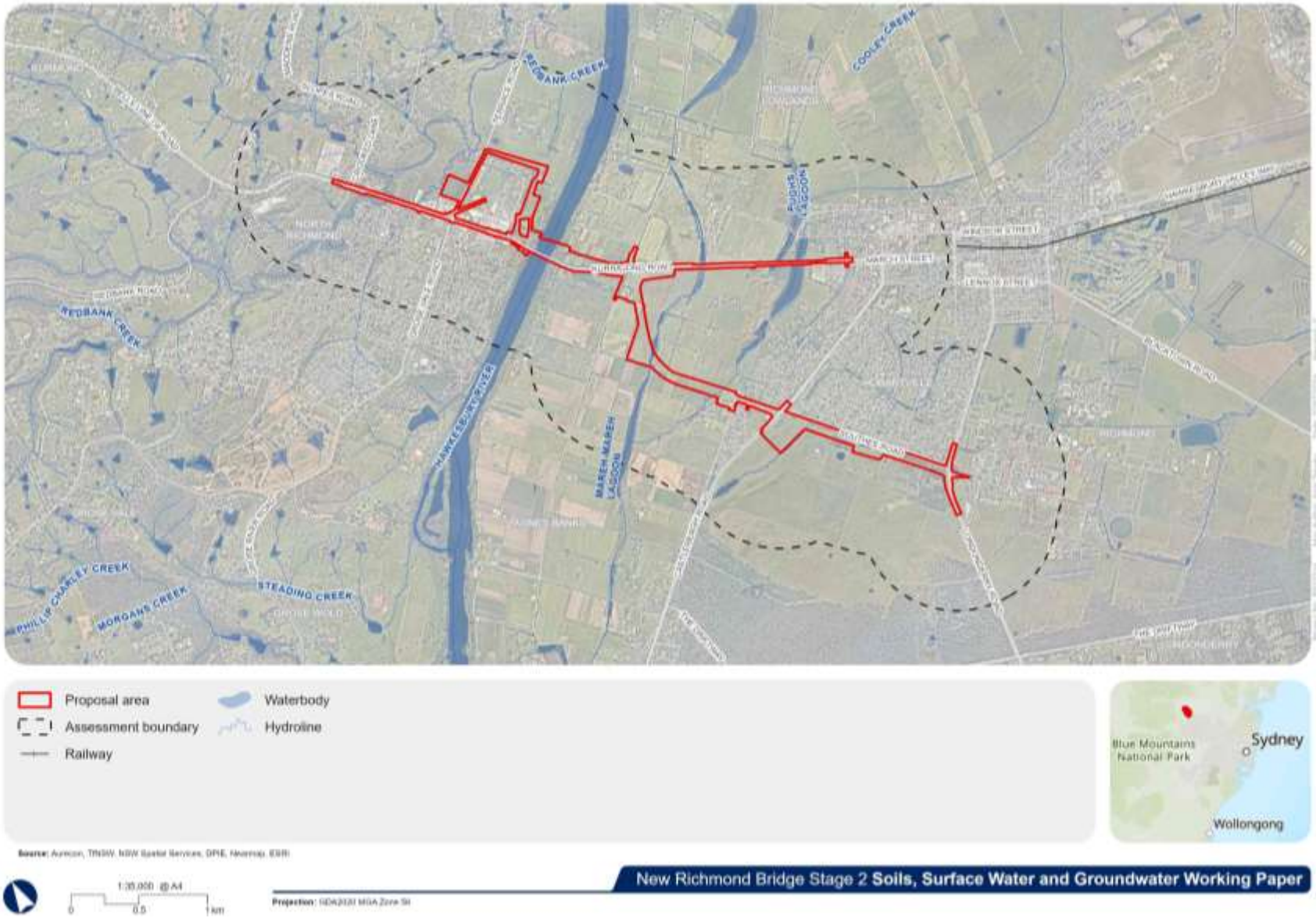

Figure 2-1 Soil, surface water and groundwater study area

2.3.2 Data sources

To support the understanding and documentation of the existing environment, databases utilised are listed in Table 2-1 Data sources These sources were reviewed, and relevant data extracted to characterise the existing environment. This informed the assessment of potential impacts as a result of the proposal.

Table 2-1 Data sources

Data	Description	Source
Australia Groundwater Explorer	Database of registered bores, associated drilling, water depth and quality data.	Bureau of Meteorology, 2023., 'Australian Groundwater Explorer', Australian Government, available at: <http://www.bom.gov.au/water/groundwater/explorer/map.shtml>.
Climate Data	Rainfall and evaporation data from Bureau of Meteorology (BoM)	Bureau of Meteorology, 2023., 'Monthly Climate Statistics – Richmond UWS Hawkesbury', Australian Government, available at: < http://www.bom.gov.au/climate/averages/tables/cw_067021.shtml>. Civil Consulting and Highway Design, 2023., 'New Richmond Bridge Stage 2 20% Concept Design Construction Staging Strategy Report'.
Elevation Data	Elvis elevation dataset	Healthy Rivers Commission, 1998., 'Healthy Rivers Commission Inquiry'. Intergovernmental Committee of Surveying and Mapping, 2023,. 'ELVIS - Elevation and Depth – Foundation Spatial Data', Commonwealth of Australia, available at <https://elevation.fsdf.org.au/>.
Environmental Data	Seed environmental dataset	SEED, 2023., 'The Central Resource for Sharing and Enabling Environmental Data in NSW', NSW Government', available at: <https://www.seed.nsw.gov.au/>.
	eSPADE environmental dataset, including soil groups	eSPADE, 2023., 'NSW Soil and Land Information', NSW Government, available at: <https://www.environment.nsw.gov.au/eSpade2Webapp/>.
	Minview explorer dataset	Landcom, 2004., 'Managing Urban Stormwater, Soils and Construction', Volume 1, 4th Edition. Mecone, 2020., 'St John of God Richmond Hospital Environmental Impact Statement for State Significant Development' Minview, 2023., 'Mining, Exploration and Geoscience', NSW Government, available at: <https://minview.geoscience.nsw.gov.au/#/>.
GDE Atlas	GDE types and locations	Bureau of Meteorology, 2023., 'Groundwater Dependent Ecosystems Atlas', Australian Government', available at: <http://www.bom.gov.au/water/groundwater/gde/map.shtml>.
Geology	Seamless Geology of NSW	Minview, 2023., 'Seamless Geology of NSW', NSW Government, available at: <https://data.nsw.gov.au/data/dataset/nsw-seamless-geology>.
Hydro-Line	The Water Management (General) Regulation 2018 hydro line spatial data is a dataset of mapped watercourses and waterbodies in NSW. It is based on the Spatial Services (Department of Finance, Services & Innovation)	NSW Government, 2018., 'Water Management (General) Regulation 2018 Hydroline Spatial Data 1.0', available at; <https://trade.maps.arcgis.com/apps/webappviewer/index.html?id=07b967fd0bdc4b0099fc5be45b6d1392>. NSW Government, 2021., 'Hawkesbury River', NSW Department of Planning and Environment, available at: <https://www.environment.nsw.gov.au/topics/water/estuaries/estuaries-of-nsw/hawkesbury-river>. NSW Government, 2021., 'State Environmental Planning Policy (Resilience and Hazards).

Data	Description	Source
	NSW Hydro Line dataset.	
NSW Planning Portal Spatial Viewer	Land uses and environmental planning policy datasets	NSW Government, 2023., 'NSW Planning Portal Spatial Viewer', Department of Planning and Environment, available at: <https://www.planningportal.nsw.gov.au/spatialviewer/#/find-a-property/address>.
NSW River Style Database	The River Styles Database classifies river character, behaviour, condition and recovery potential. It has been used extensively in Australia and overseas to categorise river types and describe river behaviour.	NSW Government, 2022., 'Contaminated Land Management Regulation'. NSW Government, 2023., 'New South Wales River Styles', Department of Planning and Environment, available at: <https://water.dpie.nsw.gov.au/__data/assets/pdf_file/0010/574489/nsw-river-styles-spatial-dataset-companion-document.pdf>.
Waterways and Water Bodies	Location of NSW defined waterways and waterbodies.	NSW Government, 2023., 'NSW Planning Portal Spatial Viewer', Department of Planning and Environment, available at: <https://www.planningportal.nsw.gov.au/spatialviewer/#/find-a-property/address>.
WaterNSW Real-time Water Data	Surface water monitoring sites and associated collected data.	WaterNSW, 2023., 'Real-time Data', available at: <https://realtimedata.waternsw.com.au/water.stm>. (Woolacotts Consulting Engineers, 2021., 'Centre of Excellence in Agricultural Education (CoE) Soil and Groundwater Assessment'
Water Sharing Plan	Source of governing Water Sharing Plans governing groundwater resources	NSW Government, 2023., 'Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2023', Department of Planning and Environment, available at: <https://legislation.nsw.gov.au/view/pdf/asmade/sl-2023-329>. NSW Government, 2023., 'Water Sharing Plans', Department of Planning and Environment, available at: <https://www.dpie.nsw.gov.au/water/plans-and-programs/water-sharing-plans>.
Wetlands	Directly of nationally important wetlands in Australia.	Council of Standards Australia, 2004., 'Australian Standard; The Storage and Handling of Flammable and Combustible Liquids'. Department of Agriculture and Water Resources, 2013., 'Guidelines for Groundwater Quality Protection in Australia: National Water Quality Management Strategy'. Department of Agriculture and Water Resources, 2018., 'National Acid Sulfate Soils Guidance: A Synthesis'. Department of Agriculture and Water Resources, 2018., 'National Water Quality Management Strategy'. Department of Climate Change, Energy, the Environment and Water, 2020., 'PFAS National Environmental Management Plan 2.0'. Department of Climate Change, Energy, the Environment and Water, 2021., 'Directory of Important Wetlands in Australia', Australian Government, available at: <https://pmst.awe.gov.au/#/map?lng=131.52832031250003&lat=-28.6905876542507&zoom=5&baseLayers=Imagery,ImageryLabels>.

2.4 Impact Assessment

The impact assessment is characterised by identified construction activities and their associated direct and indirect impacts on soils, surface water and groundwater. Mitigation measures have been presented in Section 7. The impact risk matrix, along with the corresponding descriptions of consequence and likelihood, are presented in Table 2-2, Table 2-3 and Table 2-4, respectively.

Table 2-2 Risk matrix – likelihood descriptor

Descriptor	Frequency	Probability
Almost Certain	Twice or more per year	Event would occur during the Proposal / period under review.
		High number of known incidents.
Likely	Once per year	Event likely to occur during the Proposal / period under review.
		Regular incidents known.
Possible	Once in 5 years	Event may occur in some instances during the Proposal / period under review.
		Occasional incidents known
Unlikely	Once in 10 years	Event is not likely to occur during the Proposal / period under review.
		Some occurrences known
Rare	Once in 20 years	Event would occur in exceptional circumstances during the Proposal / period under review
		Very few or no known occurrences.

Table 2-3 Qualitative risk assessment

Insignificant	Minor	Moderate	Major	Severe
Negligible change to soil quality, erosion, hydrological/ hydrogeological processes, water availability or water quality.	Short-term modification of soil quality, erosion, hydrological/ hydrogeological processes, water availability and quality within proposal tenure, but no change in beneficial use.	Medium-term modification of soil quality, erosion, hydrological/ hydrogeological processes, water availability and water quality within proposal tenure, but no change in beneficial use. Short-term modification of hydrological processes, water availability and water quality outside proposal tenure, but no change in beneficial use.	Long-term modification of soil quality, erosion, hydrological/ hydrogeological processes, water availability and water quality within proposal tenure, but no change in beneficial use. Medium-term modification of hydrological processes, water availability and water quality outside proposal tenure, with change in beneficial use.	Long-term or permanent modification of soil quality, erosion, hydrological/ hydrogeological processes, water availability or water quality outside proposal tenure, with impacts to a water dependent environmental value and/or change in beneficial use.

Table 2-4 Qualitative risk assessment

Risk Assessment		Most credible consequence level				
		Insignificant	Minor	Moderate	Major	Severe
Likelihood	Almost Certain	Medium	High	High	Extreme	Extreme
	Likely	Medium	Medium	High	High	Extreme
	Possible	Low	Medium	Medium	High	High
	Unlikely	Low	Low	Medium	Medium	High
	Rare	Low	Low	Low	Medium	Medium

3 Relevant legislation, policy and guidelines

Relevant national and state-based legislation, policy and guidelines, governing the management of soils, surface water and groundwater are outlined in the following section.

3.1 Legislation

A range of legislation governs the way in which infrastructure developments can interfere with soils, surface water and groundwater. Key legislation relevant to the proposal is outlined in Table 3-1.

Table 3-1 Key legislation relevant to the proposal

Document	Relevance
Water Act 1912	The Water Act has historically set out the licensing framework for managing water take and use in NSW. This licensing framework has largely been transitioned to a new licensing and approval framework under the Water Management Act 2000. The majority of licenses are issued under the Water Management Act 2000, but some are still issued under the Water Act 1912. The Water Act still applies to the taking of water from a water source outside water sharing plan areas; construction and use of water supply works outside water sharing plan areas; drainage works and aquifer interference activities in all areas of NSW.
Water Management Act 2000 (WM Act)	The Act aims to provide for the sustainable and integrated management of the water sources in NSW for the benefit of both present and future generations and it sets out the principles and legislative requirements for water sharing, water use, drainage and flood management, controlled activities, aquifer interference activities and environmental protection. As a public authority, TfNSW are exempt from the need to obtain any kind of controlled activity approval under the Water Management Act 2000 under clause 41 of the Water Management (General) Regulation 2018. The TfNSW Groundwater Impact Assessment Guidelines adopts a tiered approach to investigations and is intended to meet the requirements of the WM Act.
Water Management (General) Regulation 2018	The Water Management Regulation is the regulatory document which implements the WM Act providing procedural and technical matters related to the administration of the WM Act and also specifies exemptions from licence and approval requirements under the WM Act.
Contaminated Land Management Act 1997 (Amendment 2008)	This act governs the management of contaminated lands, including investigation into the existence, nature, extent of land contamination and remediation of contaminated lands. Hence, the act promotes better management of contaminated land and the amendment of environmentally hazardous environments.
Protection of the Environment Operations Act 1997 (POEO Act)	The POEO Act is an environmental protection licencing agreement relating to air pollution, water pollution, noise pollution and waste management. This Act acts as the source of licencing and approvals conditions relevant to the proposal.

Document	Relevance
Environmental Planning and Assessment Act 1979	This act seeks to manage and regulate environmental planning and assessments, introducing a uniform and simplified process for development assessments and applications. Since the proposal is not within the Sydney Drinking Water Catchment, there is no requirement to complete a Neutral or Beneficial Effects (NorBE) assessment under the Act.
Coastal Management Act 2016	This act prioritizes the protection of coastal zones through management in line with the principles of ecologically sustainable development for social, cultural and economic wellbeing in considered areas. This includes the management of coastal wetlands, with the aim to protect biological diversity and ecosystem integrity, as well as promote the rehabilitation of degraded wetlands. This includes managing shoreline recession, watercourse instability, inundation and erosion.
Fisheries Management Act 1994	Key Fish Habitats (KFHs) are managed under the Fisheries Management Act 1994. The presence of KFHs in the vicinity of the proposal is an indication of high ecological value within the waterway.

3.2 Policy and Guidelines

3.2.1 National policy and guidelines

National policies, guidelines and statutory requirements associated with soil, surface water and groundwater assessments, along with the relevance of these frameworks in respect to the proposal are presented below in Table 3-2 .

Table 3-2 National policy and guidelines

Document	Relevance
National Environmental Protection Measure (NEPM) Guideline on Investigation Levels for Soil and Groundwater (National Environment Protection Council, 2013., 'National Environment Protection Measures', Australian Government, available at: <https://www.nepc.gov.au/nepms>. National Health and Medical Research Council, 2008., 'Guidelines for Managing Risks in Recreational Water'. NSW EPA, 2020., 'Consultants Reporting on Contaminated Land'. *NSW Government,* 1912., 'Water Act'. NSW *Government, 1979., 'Environmental Planning and* Assessment Act'. *NSW Government, 1997., 'Contaminated* Land Management Act'. *NSW Government, 1997., 'Protection of* the Environment Operations Act'. NSW Government, 1998., 'NSW Acid Sulfate Soil Manual'. NSW Government, 1998., 'NSW State Groundwater Quality Protection Policy'.	The NEPM (2013) guidelines are a set of national objectives, designed to assist in the protection and management of particular ecological components. The NEPM act to outline a range of guidance measures for ambient marine, estuarine and freshwater quality, environmental impacts associated with hazardous waste, and general guidelines for the assessment of site contamination.

Document	Relevance
NSW Government, 2000., 'Water Management Act'. NSW Government, 2002., 'NSW State Groundwater Dependent Ecosystems Policy'. (NSW Government, 2002)	
National Water Quality Management Strategy (NWQMS) (Department of Agriculture and Water Resources, 2018., 'National Water Quality Management Strategy'. Department of Climate Change, Energy, the Environment and Water, 2020., 'PFAS National Environmental Management Plan 2.0'.	The proposal has the potential to impact water quality within the Hawkesbury River catchment. As such, the proposal should integrate water quality management strategies (consistent with NWQMS) such that environmental performance of the sensitive receiving waterways is minimised.
National Environment Protection (Assessment of Site Contamination) Measure (National Environment Protection Council, 2013., 'National Environment Protection Measures', Australian Government, available at: <https://www.nepc.gov.au/nepms>. National Health and Medical Research Council, 2008., 'Guidelines for Managing Risks in Recreational Water'. NSW EPA, 2020., 'Consultants Reporting on Contaminated Land'. NSW Government, 1912., 'Water Act'. NSW Government, 1979., 'Environmental Planning and Assessment Act'. *NSW Government,* 1997., 'Contaminated Land Management Act'. NSW *Government, 1997., 'Protection of the* Environment Operations Act'. *NSW Government, 1998., 'NSW* Acid Sulfate Soil Manual'. *NSW Government, 1998., 'NSW State* Groundwater Quality Protection Policy'. NSW Government, 2000., 'Water Management Act'. NSW Government, 2002., 'NSW State Groundwater Dependent Ecosystems Policy'.	This legislation ensures the adequate protection of human health and the environment, where contamination is found to exist. It outlines a set of formal methods for determining the nature, extent and levels of existing contamination and the actual risk or potential risk of introduced contamination.
Australian and New Zealand Environment and Conservation Council (ANZECC) Guideline Trigger Values for Lowland Rivers in South-East Australia (with slightly disturbed ecosystems indicated) (ANZECC, 2000., 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality – The Guidelines', Australian and New Zealand Environment and Conservation Council. ANZG, 2018., 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality', Australian and New Zealand Governments and Australian State and Territory Governments, Canberra ACT, Australia, available at:	The ANZECC guidelines indicate trigger values for aquatic ecosystems, deriving chemical stressors relevant to water quality monitoring and reporting. These standards provide a framework for assessing water quality, based on the existing physical, chemical and biologic characteristics of a waterway, and how the proposal may impact said environments. Table 3-4 outlines the guideline values for aquatic ecosystems, with the most conservative guideline highlighted in bold. Guidelines pertaining to other environmental values are outlined in Table 3-5.

Document	Relevance
<https://www.waterquality.gov.au/anz-guidelines>.	
Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000., 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality – The Guidelines', Australian and New Zealand Environment and Conservation Council. ANZG, 2018., 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality', Australian and New Zealand Governments and Australian State and Territory Governments, Canberra ACT, Australia, available at: <https://www.waterquality.gov.au/anz-guidelines>. Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018)	The proposal area has the potential to impact surface water quality, thus construction and operation of the proposal must account for the aims of the NWQMS to uphold sustainable use of water resources by protecting and enhancing their quality. This has been superseded by the Australian and New Zealand Guidelines (ANZG) 2018. However, certain guideline values are still relevant where ANZG (2018) guidelines have not been updated for certain analytes. The proposal has the potential to impact surface water quality. Given the absence of site-specific or regional guideline values, the ANZG outline default guideline values (DGVs) for a range of stressors relevant to different community values, such as aquatic ecosystems, human health and primary industries. ANZG guidelines for 95% and 99% species protection are used as the default guidelines values for assessing water quality and aquatic ecosystem protection. Through ecotoxicology studies, the level of ecosystem protection and subsequent impact can be determined. These guidelines have been reviewed and the most conservative estimates adopted to infer site specific physio-chemical and toxicant conditions and associated impacts. These impacts are separated by environmental value. Table 3-4 outlines the guideline values for aquatic ecosystems, with the most conservative guideline highlighted in bold. Guidelines pertaining to other environmental values are outlined in Table 3-5.
Guidelines for Groundwater Quality Protection in Australia (Council of Standards Australia, 2004., 'Australian Standard; The Storage and Handling of Flammable and Combustible Liquids'. Department of Agriculture and Water Resources, 2013., 'Guidelines for Groundwater Quality Protection in Australia: National Water Quality Management Strategy'. Department of Agriculture and Water Resources, 2018., 'National Acid Sulfate Soils Guidance: A Synthesis'. Department of Agriculture and Water Resources, 2018., 'National Water Quality Management Strategy'. Department of Climate Change, Energy, the Environment and Water, 2020., 'PFAS National Environmental Management Plan 2.0'.	The proposal area has the potential to impact groundwater quality. These guidelines are designed to support the governing objectives of the NWQMS, focusing on protecting and enhancing groundwater quality to support environmental performance values and preventing groundwater contamination.
Per- and Polyfluoroalkyl Substances (PFAS) National Environmental Management Plan Version 2.0 (DCCEEW, 2020)	This plan establishes a practical basis for nationally consistent environmental guidance and standards for managing PFAS contamination, identified in regional studies and site specific assessments.
Guidelines for the Management of Acid Sulfate Materials, (TfNSW, 2020., 'Guideline for Assessing the Impacts of Treated Water Discharge from Water Quality Treatment Controls'. TfNSW, 2023., 'Water Sensitive Urban Design Guideline'.	These guidelines influence the assessment and management of acid sulfate potentially forming soil and rock. The identified risk of acidic soils in sections of the proposal must be managed as per these guidelines.

Document	Relevance
Transgrid, 2020., ‘Environmental Handbook’. (TfNSW, 2020., ‘Guideline for Assessing the Impacts of Treated Water Discharge from Water Quality Treatment Controls’. TfNSW, 2023., ‘Water Sensitive Urban Design Guideline’. Transgrid, 2020., ‘Environmental Handbook’.	
The TfNSW Groundwater Impact Assessment Guidelines	Transport for NSW Groundwater Assessment Guideline adopts a tiered approach to recommend investigation and assessment scopes that are in line with the potential impact on groundwater resources, groundwater users and groundwater-dependant ecosystems. The guideline is used by Transport staff and industry partners to deliver environmental assessments that meet the requirements of the Water Management Act 2000, the NSW Aquifer Interference Policy 2012 and water sharing plans that have been approved under the Water Management Act 2000.

3.2.2 State-wide and local policy and guidelines

NSW state-based policies, guidelines and statutory requirements associated with soils, surface water and groundwater assessments, with their relevance to the proposal, are presented in **Error! Reference source not found.**.

One governing management scheme governing soils, surface water and groundwater is the range of State Environmental Planning Policies (SEPP) (Resilience and Hazards) 2021 (NSW Government, 2021., ‘State Environmental Planning Policy (Resilience and Hazards).

).

Table 3-3 NSW and local policy and guidelines

Document	Relevance
Groundwater	
NSW Aquifer Interference Policy (AIP)	Aquifer interference proposals (i.e., activities with the potential to interfere with groundwater aquifers) are required to assess their impact on GDEs and culturally significant sites that are groundwater dependent. There are GDEs present in proximity to the proposal area and groundwater levels are high in discrete areas of the proposal area. As such, there is the potential for aquifer interception. The NSW AIP governs (and replaces the NSW State Groundwater Dependent Ecosystems Policy) the extent to which aquifers can be interfered with, including groundwater source categories and relevant minimal impact considerations for groundwater quality. Groundwater source categories are divided into either “highly productive” or “less productive” and are divided by geological type. “Highly productive” sources are declared as: ■ Having total dissolved solids of less than 1,500 milligrams per litre (mg/L) ■ Contains water supply works that can yield water at a rate of greater than 5 litres per second (L/s). The productivity and type of aquifer deems the capacity to which it can be interfered with and managed accordingly. The conditions of aquifer interference for highly and less productive sources, respectively, are outlined in Appendix A – Aquifer Interference Policy Guidelines.
NSW State Groundwater Quality Protection Policy (NSW Government, 1998., ‘NSW State Groundwater Quality Protection Policy’. NSW *Government, 2000.,* ‘Water Management Act’.	Construction and operation of the proposal should account for the principles and processes expressed in this policy, focused on protecting groundwater quality. Groundwater levels are high in discrete areas of the proposal area, focused across the floodplain. As such, there is the potential for aquifer interception.
QA Specification G38; Soil and Water Management. (Transport for NSW, 2020)	This Specification sets out the requirements for preventing water pollution, minimising soil erosion and controlling sedimentation on work sites. An Erosion and Sediment Control Plan (ESCP) and Erosion Risk Management Plan (ERMP) has been prepared by SEEC in accordance with the Managing Urban Stormwater Soils and Construction ‘The Blue Book’ (4th Edition, Landcom 2004)
Draft Water Discharge and Reuse Guideline (Transport for NSW, 2020)	This guidelines provides guidance on managing, discharging and reusing excess water on Transport’s construction sites. This includes discharge of water from all sources on site, including sediment basins, temporary and informal basins and ponds, excavations, pits, boreholes, low points, storage bins, and any other areas on a construction site that may receive and store water. Where dewatering may be required during excavations, bridge pylons (Stage 2A only) or other structures intersect the water table. Therefore, a dewatering management plan will following the methodology provided by this guideline.

Document	Relevance
Greater Metropolitan Region Groundwater Sources (NSW Government, 2023., 'Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2023', Department of Planning and Environment, available at: <https://legislation.nsw.gov.au/view/pdf/asmade/sl-2023-329>. NSW Government, 2023., 'Water Sharing Plans', Department of Planning and Environment, available at: <https://www.dpie.nsw.gov.au/water/plans-and-programs/water-sharing-plans>.	Surface and groundwater resources are regulated through Water Sharing Plans (WSP). Groundwater entities are further divided into management regions and subregions. These specific management plans act to protect, enhance the condition of the water resource and prevent structural damage to aquifers because of excessive groundwater extraction. This WSP determines the extraction and interaction guidelines for aquifers covered by this source. WSPs are divided into separate groundwater entities, determining specific extraction availabilities and allocations.
Greater Metropolitan Region Groundwater Sources Water Sharing Plan (NSW Government, 2023., 'Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2023', Department of Planning and Environment, available at: <https://legislation.nsw.gov.au/view/pdf/asmade/sl-2023-329>. NSW Government, 2023., 'Water Sharing Plans', Department of Planning and Environment, available at: <https://www.dpie.nsw.gov.au/water/plans-and-programs/water-sharing-plans>.	Surface and groundwater resources are regulated through water sharing plans. The proposal area is encapsulated by the Greater Metropolitan Region Groundwater Sources (NSW Government, 2023., 'Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources 2023', Department of Planning and Environment, available at: <https://legislation.nsw.gov.au/view/pdf/asmade/sl-2023-329>. NSW Government, 2023., 'Water Sharing Plans', Department of Planning and Environment, available at: <https://www.dpie.nsw.gov.au/water/plans-and-programs/water-sharing-plans>. This replaced the 2011 Greater Metropolitan Region Groundwater Sources WSP. This plan outlines the environmental flow rules, minimum daily flow targets at a range of sites in the region, establishes environmental water allowances and outlines the maintenance of water supply annually. The updated WSP further outlines environmental mitigation mechanisms that work to protect the surrounding water resources and dependent groups from water work activities. Within the WSP, different sub-management zones exist. The proposal area is governed by the: ■ Hawkesbury Alluvium Groundwater Source (on either side adjacent to the Hawkesbury River) ■ Sydney Basin Central Groundwater Source (at the southern end of the proposal area) ■ Sydney Basin West Groundwater Source (northern end of the proposal area) These WSPs have been used to determine impact and regulatory frameworks unique to each groundwater resource. Figure 3-1 delineates the boundary between these sources.
Water Management (General) Regulation (NSW Government, 2016., 'NSW EPA Waste Classification Guidelines'. NSW Government, 2018., 'Water Management (General) Regulation'.	This regulation replaced the 2011 regulation, specifying procedural, technical and licence requirements under the Water Management Act 2000, as well as the functions and powers of water supply authorities. This regulation guides water licence access and approval exemptions.

Document	Relevance
NSW River Condition Index (RCI)	The NSW RCI is a long-term reporting tool used to assess river condition and health. This may be used to identify the health of surface water bodies that are highly connected to groundwater resources and the impact on groundwater dependent ecosystems.
Surface Water	

Document	Relevance
NSW Water Quality Objectives (NSW Government, 2006., 'NSW Water Quality and River Flow Objectives', Department of Environment, Climate Change and Water.	The NSW Water Quality Objectives (WQOs) are the agreed environmental values and long-term goals for NSW's surface waters. The community's values and uses for rivers, creeks, estuaries and lakes (e.g., aquatic foods, healthy aquatic ecosystems, industrial, irrigation, livestock water supply, water suitable for recreational activities like swimming and boating and drinking water). The proposal is located within the Hawkesbury River catchment. At the introduction of environmental objectives approved by the Government (September 1999), the Healthy Rivers Commission (HRC) had completed or substantially completed a public inquiry for the Hawkesbury-Nepean river (Healthy Rivers Commission, 1998., 'Healthy Rivers Commission Inquiry'. As such, no newly endorsed NSW WQOs were set for the Hawkesbury-Nepean catchment. The HRC recommended Water Quality Objectives in its report, refer to Table 3-4 and Table 3-5.. ANZG ANZECC, 2000., 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality – The Guidelines', Australian and New Zealand Environment and Conservation Council. ANZG, 2018., 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality', Australian and New Zealand Governments and Australian State and Territory Governments, Canberra ACT, Australia, available at: <https://www.waterquality.gov.au/anz-guidelines>.and ANZECC, 2000., 'Australian and New Zealand Guidelines for Fresh and Marine Water Quality – The Guidelines', Australian and New Zealand Environment and Conservation Council. guidelines have also been considered when selecting WQOs for the proposal. If any licensed sediment basins are proposed for construction, all community values should be considered when establishing discharge criteria (for TSS and turbidity) in accordance with TfNSW Guideline for Assessing the Impacts of Treated Water Discharge from Water Quality Treatment Controls. The relevant trigger values can also be used to assess the significance of any changes in water quality detected as part of a construction phase monitoring regime. The trigger values are not intended as being adopted as a discharge criteria for operational water quality control measures but it is the intent of the projects operational water quality control measures to minimise any impacts to water quality within the receiving waters and as such maintain the WQOs where they are achieved or avoid disrupting the long term goal of achieving the WQOs in the future through broader catchment improvements.

Document	Relevance
Healthy Rivers Commission (Healthy Rivers Commission, 1998., 'Healthy Rivers Commission Inquiry'.	The HRC was established in 1995 by the NSW Government to make recommendations on: ■ Suitable objectives for water quality, flows and other goals central to achieving ecologically sustainable development in a realistic time frame ■ The known or likely views of stakeholder groups on the recommended objectives ■ The economic and environmental consequences of the recommended objectives ■ Strategies, instruments and changes in management practices that are needed to implement the recommended objectives The Inquiry established environmental values for the catchment, however, these were superseded by the ANZECC Guidelines, as part of the NWQMS. The HRC guidelines provide additional clarification on environmental values to be protected and have been considered when establishing WQOs for the proposal.
NSW River Flow Objectives (NSW Government, 2006., 'NSW Water Quality and River Flow Objectives', Department of Environment, Climate Change and Water.	The NSW River Flow Objectives (RFOs) are the agreed high-level goals for surface water flow management. They identify the key elements of the flow regime that protect river health and water quality for ecosystems and human uses. The following river flow objectives have been set for 'waterway affected by urban development' within the Hawkesbury River catchment: ■ Maintain natural flow variability, ■ Maintain natural rates of change in water levels, ■ Maintain wetland and floodplain inundation, ■ Minimise effects of weirs and other structures. Unlike WQOs, there's no quantitative thresholds set for RFOs, so impact assessment of impact is to be completed on a qualitative basis.
'Blue Book' Guidelines – Managing Urban Stormwater: Soils and Construction (Department of Environment and Climate Change, 2008)	Commonly referred to as the 'Blue Book', these guidelines outline a range of mechanisms to reduce the impacts of land disturbance activities on waterways through better management of soil erosion and sediment controls during construction. These set of guidelines are of particular relevance to the proposal, due to the proximity of riverbank works and sensitive receiving environments.
Water Management (General) Regulation (NSW Government, 2016., 'NSW EPA Waste Classification Guidelines'. NSW Government, 2018., 'Water Management (General) Regulation'.	This regulation replaced the 2011 regulation, specifying procedural, technical and licence requirements under the Water Management Act 2000, as well as the functions and powers of water supply authorities. This hence guides water licence access and approval exemptions.

Document	Relevance
Guidelines for Instream Works on Waterfront Land (NSW Government, 2012., 'Guidelines for Instream Works on Waterfront Land', Department of Primary Industries. NSW Government, 2012., 'Guidelines for Watercourse Crossings on Waterfront Land', Department of Primary Industries.	These guidelines provide detailed requirements for managing instream works on waterfront land, as to uphold water quality, erosion and sediment control objectives.
Guidelines for Watercourse Crossings on Waterfront Land (NSW Government, 2012)	These guidelines provide detailed requirements for managing water crossings on waterfront land, as to uphold water quality, erosion and sediment control objectives.
Water Sensitive Urban Design Guideline (TfNSW, 2023., 'Water Sensitive Urban Design Guideline'.	Water sensitive urban design describes the integration of water cycle management into the planning, design and construction of the built environment. This is relevant to the upgrade and introduction of road surfaces across the floodplain, and the impact this would have on water movement, erosion, sourcing and quality.
Water Sharing Plan for the Greater Metropolitan Region Unregulated River Water Sources (NSW Government, 2023).	Sharing plans exist to regulate the extraction and use of water resources, to prevent structural damage to sources as a result of excessive extraction. The study area imposes upon the Greater Metropolitan Region Unregulated River Water Sources Water Sharing Plan.
NSW River Condition Index (RCI)	The NSW RCI is a long-term reporting tool used to assess river condition and health. This may be used to identify the health of surface water bodies and dependent ecosystems, including groundwater dependent ecosystems.
Soils	
NSW Acid Sulfate Soil Manual (ASSMAC) (NSW Government, 1998., 'NSW Acid Sulfate Soil Manual'.	This manual provides guidance on the best practices in assessing and managing the impacts of proposed works in areas likely to contain acid sulfate soils (ASS).
NSW Environment Protection Authority (EPA) Waste Classification Guidelines (NSW Government, 2016., 'NSW EPA Waste Classification Guidelines'.	These guidelines prove detailed requirements for classifying waste for disposal. These classifications are used to segregate waste types, which can be used or disposed of in line the with relevant waste code and description.

Document	Relevance
Managing Urban Stormwater, Soils and Construction (Landcom, 2004., 'Managing Urban Stormwater, Soils and Construction', Volume 1, 4th Edition. Mecone, 2020., 'St John of God Richmond Hospital Environmental Impact Statement for State Significant Development'	These guidelines provide detailed requirements for assessing and managing erosion caused and sediment generated by construction activities to prevent environmental pollution.
Contaminated Land Guidelines: Sampling Design (Parts 1 and 2), (NSW Government, 2022., 'Contaminated Land Management Regulation'. .	These guidelines determine sampling design and methods, suitable for contaminated land sites. The presence of known sites of historic and legacy contamination across site requires appropriate management in line with correct sampling design.
NSW EPA Consultants Reporting on Contaminated Land, Contaminated Land Guidelines (NSW EPA, 2020., 'Consultants Reporting on Contaminated Land'.	The reporting of contaminated land sites is regulated by these guidelines, impacting the way in which information is provided, recommendations given, and knowledge shared.
NSW Government, 1998., 'NSW Acid Sulfate Soil Manual'.	

Water Quality Objectives

Table 3-4 provides a summary of the known local water quality objectives (WQOs). It is noted that there are no WQOs for the Hawkesbury Nepean catchment upstream of the estuarine areas. To close any gaps in the WQOs, a range of potential values have been compiled for the receiving environment and may need to be considered for construction discharge quality assessments.

It is also acknowledged that these WQOs are not the same as stormwater pollution management targets. Generally speaking, where stormwater management targets are not prescribed, a risk based approach should be applied which considers the sensitivity of receiving waters. This approach is in line with the TfNSW WSUD guideline, which has been adopted to develop the WQ strategy for the Project

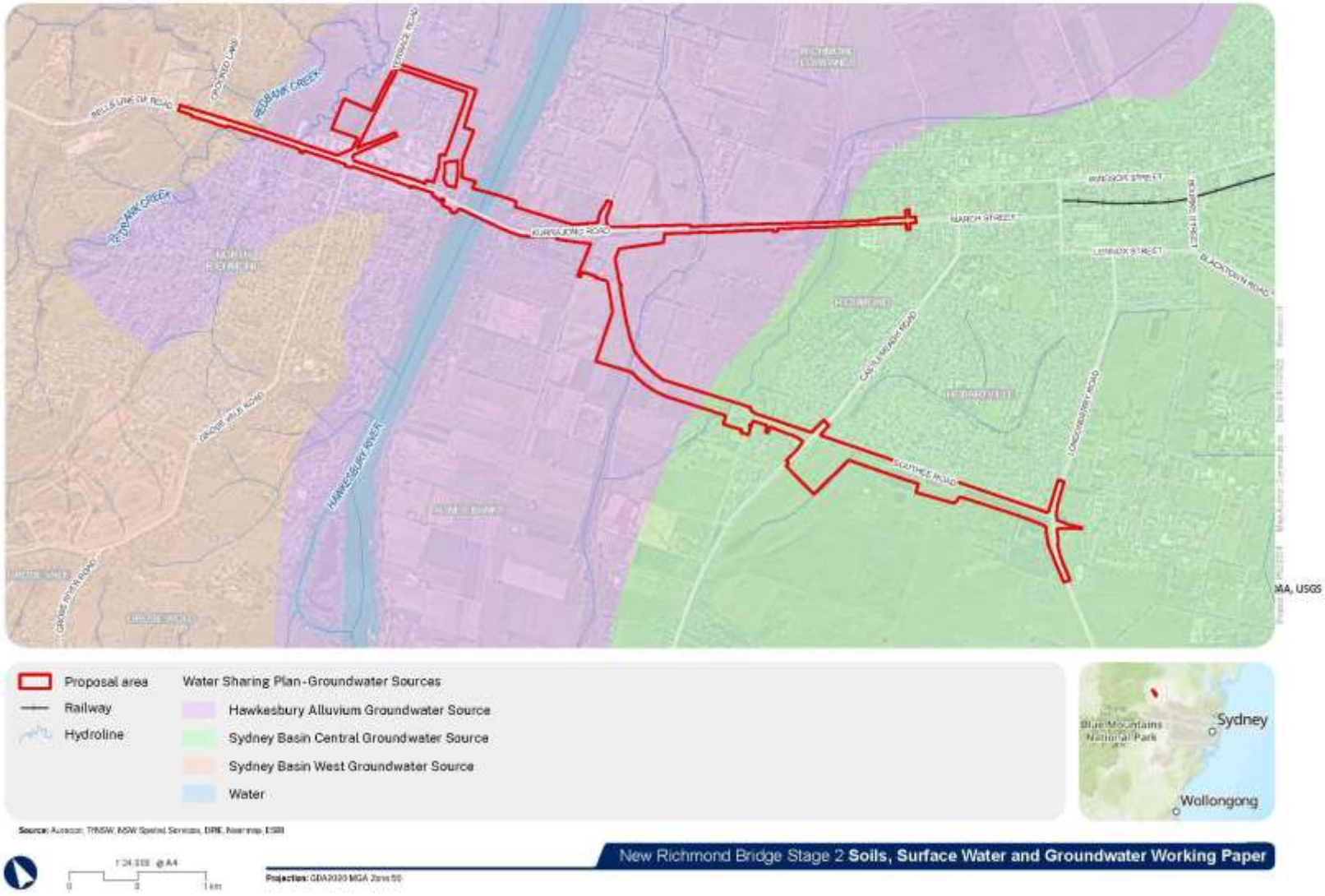

Figure 3-1 Water Sharing Plan groundwater source boundaries

Table 3-4 Aquatic ecosystem guideline values

Environmental Value	Indicator	Guideline Value			Key Applicability to the proposal
		ANZECC Guideline Trigger Values for Lowland Rivers in South-East Australia (with slightly disturbed ecosystems indicated).	ANZG Species Protection (Lowland Rivers)	Hawkesbury-Nepean (H-N) Water Quality Objectives (Estuarine Areas)	
Aquatic ecosystems – maintaining or improving the ecological condition of waterbodies and riparian zones over the long term. Applies to surface water and groundwater resources.	Total Phosphorus (TP) (microgram per litre) (µg/L)	30	-	30	Road runoff during operation.
	Total Nitrogen (TN) (µg/L)	500	500	400	Road runoff during operation.
	Chlorophyll-a (µg/L)	10-15	-	7	Waterway impact due to elevated nutrients in road runoff.
	Turbidity (Nephelometric Turbidity Unit) (NTU)	6 - 50	50	-	Sediment laden runoff during construction and operation.
	Salinity (electrical conductivity) (microSiemens per centimetre) (µS/cm)	125 – 2,200	2,200	-	Construction discharges.
	Dissolved Oxygen (DO) (% saturation)	85 – 110	-	-	Road runoff during operation.
	pH	6.5 – 8.0	6.5 to 8.5	-	Construction discharges.
	Toxicants (µg/L)	As per ANZG (2018) toxicant guidelines for slightly to moderately disturbed ecosystems.	Ammonia 900 Chlorine 3 Cyanide 7	-	Heavy metals and hydrocarbons in road runoff.

Environmental Value	Indicator	Guideline Value			Key Applicability to the proposal
		ANZECC Guideline Trigger Values for Lowland Rivers in South-East Australia (with slightly disturbed ecosystems indicated).	ANZG Species Protection (Lowland Rivers)		Hawkesbury-Nepean (H-N) Water Quality Objectives (Estuarine Areas)	
			Nitrate as N	700		
			Aluminium	55		
			Arsenic (III)	2.4		
			Boron	370		
			Cadmium	0.2		
			Chromium (VI)	0.4		
			Copper (filtered)	1.4		
			Iron	300		
			Lead	3.4		
			Manganese	1,900		
			Mercury	0.6		
			Nickel	11		
			Selenium (total valence) – 11	11		
			Zinc (filtered)	8		
			Benzene	950		
			O-xylene	350		
			P-xylene	200		

Environmental Value	Indicator	Guideline Value			Key Applicability to the proposal
		ANZECC Guideline Trigger Values for Lowland Rivers in South-East Australia (with slightly disturbed ecosystems indicated).	ANZG Species Protection (Lowland Rivers)	Hawkesbury-Nepean (H-N) Water Quality Objectives (Estuarine Areas)	
			Naphthalene 16		
			1,1,2-trichloroethane – 6500 6,500		
			Hexachloroethane – 360 360		
	Other toxicants (µg/L)	-	Phenol – 320 320	-	Potential for contamination to enter surface water and groundwater from upstream surfaces during construction.
			Organochlorine pesticides to be reviewed against individual chemical compounds listed by ANZG (2018)		
			Organophosphorus pesticides – to be reviewed against individual chemical compounds listed by ANZG (2018)		
	Visual clarity and colour	As per the visual amenity guidelines.	-	-	As per the visual amenity relevance.
	Surface films	As per the visual amenity guidelines.	-	-	As per the visual amenity relevance.

Table 3-5 Other environmental values and associated guidelines

Environmental Value	Indicator	Guidelines		Key Applicability to the proposal
		ANZECC Guideline Trigger Values for Lowland Rivers in South-East Australia (with slightly disturbed ecosystems indicated).	**Hawkesbury-Nepean (H-N) Water Quality Objectives (Estuarine Areas)**	
Visual amenity – aesthetic qualities of waters. Applies to surface water resources.	Visual clarity and colour	Natural visual clarity should not be reduced by more than 20%. Natural hue of water should not be changed by more than 10 points on the Munsell Scale. The natural reflectance of the water should not be changed by more than 50%.	-	Road runoff flowing into drainage lines flowing into South Creek.
	Surface films and debris	Oils and petrochemicals should not be noticeable as a visible film on the water, nor should they be detectable by odour. Waters should be free from floating debris and matter.	-	Oils, petrochemicals and gross polluitants in road runoff.
	Nuisance organisms	Macrophytes, phytoplankton scums, filamentous algal mats, blue-green algae, sewage fungus and leeches should not be present in unsightly amounts. No quantitative value specified	Reduction in phosphorus inputs should remain the priority nutrient control strategy throughout most of the catchment.	Potential impact in waterway as a result of nutrient impacts.
Secondary contact recreation – maintaining or improving water quality of activities such as boating and wading, where there is a low probability of water being swallowed. Applies to surface water resources.	Faecal coliforms, enterococci, algae and blue-green algae	As per the Guidelines for managing risks in recreational water according to the National Health and Medical Research Council (NHMRC) (National Health and Medical Research Council, 2008., 'Guidelines for Managing Risks in Recreational Water'. .	-	N/A
	Nuisance organisms	As per the visual amenity guidelines. Large numbers of midges and aquatic works are undesirable.	-	As per the visual amenity relevance.

Environmental Value	Indicator	Guidelines		Key Applicability to the proposal
		ANZECC Guideline Trigger Values for Lowland Rivers in South-East Australia (with slightly disturbed ecosystems indicated).	**Hawkesbury-Nepean (H-N) Water Quality Objectives (Estuarine Areas)**	
See Section 5.2.2.2 and Table 5.2.3 of ANZECC (2000), for specific primary contact guidelines.	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucous membranes are unsuitable of recreation. Toxic substances should not exceed values provided in the Guidelines for managing risks in recreational water (National Health and Medical Research Council, 2008., 'Guidelines for Managing Risks in Recreational Water'. .	-	Heavy metals in road runoff.
	Visual clarity and colour	As per the visual amenity guidelines.	-	As per the visual amenity relevance.
	Surface films	As per the visual amenity guidelines.	-	As per the visual amenity relevance.
Primary contact recreation – maintaining or improving water quality for activities such as swimming where there is a high probability of water being swallowed. Applies to surface water resources. See Section 5.2.2.1 and Table 5.2.3 of ANZECC (2000), for specific primary contact guidelines.	Faecal coliforms, enterococci, algae and blue-green algae	As per the Guidelines for managing risks in recreational water (National Health and Medical Research Council, 2008., 'Guidelines for Managing Risks in Recreational Water'. .	-	N/A
	Protozoans	Pathogenic free-living protozoans should be absent from bodies of fresh water.	-	N/A
	Chemical contaminants	Waters containing chemicals that are either toxic or irritating to the skin or mucus membranes are unsuitable for recreation. Toxic substances should not exceed values provided in the Guidelines for managing risks in recreational water (National Health and Medical Research Council, 2008., 'Guidelines for Managing Risks in Recreational Water'. .	-	Road runoff flowing into drainage lines flowing into South Creek.

Environmental Value	Indicator	Guidelines		Key Applicability to the proposal
		ANZECC Guideline Trigger Values for Lowland Rivers in South-East Australia (with slightly disturbed ecosystems indicated).	**Hawkesbury-Nepean (H-N) Water Quality Objectives (Estuarine Areas)**	
	Visual clarity and colour	As per the visual amenity guidelines.	-	As per the visual amenity relevance.
	Temperature	16° - 34 degrees Celsius (°C) for prolonged exposure.	-	Road runoff and construction discharges.
Aquaculture and aquatic foods – guidelines for prioritizing influent and source water quality, wild fish stocks, seafood production and consumption relevant to critical in-stream, and dependent agriculture.. Applies to surface water and groundwater resources. See Table 4.4.2, and Table 4.4.3 of ANZECC (2000), for the specific physio-chemical stressor and toxicant guidelines, respectively.	Alkalinity (mg/L)	>20	-	Road runoff and discharges.
	Biochemical oxygen demand	-	-	Road runoff and discharges into receiving wetlands and surface water bodies.
	Chemical oxygen demand (COD)	-	-	Road runoff and discharges into receiving wetlands and surface water bodies, infiltrated into groundwater.
	Carbon dioxide (mg/L)	<15	-	Road runoff and discharges.
	Dissolved oxygen (mg/L)	>5	-	Waterway impact due to elevated nutrients in road runoff.
	pH	6.0-9.0	-	Construction discharges.
	Suspended solids (Brackish) (mg/L)	<75	-	Sediment laden runoff during construction and operation.
	Temperature	<2° C over 1 hour	-	NA
		Aluminium <10	-	

Environmental Value	Indicator	Guidelines			Key Applicability to the proposal
		ANZECC Guideline Trigger Values for Lowland Rivers in South-East Australia (with slightly disturbed ecosystems indicated).		Hawkesbury-Nepean (H-N) Water Quality Objectives (Estuarine Areas)	
	Toxicants (saltwater brackish and marine water) (µg/L)	Ammonia	<100		Heavy metals and hydrocarbons in road runoff.
		Arsenic	<30		
		Cadmium	<0.5-5		
		Chlorine	<3		
		Chromium	<20		
		Copper	<5		
		Cyanide	<5		
		Hydrogen sulfide	<2		
		Iron	<10		
		Lead	<1-7		
		Magnesium	Non-detect (ND)		
		Manganese	<10		
		Mercury	<1		
		Nickel	<100		
		Nitrate	<100,000		
		Nitrite	<100		
		Phosphates	<50		
		Selenium	<10		
		Zinc	<5		

Environmental Value	Indicator	Guidelines			Key Applicability to the proposal
		ANZECC Guideline Trigger Values for Lowland Rivers in South-East Australia (with slightly disturbed ecosystems indicated).		Hawkesbury-Nepean (H-N) Water Quality Objectives (Estuarine Areas)	
		Oils and greases	ND		
	Other toxicants (µg/L)	Phenols	ND	-	Potential for contamination to enter surface water and groundwater from upstream surfaces during construction.

Groundwater Extraction Regulation

Groundwater extraction may be required as part of construction dewatering, at excavations that sit below the water table. The *Water Management Act 2000* (WMA) governs the extraction of groundwater from its source and use, including waste and disposal that may require approval under the WMA (NSW Government, 2000., 'Water Management Act'.

The NSW Department of Climate Change, Energy, the Environment and Water (DCCEEW) is the direct contact for construction activities expected to impact groundwater, governing/ licencing, availability and allocations.

Relevant approvals and licences to be obtained by the contractor, as required may include:

- Water Supply Work Approval (WSWA) – to implement equipment or means of removal, transport, storage and disposal of groundwater from its source i.e., pumps, drainage systems, bores. This approval is required when taking any groundwater.
- Water Access Licence (WAL) – authorises licence holder to undertake groundwater removal activities from a specific source, in accordance with the specified allocation per water year as granted. This licence is required when greater than 3 ML per year of groundwater is anticipated to be extracted.
- Water Use Approval – to use or dispose of the water taken from its source.

An assessment of the relevance of these licences are outlined in Section 6.1.8.

Contaminant Guidelines for Site Investigations

Contaminations of potential concern (COPC) are substances that are regularly assessed for use in quantitative site assessments. As part of the Detailed Site Investigation (DSI), the following guidelines were used to inform trigger values for site investigation and assessment.

Table 3-6 Contaminant of Potential Concern Guidelines

Media	Guideline	COPC	Rationale
Soil (Human Health)	NEPM 2013 Health-based Investigation Levels (HIL) (D)	Heavy metals, organochlorine pesticides and organophosphorus pesticides (OCPs/OPPs), polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs)	Guideline is considered protective of human health in occupational exposure scenarios, specifically for onsite intrusive workers engaged in trenching and earthmoving activities
	NEPM 2013 Health Screening Levels (HSL) (D)	Benzene, toluene, ethylbenzene and total xylene (BTEXN) and total recoverable hydrocarbons (TRH)	Guideline is protective of human health in commercial and industrial land use setting.
	Cooperative Research Centre (CRC) CARE HSL Intrusive Maintenance Worker (Shallow Trench)	BEX and TRH	Guidelines are protective of human health in occupational exposure scenarios via direct contact during open trench works.
	PFAS National Environmental Management Plan (NEMP 2.0) 2020	PFAS	Criteria derived for human exposure to PFAS in soil.
	NEPM 2013 Ecological Investigation Levels (EILs) (D)	Heavy metals	Criteria specific to ecological exposure to heavy metals.
Soil (Ecological Health)	NEPM 2013 Ecological Screening Levels (ESLs) (D)	TRH, BTEX and benzo(a)pyrene.	ESLs for urban residential and public open space (unfenced, publicly accessible areas of the site

Media	Guideline	COPC	Rationale
			and conservative approach for fenced areas).
	PFAS National Environmental Management Plan (NEMP 2.0) 2020	PFAS	Criteria derived for ecological exposure to PFAS in soil.
	NEPM 2013 Groundwater Investigation Levels (GILs) for drinking water	Heavy metals, inorganic ions, BTEX, PAHs and OPPs.	GILs derived for drinking water (ingestion of contamination groundwater).
Sediment	Australian and New Zealand Guidelines for Fresh and Marine Water Quality	Heavy metals, Metalloids, Organometallics, Organics	DGVs for toxicants in sediment are listed in Table 1 of this guideline. As per the DGVs for toxicants in water, the sediment DGVs indicate the concentrations below which there is a low risk of unacceptable effects occurring and should be used, with other lines of evidence, to protect aquatic ecosystems.
Water (Human Health)	Cooperative Research Centre (CRC) CARE HSL (D)	Petroleum hydrocarbons (Benzene and TRH C6-C10)	Groundwater health screening levels derived for vapour intrusion.
	PFAS National Environmental Management Plan (NEMP 2.0) 2020	PFAS	Criteria derived for exposure scenarios for PFAS in water.
	NEPM 2013 Groundwater Investigation Levels (GILs) for freshwater.	Heavy metals, BTEXN and PAHs	GILs for freshwater and marine water species protection.
Water (Ecological Health)	ANZG 2018 Guidelines for Freshwater and Marine Quality (95% and 99% species protection)	Heavy metals, BTEXN and PAHs	Guidelines supersede the ANZECC 2000 Guidelines for Freshwater and Marine Water Quality referenced by NEPM 2013 GILs.
	PFAS National Environmental Management Plan (NEMP) 2020	PFAS	Criteria derived for freshwater and marine water species protection.
	NEPM 2013 Groundwater Investigation Levels (GILs) for freshwater.	Heavy metals, BTEXN and PAHs	GILs for freshwater and marine water species protection.
Waste Classification	NSW EPA 2014 Waste Classification Guidelines – Part 1: Classifying Waste (including relevant resource recovery exemptions)	TRH, PAH, BTEX, OCPs, OPPs, heavy metals	Guidelines are applicable in classifying excavated materials for disposal to landfill or offsite beneficial reuse.
	2016 Addendum to the NSW EPA 2014 Waste Classification Guidelines – Part 1: Classifying Waste	PFAS (PFOS, PFOA and PFHS only)	
	NSW EPA 2014 Waste Classification Guidelines – Part 4: Acid Sulfate Soils	Acid Sulfate Soils	
	NSW EPA Excavated Natural Material Order 2014	TRH, PAH, BTEX, heavy metals	Evaluation of potential resource recovery options.

4 Existing environment

4.1 Land use

The land-use of the proposal area is varied and complex, as shown in Figure 4-1. The northern part of the alignment, north of the Hawkesbury River, lies within the urbanised North Richmond. North Richmond is predominately an industrial and commercial estate immediately adjacent to Bells Line of Road. Here exists a local commercial centre and general industrial zone. Surrounding the commercial precinct exists low to medium density residential areas, with recreation zones, educational establishments and sewerage works systems. Along the northern Hawkesbury Riverbank is Hanna Park and North Richmond Heritage Park. This area includes open green spaces, playgrounds, and parks.

The area south of the Hawkesbury River, between the River and Hobartville to the southeast, is a floodplain largely divided into numerous lots, typically bounded by a local road network. The floodplain is primarily used for rural or farming purposes and is covered by market gardens, turf farms and nurseries. Additionally, some recreational activities including polo clubs and playing fields are present. Further to the southeast, on slightly more elevated land, are the suburbs of Hobartville and Richmond that are primarily residential and commercial in use.

The existing alignment includes the major roads of Kurrajong Road and Bells Line of Road, that connect to cross the Hawkesbury River, passing through North Richmond and Richmond. Bells Line of Road then links Sydney via the M2 and M7 Motorways. This provides an alternative road to Great Western Highway, for access between Sydney, the Blue Mountains and Central West. Kurrajong Road and Bells Line of Road is an arterial road, with local and regional traffic including heavy traffic.

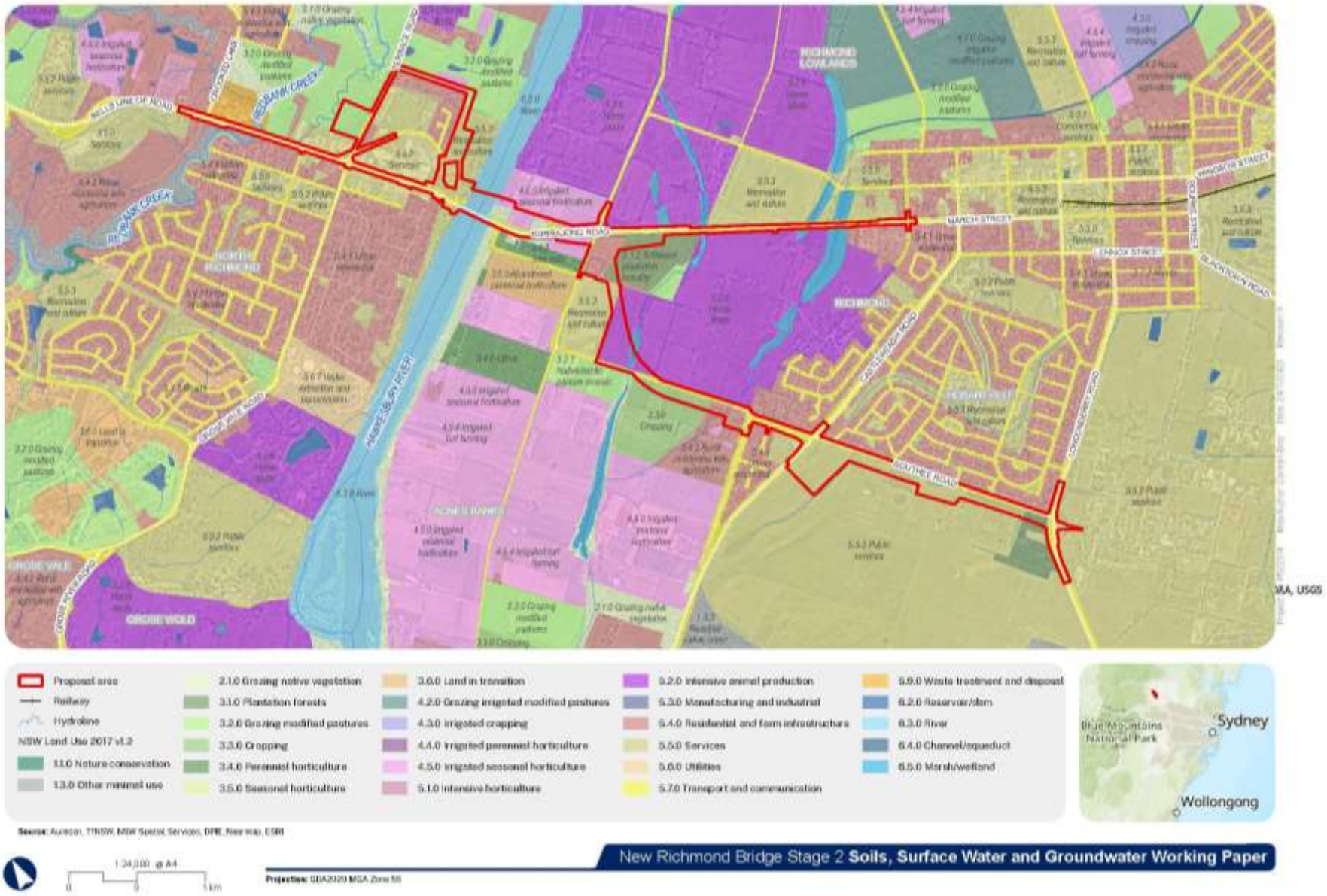

Figure 4-1 Land uses surrounding the proposal area

4.2 Climate

A review of data available through the Bureau of Meteorology (BoM) – Monthly Statistics: Climate Data Online indicates that the nearest BoM weather station, with sufficient coverage of rainfall data, is in Richmond, at the Western Sydney University (WSU) (Bureau of Meteorology, 2023., 'Monthly Climate Statistics – Richmond UWS Hawkesbury', Australian Government, available at: < http://www.bom.gov.au/climate/averages/tables/cw_067021.shtml>.

Civil Consulting and Highway Design, 2023., 'New Richmond Bridge Stage 2 20% Concept Design Construction Staging Strategy Report'. Rainfall values at Station 067021 (WSU) for the local area, have been extracted from the long-term record (1881-2023). Key rainfall statistics for each calendar month over this period are summarised in Table 4-1. A review of the rainfall data indicates there is seasonal variation in mean monthly rainfall. Rainfall is highest during late summer and early autumn, peaking in January to March and lowest in winter and early spring.

Evaporation data was derived from the BoM website, that presents Australia's open pan evaporation on a series of monthly detailed contoured maps. The dataset was collected between 1975 and 2005. Monthly evaporation data is presented in Table 4-1 Seasonal evaporation shows strong seasonal trends and low variability, with higher rates occurring during the warmer months of November and December. Evaporation is lowest in June with a mean evaporation rate of 55 millimetres (mm). Evaporation exceeds rainfall for all months except May and June with the largest deficits being in the months of November and December.

Temperature is no longer measured at the WSU station but has been monitored at the Royal Australian Air Force (RAAF) station (067105) since 1993, located approximately 2.4 km north of Richmond. Mean minimum and maximum temperatures are presented in Table 4-1. Analysis of climate records revealed the Richmond area to have a temperate climate with warm and hot summers, with maximum temperatures averaging ranging from 32.6 to 34.1 ˚C during the summer months. Winters are cooler with average maximum monthly temperatures between 14.8 to 17.5˚C. Consecutive La Niña weather events and extreme rainfall exacerbated by climate change, led to record widespread flooding along the east coast of Australia during 2021 and 2022. The severe storm events caused the Hawkesbury River floodplain to experience major flooding throughout late March 2021 to early July 2022 between the 10 per cent annual exceedance probability (AEP) and 20 per cent AEP, resulting in damage to turf farms and other low-lying industry and road closures.

Table 4-1 Climate monthly data

Average	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Total
Mean rainfall (mm)	96.5	94.5	94.0	67.1	55.8	60.1	45.3	41.8	41.9	57.1	73.6	75.1	804.0
Evaporation (mm)	160	110	140	110	70	55	70	90	110	160	180	180	1500
Mean temperature (˚C)	30.4	29.2	27.0	24.2	20.9	18.0	17.9	19.9	22.9	25.3	27.0	28.9	-
Mean maximum temperature (˚C)	34.1	32.6	30.3	28.1	23.9	20.1	20.4	22.8	26.2	28.4	30.5	33.0	-

4.3 Topography

The proposal area extends along the Bells Line of Road and Kurrajong Road, from Grose Vale Road, North Richmond to Bosworth Street at the northern edge of Richmond. The proposal area also extends south of the Hawkesbury River from Kurrajong Road along Yarramundi Lane to the southwest and then along Inalls Lane to the southeast, to the south of Hobartville, terminating at the intersection with Londonderry Road.

In the northern section of the proposal area, the elevation of Bells Line of Road in North Richmond is at its highest, at 23 m Australian Height Datum (m AHD) at Grose Vale Road. The topography declines relatively steeply at a gradient of around 8 % to the floodplain around the Hawkesbury River to an elevation of 9 m AHD. The low-lying floodplain is relatively flat to undulating, before rising to above 10 m AHD on the outskirts of Hobartville (ICSM, 2023).Healthy Rivers Commission, 1998., 'Healthy Rivers Commission Inquiry'.

Intergovernmental Committee of Surveying and Mapping, 2023,. 'ELVIS - Elevation and Depth – Foundation Spatial Data', Commonwealth of Australia, available at <https://elevation.fsdf.org.au/>.

Figure 4-2 details the proposal area topography along the proposed alignment.

Figure 4-2 Topography

4.4 Surface Water

4.4.1 Catchment and local water features

The proposal area is situated within the Hawkesbury-Nepean catchment. The Hawkesbury-Nepean River catchments is one of the largest coastal basins in NSW. The catchment spans 21,400 square-kilometres (km^2), of which, 70% consists of mountainous terrain (Department of Planning and the Environment, 2023., 'Hawkesbury Nepean', NSW Government, available at: <https://www.dpie.nsw.gov.au/water/basins-and-catchments/catchments/hawkesbury-nepean>.

Department of Primary Industries, 2012., 'NSW Aquifer Interference Policy', NSW Government, available at: <https://www.industry.nsw.gov.au/__data/assets/pdf_file/0005/151772/NSW-Aquifer-Interference-Policy.pdf>. Whilst the basin is considered an unregulated river flow, it contains five major dams supplying drinking water for 70% of the New South Wales population (Hawkesbury-Nepean Catchment Management Authority, 2009., 'Hawkesbury-Nepean Catchment Management Authority Annual Report 2008/9', available at: <https://media.opengov.nsw.gov.au/pairtree_root/b9/3a/23/f0/cd/fa/ff/82/09/b9/88/15/1b/4a/63/31/obj/document.pdf>. as well as a range of weirs that control and retain river flows.

The Hawkesbury River originates at the confluence of the Nepean River and Grose River, approximately 3km upstream of where the proposal intersects the Hawkesbury River, flowing northerly towards Wisemans Ferry and then south easterly towards Broken Bay. It is a perennial watercourse and tidally influenced adjacent to the proposal area.

The proposal area overlays the Richmond and Windsor floodplain, with a long history of deep flooding. Frequent flooding events have occurred in recent years, including major flooding events in 2020 and 2021 that lead to major accessibility issues. The highest flood on record occurred in 1867, with a relative flood level of 19.1m above normal river level (Roads and Maritime Service, 2015., 'Stockpile Site Management Guidelines'.

Roads and Transport Authority, 1999., 'Code of Practice for Water Management'.

Roads and Transport Authority, 2005., 'Guidelines for the Management of Acid Sulfate Materials'.

Roads and Transport Authority, 2013., 'Richmond Bridge and Approaches Congestion Study', NSW Government.

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State Emergency Service, 2022., 'Richmond/Windsor Floodplain', NSW Government, available at: < https://www.ses.nsw.gov.au/media/5374/ins9832_2_flood_events_6pp_richmond_windsor_v8.pdf>.

Strategic Environmental and Engineering Consulting, 2023., 'New Richmond Bridge and Traffic Improvements – Stage 2' Preliminary Erosion and Sedimentation Assessment'.

Strategic Environmental and Engineering Consulting, 2023., 'New Richmond Bridge Stage 2 Erosion and Sedimentation Management Report – Revision A'.

Sydney Water, 2021., 'Richmond System Wastewater Upgrade Review of Environmental Factors'

TfNSW, 2020., QA Specification G38; Soil and Water Management.To the north of the Hawkesbury River, the proposal area intersects Redbank Creek, a 5th order, perennial watercourse originating from the hills of Grose Vale which drains easterly into the Hawkesbury River around 600 m south east of Terrace Road in North Richmond. Redbank Creek's catchment is primarily made up of rural land uses except for the urban development in North Richmond.

To the south of the Hawkesbury River, a system of ponds and water bodies are scattered throughout the floodplain, some of which are mapped as coastal wetlands (refer section 4.9.2 for further discussion on the coastal wetlands). The mapped coastal wetlands and associated tributaries are part of a large system of back swamps, marshes and wetlands that are connected by drainage channels along the agriculturally productive floodplain from Yarramundi Lagoon to the Richmond. This system may be an old anabranch of the Hawkesbury River (Hawkesbury City Council, 2014). Ecological assessment of the wetlands indicated they are freshwater wetlands of varying quality. Two of these wetlands are named: Pughs Lagoon and Mareh-Mareh Lagoon (refer Figure 4-3) with the others understood to be un-named.

The proposal area associated with the proposed active transport works intersects Pughs Lagoon. Pughs Lagoon comprises three ponds adjacent to Pughs Lagoon Reserve and Smith Park that contain fringing vegetation and emergent macrophytes (Roads and Transport Authority, 2013., 'Richmond Bridge and Approaches Congestion Study', NSW Government.

The construction of Kurrajong Road, which intersects Pughs Lagoon, during the 1960s and subsequent landscape reclamation of wetlands in the 1970s to create Smith Park significantly altered the hydrology of this chain of lagoons. Alterations to invert levels at culverts under the road and further modifications for the purpose of post-flood drainage control were undertaken as part of the road works. The lagoon provides vital habitat for many native plant and bird species, with significant community cultural, indigenous heritage and aesthetic value (Hawkesbury City Council, 2014).

The proposal area also intersects Mareh-Mareh Lagoon near Inalls Lane where a 150m bridge is proposed. Mareh Mareh Lagoon is connected to Yarramundi Lagoon to the south adjacent to Agnes Banks and the Hawkesbury River to the north via a series of ponds and open drains and watercourses. An unnamed lagoon, immediately south of Kurrajong Road is connected to Mareh-Mareh Lagoon by a narrow watercourse. The proposal intersects this connecting watercourse at Inalls Lane.

Both Pughs Lagoon and Mareh-Mareh Lagoon and their associated tributaries were considered in the Biodiversity Assessment Report (BDAR) (Wedgetail, 2023). The BDAR identified both lagoons and respective tributaries to contain pockets of riparian and instream vegetation. However, there were portions of riparian corridor that were highly managed (e.g. horse paddocks) that had little to no vegetation.

Two ponds owned by Western Sydney University (WSU) and associated with the Sydney Vegetable Demonstration Farm are located within the proposal area adjacent to Southee Road near Castlereagh Road (WSU001) and opposite Hill Avenue (WSU002). Both ponds are proposed to be demolished and replaced like for like within close proximity of the existing ponds with both relocated ponds expected to function as the existing ponds. Pond WSU001 and WSU002 both are likely to sit partially below groundwater which may discharge into the pond at times, but their primary source of water is likely to be local runoff which is held in the pond due to low permeability of the surrounding soil.

A portion of the Stage 2B works is located within the Rickaby's Creek catchment with the proposal area ultimately draining to the creek via a series of roadside swales, ponds and rural drains. Rickaby's Creek flows northerly from Wianamatta Nature Reserve to the Hawkesbury River at Windsor. The catchment comprises a range of rural land uses and small towns with low to medium density residential land use.

Local water features are detailed in Figure 4-3.

Figure 4-3 Local water features

4.4.2 Surface water quality

The Hawkesbury-Nepean catchment faces significant water quality challenges due to localised intensive urban and industrial development, as well as water management challenges of providing reliable, recirculated water supply. These challenges include managing pollution, algae and weed growth, riverbank stability and sufficient flows, in line with increasing instream constructions and water demand for urban and industry growth.

Water quality within the Hawkesbury River is largely impacted by the severity and extent of floods, as well as local land uses. A long-term water quality monitoring program undertaken by the NSW Department of Environment and Climate Change, monitored water quality from the 1980s until 2009. This program demonstrated improvements in long-term water quality, with decreases in filterable and total phosphorous and blue-green algal cell counts (Department of Environment and Climate Change, 2008, 'Managing Urban Stormwater: Soils and Construction'.

Department of Environment and Climate Change, 2009., 'Hawkesbury-Nepean River Environmental Monitoring Program – Final Technical Report', Sydney Catchment Authority, available at: <https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Water/Water-quality/hawkesbury-nepean-river-environmental-monitoring-program-final-technical-report-09112.pdf>. This was largely attributed to nutrient reductions in sewage treatment plant discharges across the period. However, increases in total and inorganic nitrogen, and electrical conductivity were observed over the period. This was attributed to increases in urban and agricultural runoff entering the Hawkesbury River.

The ecological state of the catchment, as well as historical flooding events impacting water health in the area was investigated by the DPE as part of a 2022-2023 monitoring program (NSW Government, 2023). Along with flooding events, debris often remains in the river for extended periods of time. Water quality sampling is regularly conducted by the NSW Government, testing river water quality at a range of sites to understand salinity, algal, bacterial, and potential chemical contamination after these severe events. The ongoing water quality monitoring program has shown the estuary to have fair overall water quality, with:

- Algae abundance graded fair (C)
- Water clarity graded good (B),
- Overall estuary health graded as fair (C).

This grade has been slowly improving since the 2000s-2010s, with historically D (poor) grades. Lower, downstream sections of the Hawkesbury River were recognised to have higher quality water, due to the beneficial impact of tidal influences. The section of the river adjacent to the proposal area, was reported as having degraded river health, likely due to the impact of sewage treatment plant discharges and diffuse-source pollution from urban and agricultural runoff. Additionally, decreases in chlorophyll-a concentrations within the Hawkesbury River were attributed to decreased river flows from a return to average rainfall levels and fewer water releases from Warragamba Dam, advancing algal residence times.

Pughs Lagoon is characterised as in moderately good condition with high nutrient loadings, turbidity, and reduced oxygen levels in the water column (Hawkesbury City Council, 2014). Water quality is largely challenged by reduced upstream flows as a result of water diversion and flood mitigation measures, as well as introduced weed infestations and pest animal species. Algal blooms are also reported to occur (Hawkesbury City Council, 2014).

Site specific, surface water quality sampling was undertaken as part of the DSI. Physiochemical field parameters, as well as samples for chemical laboratory analysis were collected from two waterways: SW01: the Hawkesbury River and SW02: Pughs Lagoon. The locality of these sampling sites are detailed in Figure 4-4. Pughs Lagoon was selected for surface water quality monitoring as part of the DSI as it was historically identified to exhibit PFAS contamination. Given Mareh-Mareh Lagoon and the other lagoon systems have a similar catchment (partially urbanised with agricultural floodplain) and altered hydrological characteristics, the physical and chemical characteristics reported for Pughs Lagoon are likely to be similar to Mareh-Mareh Lagoon.

The Contaminants of Potential Concern (COPCs) analysed as part of the investigation program included:

- Benzene, Toluene, Ethylbenzene, Total Xylenes

- Total Petroleum/Recoverable Hydrocarbons C6-C40
- Polycyclic aromatic hydrocarbons
- Heavy Metals (8) – arsenic, cadmium, chromium, copper, mercury, nickel, lead, zinc
- Organochlorine and Organophosphorus pesticides
- Per-and-Polyfluoroalkyl Substances (PFAS)
- Inorganics
  - Total Dissolved Solids (TDS)
  - Total Suspended Solids (TSS)
- Potential hydrogen (pH)

The results of the surface water quality analysis undertaken for this investigation are outlined in Table 4-2. While the single round of monitoring was focussed on detecting contamination, rather than baseline water quality, the results indicate where water quality issues may arise.

Both waterways showed no signs of sheens and/or algal blooms present at the time of inspection. Electrical conductivity results indicate freshwater conditions at both locations. Redox potential testing indicated surface water is under oxidising conditions at both locations. The pH was slightly acidic to neutral water conditions and just outside the DGV range in Pughs Lagoon. Very low levels of DO were recorded in Pughs Lagoon which aligns with that reported by Hawkesbury City Council (2014). The low DO levels could potentially lead to adverse conditions for aquatic organisms. However, DO concentrations vary with temperature, dissolved salts and biological activity and may change considerably over a daily period with severe DO depletion occurring at times within wetlands particularly if stratification occurs (ANZECC 2000).

At the Hawkesbury River monitoring point (SW01), concentrations were below laboratory detection limits for BTEXN, TRH, Heavy Metals (8), OCPs/OPPs and PFAS. Hence, the existing environment is shown to fall within water quality objective guidelines for most water quality parameters, at the sampling sites.

At Pughs Lagoon (SW02), BTEXN, TRH, OCPs/OPPs, the majority of heavy metals and PFAS chemical contaminants were also below the limit of reporting. However, copper, lead and zinc, exceeded the 95% and 99% LOSP Toxicant DGVs. Elevated levels of copper, lead and zinc are typical within waterways with catchments impacted by urbanisation. Additionally, PFAS was detected at 0.07µg/L, at SW02 and the PFOS concentration (0.03 µg/L) exceeded the adopted freshwater assessment criteria for 99% species protection. The PFAS contamination is likely a result of historical use at the Richmond RAAF Defence Base, located approximately two kilometres east of the proposal at the closest point.

The water quality sampling results indicate good water quality within Hawkesbury River during ambient conditions at the time of sampling. Water quality within Pughs Lagoon is shown to be moderately disturbed by urbanisation within the catchment. This is also likely to be the case for the other lagoons and tributaries within the system, including Mareh-Mareh Lagoon.

Figure 4-4 Surface water sample locations as part of the Stage 2 DSI

Table 4-2 Surface water quality data from the Stage 2 DSI (2023)

Analyte	Units	Water Quality Guidelines		Sample ID	
		ANZG (2018) Freshwater 95% LOSP Toxicant DGCs	ANZG (2018) Freshwater 99% LOSP Toxicant DGCs	SW01	SW02
Sample depth	m	-		1.0	0.3
Field Parameters					
pH		6.5-8.5	6.5-8.5	7.06	6.36
Temperature	℃	-	-	24.4	24.2
Electrical conductivity	µS/cm	2,200	-	401	342
Reduction Potential (ORP)	mV	-	-	111.4	45.1
Dissolved Oxygen (DO)	mg/L	-	-	8.32	1.59
	% saturation	85-100	85-100	98	19
Laboratory Analysis					
Total Dissolved Solids (TDS)	mg/L	-	-	173	-
Total Suspended Solids (TSS)	mg/L		-	<5	-
Total BTEX	ug/L			<1	<1
Arsenic (III)	ug/L	24	-	<1	3
Cadmium	ug/L	0.2	0.06	<0.1	<0.1
Chromium (III+VI)	ug/L	0.4	-	<1	4
Copper	ug/L	1.4	1	<1	4
Lead	ug/L	3.4	1	<1	6
Mercury	ug/L	0.6	0.06	<0.1	<0.1
Sum of PFAS	ug/L	-	-	<0.01	0.07
PFOS	ug/L	0.13*	0.00023*	<0.01	0.03
PFOA	ug/L	220	19	<0.01	<0.01
Nickel	ug/L	11	8	<1	3
Zinc	ug/L	8	2.4	<5	14

Note. Exceedances in guideline levels are highlighted in red.

*Guidelines values for PFOS adopted from PFAS National Environmental Management Plan (NEMP 2.0) 2020

4.4.3 Geomorphology

The River Style Framework was used to characterise the geomorphological characteristics of the local waterways. A river style can be described as a discrete river type, defined by its valley setting, bed material, planform and geomorphic units. Classification of waterways into different river styles assists the grouping of management procedures, with tools for interpreting river behaviour, condition and recovery potential. The predictive basis of this framework provides a solid foundation for decision-making, when it comes to river management. Human activities have significantly impacted the inherent patterns and rates of river adjustment, altering overall behaviour.

The stretch of the Hawkesbury River adjacent to the proposal, has been determined as a laterally unconfined, continuous channel with low sinuosity and a sand bed (NSW Government, 2023). The geomorphic stream condition of the Hawkesbury River has been classified as moderate, with medium priority rehabilitation prioritisation.

Redbank and Rickabys Creeks are defined as laterally unconfined, continuous channels with low sinuosity and a fine-grained bed. Redbank Creek is defined as having moderate geomorphic stream condition, with high recovery potential. Rickabys Creek is defined as having moderate geomorphic stream condition, with moderate recovery potential.

One unnamed stream, parallel to Charles Street and crossing Bells Line of Road, which is intersected by the proposal area has been identified as an anthropogenic, bedrock margin-controlled, urban watercourse with a bedrock bed and poor geomorphic stream condition with low recovery potential.

The geomorphic condition of graded streams within proximity to the Proposal are detailed in Figure 4-5.

The system of lagoons to the south of the Hawkesbury River including Pughs Lagoon and Mareh Mareh Lagoon are highly disturbed systems as discussed in section 4.4.1. The banks of Pughs Lagoon are also reported to be disturbed and eroding (Hawkesbury City Council, 2014).

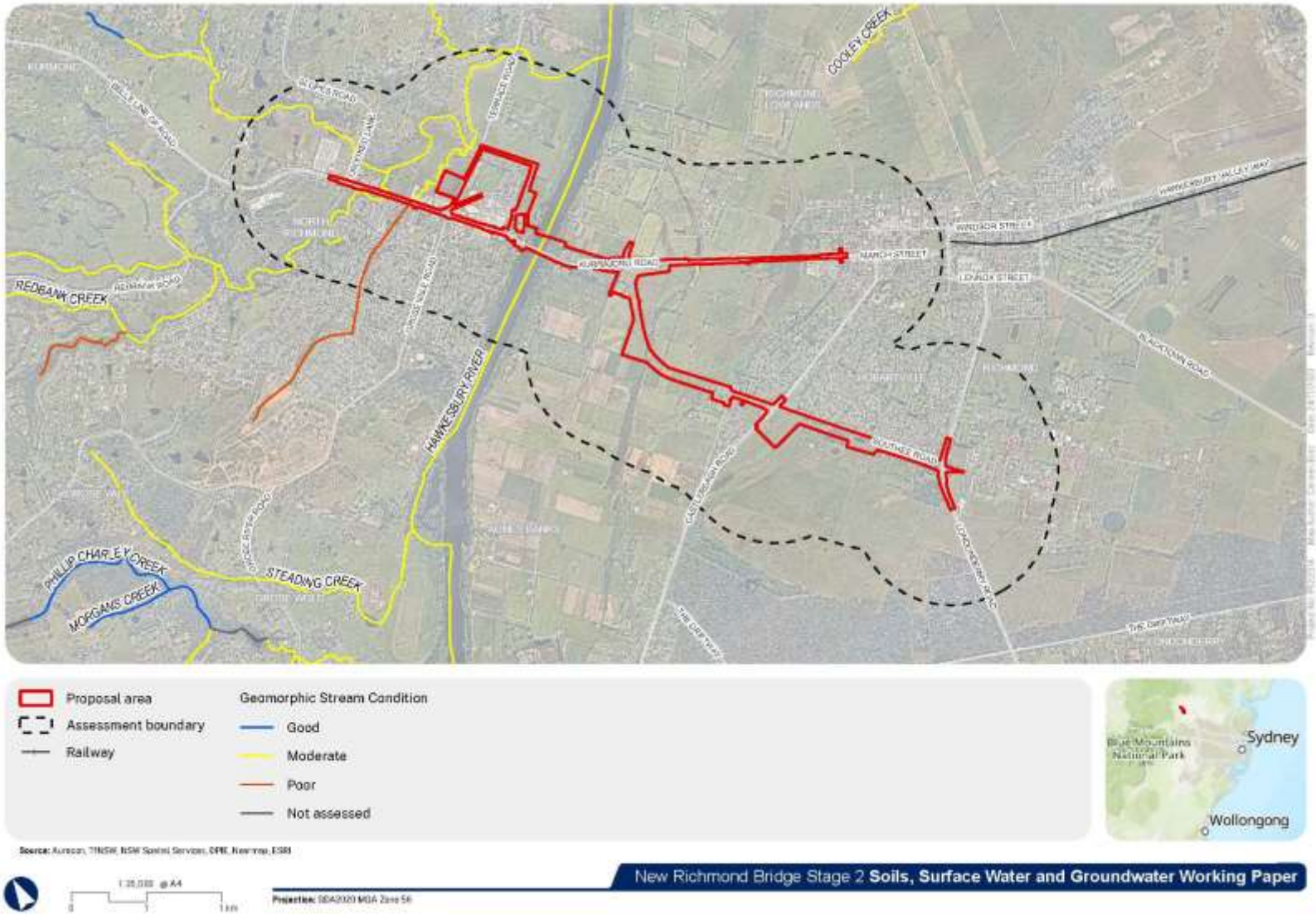

Figure 4-5 Geomorphic stream conditions

4.5 Soils

4.5.1 Soil landscapes

Soil landscapes were identified using the eSPADE portal (eSPADE, 2023., 'NSW Soil and Land Information', NSW Government, available at: <https://www.environment.nsw.gov.au/eSpade2Webapp/>. The soil landscapes intersected by the alignment are shown in Figure 4-6. The study area is predominantly comprised of the Freemans Reach and Richmond soil landscapes. The key, mapped soil landscapes along the alignment are outlined in Table 4-3.

Table 4-3 Soil landscapes across the proposal area

Soil landscape	Description
Blacktown (9030bt)	Gently undulating rises on Wianamatta Group shales. Local relief to 30 m, slopes usually >5%. Cleared Eucalypt woodland and tall open-forest (dry schlerophyll forest). Shallow to moderately deep (>100 centimetres (cm)) hard setting mottled texture contrast soils, Red and Brown Podzolic Soils on crests grading to Yellow Podzolic Soils on lower slopes and in drainage lines. Localised seasonal waterlogging, localised water erosion hazard, moderately reactive highly plastic subsoil, localised surface movement potential.
Lucas Heights (9030lh)	Gently undulating crests and ridges on plateau surfaces of the Mittagong formation (alternating bands of shale and fine-grained sandstones). Local relief to 30 m, slopes <10 %. Rock outcrop is absent. Extensively or completely cleared, dry sclerophyll low forest and woodland. Moderately deep (50–150 cm), hard setting Yellow Podzolic Soils and Yellow Soloths; Yellow Earths on outer edges. Stony soil, low soil fertility, low available water capacity
Freemans Reach (9030fr)	Present active floodplain of the Nepean River. Level with minor (<10 m) relief to meander scrolls, levees, and back swamps. Deep brown sands and loams, apedal to moderately structured, usually friable. Alluvial Soils, Solods and dark Podzolic Soils. High streambank erosion hazard, flood hazard, permanently high-water tables, seasonal waterlogging, localised wave erosion hazard, localised non-cohesive soils.
Richmond (9030ri)	Quaternary terraces of the Nepean and Georges Rivers. Mainly flat (slopes <1%). Splays and levees provide local relief (<3 m). Tree cover, now almost completely cleared, was formerly a low open woodland (dry sclerophyll). Poorly structured orange to red clay loams, clays and sands. Texture may increase with depth. Ironstone nodules may be present. Plastic Clays in drainage lines. Deep acid noncalcic Brown Soils, Red Earths and Red Podzolic Soils, occur on terrace surfaces with Earthy Sands on terrace edges. Localised flood hazard, localised seasonal waterlogging, localised water erosion hazard on terrace edges.
Berkshire Park (9030bp)	Dissected, gently undulating low rises on the Tertiary terraces of the Hawkesbury/Nepean River system. Weakly pedal orange heavy clays and clayey sands often mottled. Ironstone nodules common. Large (up to 20 cm) silcrete boulders occur in sand/clay matrix. Solods, Yellow Podzolic Soils, Red Podzolic Soils, Chocolate Soils, Structured Plastic Clays, Structured Clays. Very high wind erosion hazard if cleared. Gully, sheet, and rill erosion on dissected areas. Localised seasonal waterlogging, localised flood hazard, impermeable subsoils, low fertility.

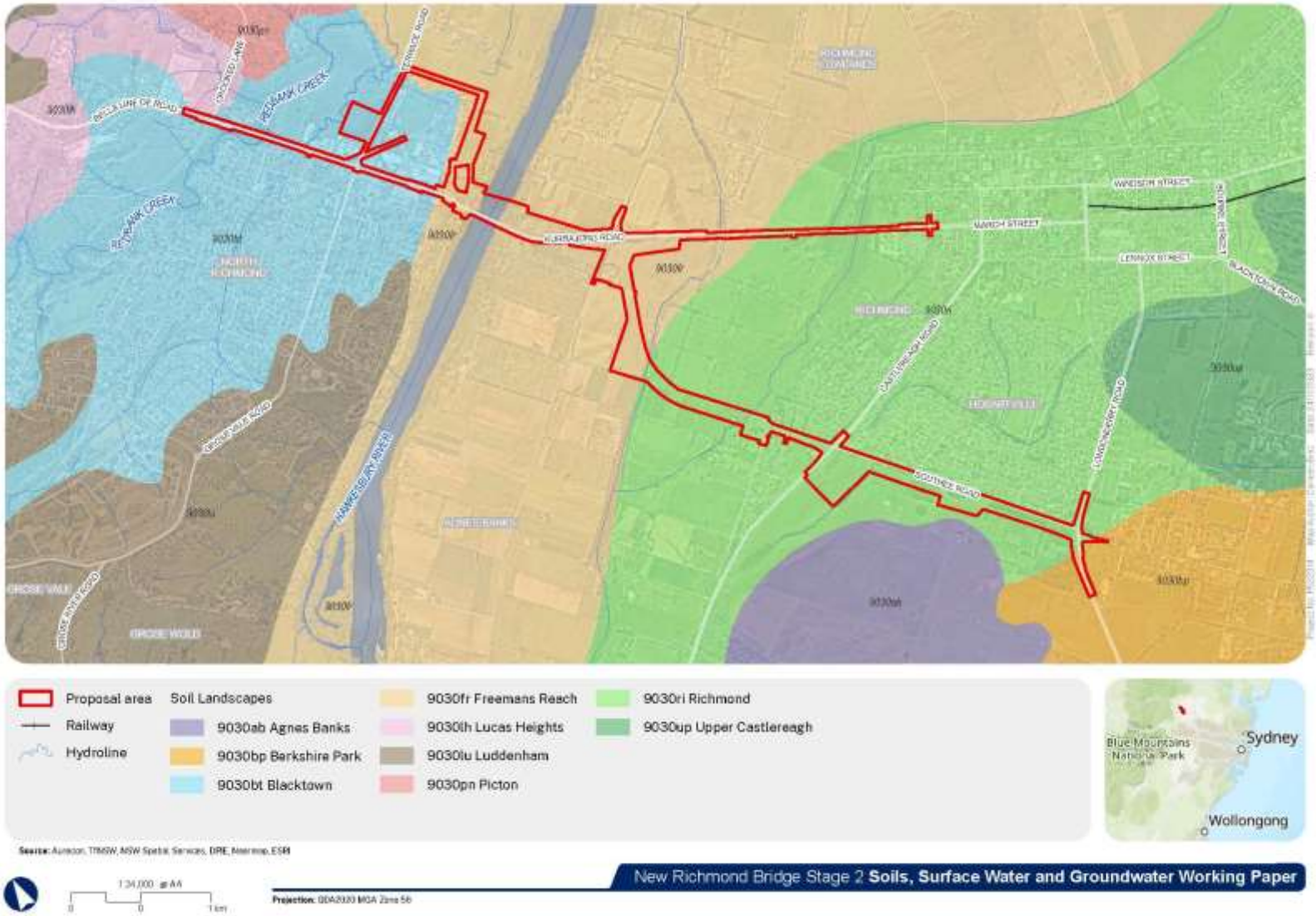

Figure 4-6 Soil landscapes

4.5.2 Erosion hazard

SEEC undertook an evaluation of the erosion hazard using the approach in Chapter 4 of the Blue Book (Landcom, 2004) and a Preliminary Erosion and Sedimentation Assessment (PESA) in accordance with TfNSW Procedure PN 143P. Several construction sub-catchments were identified as having High Erosion Hazard and the proposal was identified as High Risk due to the following factors (SEEC, 2024):

- Steep topography either side of the Hawkesbury River
- Complexity of the proposal and the prevailing environmental conditions, which result in it being inherently high risk as ongoing installation and maintenance of controls would require extensive co-ordinated resources
- The proposal would discharge into the Hawkesbury River and into lagoons that are mapped as Coastal Wetlands, or into lagoons which flow into mapped Coastal Wetlands.

As such an Erosion and Sediment Management Report (ESMR) is required in accordance with PN 143P. The ESMR, including the PESA are provided in Appendix B.

4.5.3 Acid sulfate soils

Acid sulfate soils (ASS) are natural sediments that contain iron sulfides, formed from the process of sulfate reduction that often naturally occur in lakes, rivers, wetlands and oceans. ASS is found mainly in coastal and estuarine wetlands, however, can also occur inland in waterways, wetlands and drainage channels. ASS develop in waterlogged, saline and anaerobic conditions.

ASS are benign when left undisturbed in a waterlogged environment. However, when exposed to air, the iron sulfides in the soils react with atmospheric oxygen and water to produce sulfuric acid. Exposure to air occurs in response to a reduction in water levels within the hydromorphic zone of soils (e.g., during droughts and dredging operations). The production of sulfuric acid can cause major cations and anions (such as Na^{+}, Mg^{2+}, Ca^{2+}, Cl^{-}, SO_4^{2-}), trace elements and metal ions (including Fe^{3+} and Al^{3+}) to be released and become mobile. Inland ASS risk is determined by presence of waterways, wetlands and drainage channels and dryland salinity.

A review of the eSpade database (eSPADE, 2023) indicates there are four areas identified as potentially containing ASS within the Hawkesbury River floodplain sediments as shown in Figure 4-7. These four areas are:

- Approximate 40 m wide corridor along the northern bank of the Hawkesbury River
- Approximate 60 m wide corridor along the southern bank of the Hawkesbury River
- In the centre of the southern floodplain an approximate 20 to 40 m wide corridor following Mareh-Mareh Lagoon
- Along the northern edge of Richmond, a 100 to 200 m wide corridor along Pughs Lagoon

This database informed sampling locations targeting ASS analysis, as part of the DSI for Stage 2. Natural soils from a total of ten sample locations, potentially containing acidic forming materials (potential acid sulfate soil) (PASS), were analysed using chromium reducible sulfur (CRS) acid base accounting analytical methods. Where acid neutralisation capacity (ANC) could not be reported by the laboratory due to matrix interference, the DSI adopted an ANC of zero (‘0’) for a conservative interpretation of the dataset. This was used to assess ASS at specific locations relevant to the proposal area. A summary of the key results are as follows:

- The pH_F readings in analysed samples ranged between 6.1 and 8.8 and therefore did not indicate the presence of any ‘actual’ ASS (i.e. pH levels below 4).
- pH_{FOX} (field pH peroxide test) results ranged between pH 2.3 and pH 7.4.
- Net Acidity (as %S) exceeded the adopted criterion of ≥0.03 %S (Department of Agriculture and Water Resources, 2018., ‘National Acid Sulfate Soils Guidance: A Synthesis’.
- in 4 out of the 36 samples analysed.

- CRS (as %S) returned levels between the limit of reporting (<0.005 %S) and 0.033 %S, indicating that the samples analysed had low sulfide content.

Based on the DSI findings from the desktop review and laboratory analysis of selected soil samples collected from natural soils, results indicated that the subject materials did not comprise PASS except for sample locations BH201 and BH202. Soils collected from these locations are considered ‘low risk’ for PASS at depths of approximately 1.5 m bgs at BH201, and between 2.7 m bgs and 7.4 m bgs at BH202. These sampling locations were located proximal to ‘Mareh-Mareh Lagoon’. Data collected from natural sediments indicated that the that the subject materials do not comprise PASS and/or AASS.

Given that samples collected at BH201 and BH202 exceeded the action criteria, a detailed acid sulfate soil management plan (ASSMP) was prepared by Aurecon for the proposal in accordance with the ASSMAC (1998) and NASSG (2018), as well as the Hawkesbury LEP (2012).

This document would make sure that PASS is appropriately managed at relevant areas of the study area during the future construction program earthworks and deeper excavations.

Figure 4-7 Acid sulfate soils

4.5.4 Soil salinity

Salinity refers to the concentration and mobility of salt within soil and natural waters. Salinity processes are driven by the interactions between water use characteristics of vegetation, physical soil properties and hydrogeological processes within a hydrogeological landscape. Salts occur naturally within soil, as a result of salts within marine sediments, rain, wind (windblown marine salts) and weathering of rocks. Saline conditions can affect water movement, as well as the structure, microbial and plant diversity of soils.

Typically, in Western Sydney, saline groundwater occurs naturally within the Wianamatta Shale, due to its marine origin. In recent years the removal of the natural deep-rooted vegetation has caused the saline groundwater levels to rise and sometimes reaching the ground surface causing salt scalding and degrading the soil structure. Causes for increased soil salinity are:

- alteration of natural drainage patterns by the construction of roads and channels causing groundwater to reach the ground surface,
- creation of wet zones of waterlogged soil by impeded drainage,
- leakage of standing water bodies, lakes and services pipes,
- exposure of susceptible soils,
- irrigation and
- a decrease in deep-rooted vegetation.

Analysis of the eSPADE salinity hazard mapping revealed the potential for saline soils along the alignment (eSPADE, 2023). The overall salinity hazard for the alignment is mapped as moderate. A low land salinity risk exists immediately adjacent to Redbank Creek, in North Richmond, covering a small section of the proposal area. Additionally, sections of the Hawkesbury River have been identified as containing a low salinity risk as although the river is tidally influenced the water is not saline. The area surrounding Pughs Lagoon has been mapped as of high salinity potential. Areas classified as moderate risk for salinity are unlikely to show significant expressions of salinity (e.g. vegetation decline, excessive erosion, salt damage to built structures). However, excessive groundwater recharge in areas of moderate risk can cause or exacerbate surface expressions of salinity in high risk areas.

Saline soils are not considered to represent a risk to the study area as areas mapped as comprising a salinity risk do not lie within areas of proposed excavation or inground structures. As such, further evaluation of salinity risk at the study area was not considered warranted. The salinity risk across the proposal area is presented in Figure 4-8.

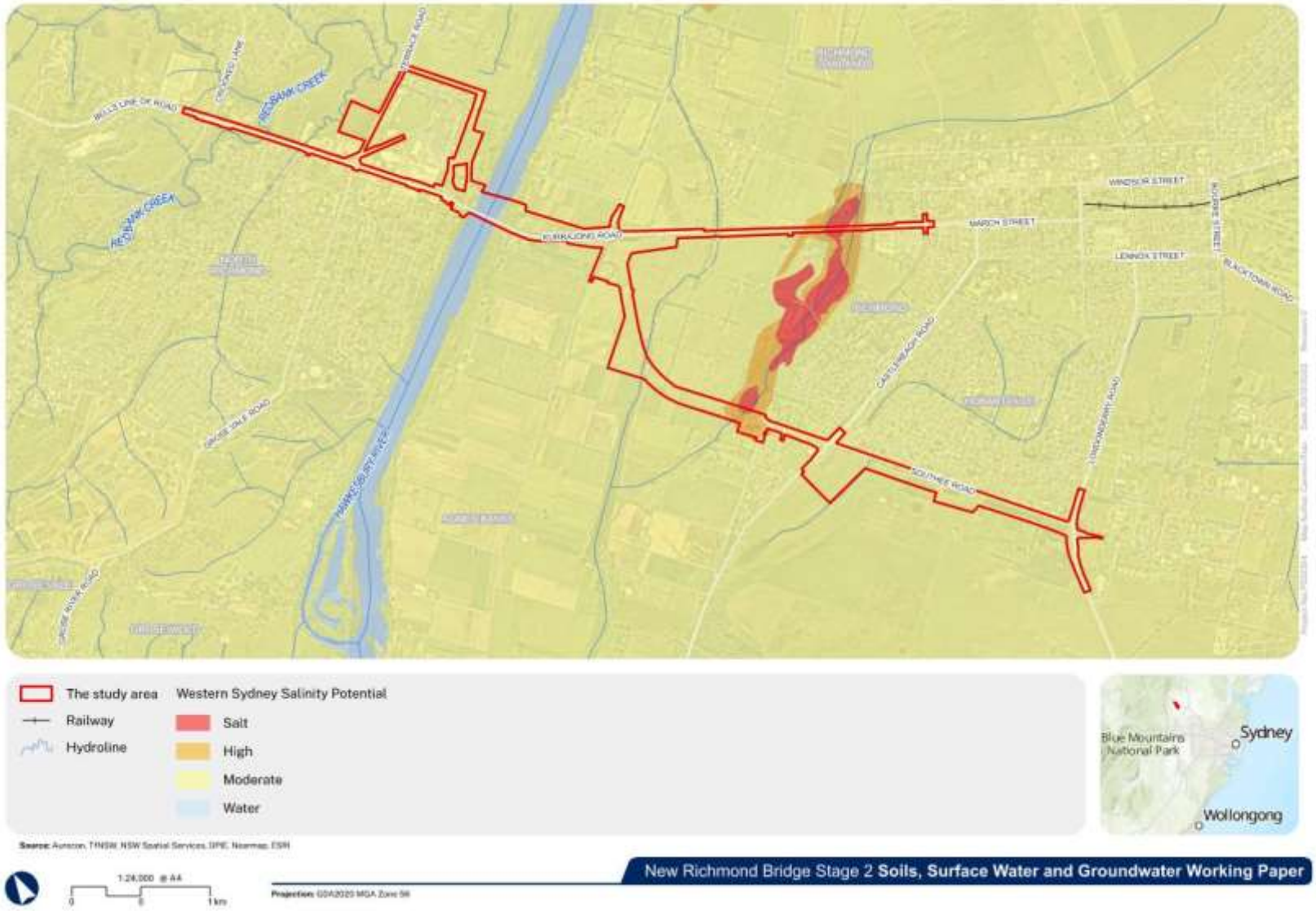

Figure 4-8 Salinity hazard

4.5.5 Hydrologic soil properties

Within the eSPADE database, soils are classified into four hydrologic soil classes, depending on the soil's runoff and infiltration potential (eSPADE, 2023). These four groups are categorised as A, B, C and D, with Group A generally having the lowest runoff potential and Group D the largest. Analysis of the eSpade portal (Soil/State-wide land and soil mapping/Hydrologic Soil group) revealed that the alignment intersects most hydrologic soil groups.

The northern and southern parts of the alignment are classified as Group C Soils, having slow infiltration properties reflecting the high proportion of clays and silts within the weathered shale soils in the north and elevated floodplain sediments in the south. Hawkesbury River sediments are classified as Group B Soils, having moderate infiltration properties, reflecting the higher sand and gravel content compared to the elevated terrace deposits to the south. Within the floodplain sediments are pockets of Group D Soils, having very slow infiltration properties reflecting the high clay content that infill the floodplain lagoons.

As the soils along the entirety of the alignment are in either urbanised or rural/agricultural environments (refer to Figure 4-1), the soil profiles are expected to be significantly disturbed from the natural soil landscapes described above. Hydrologic soil properties along the alignment are presented Figure 4-9.

4.5.6 Naturally occurring asbestos

The Naturally Occurring Asbestos in NSW database was searched for the proposal area. No mapped naturally occurring asbestos is present within the proposal area.

Figure 4-9 Hydrologic soil properties

4.6 Geology

Regionally, the proposal area is located within the Permo-Triassic Sydney Basin that is characterised by sub-horizontal lying sediments of mainly sandstone and shale. Reference to the Penrith 1:100,000 geological sheet 9030 (Clark N.R. and Jones D.C., 1991., 'New South Wales Department of Minerals and Energy (1981)', *Penrith 1:100 000 Geological Series Sheet 9030*, Edition 1. indicates the northern part of the alignment is underlain by the Ashfield Shale (Rwa) that is composed of a laminated dark grey to black claystone/siltstone and fine-grained siltstone/sandstone laminate. The floodplain is underlain by the Quaternary alluvium Lowlands Formation (Qpl) composed of gravel, sand, silt and clay. The south-eastern part of the alignment beneath Richmond and Hobartville is underlain by Clarendon Formation (Qpd) that is composed of clay, clayey sand and silt.

The geology and stratigraphical sequence from Minview's seamless geology dataset is presented in Figure 4-10, illustrating the lithology, depositional environment and ages of the various formations (Minview, 2023., 'Seamless Geology of NSW', NSW Government, available at: <https://data.nsw.gov.au/data/dataset/nsw-seamless-geology>.).

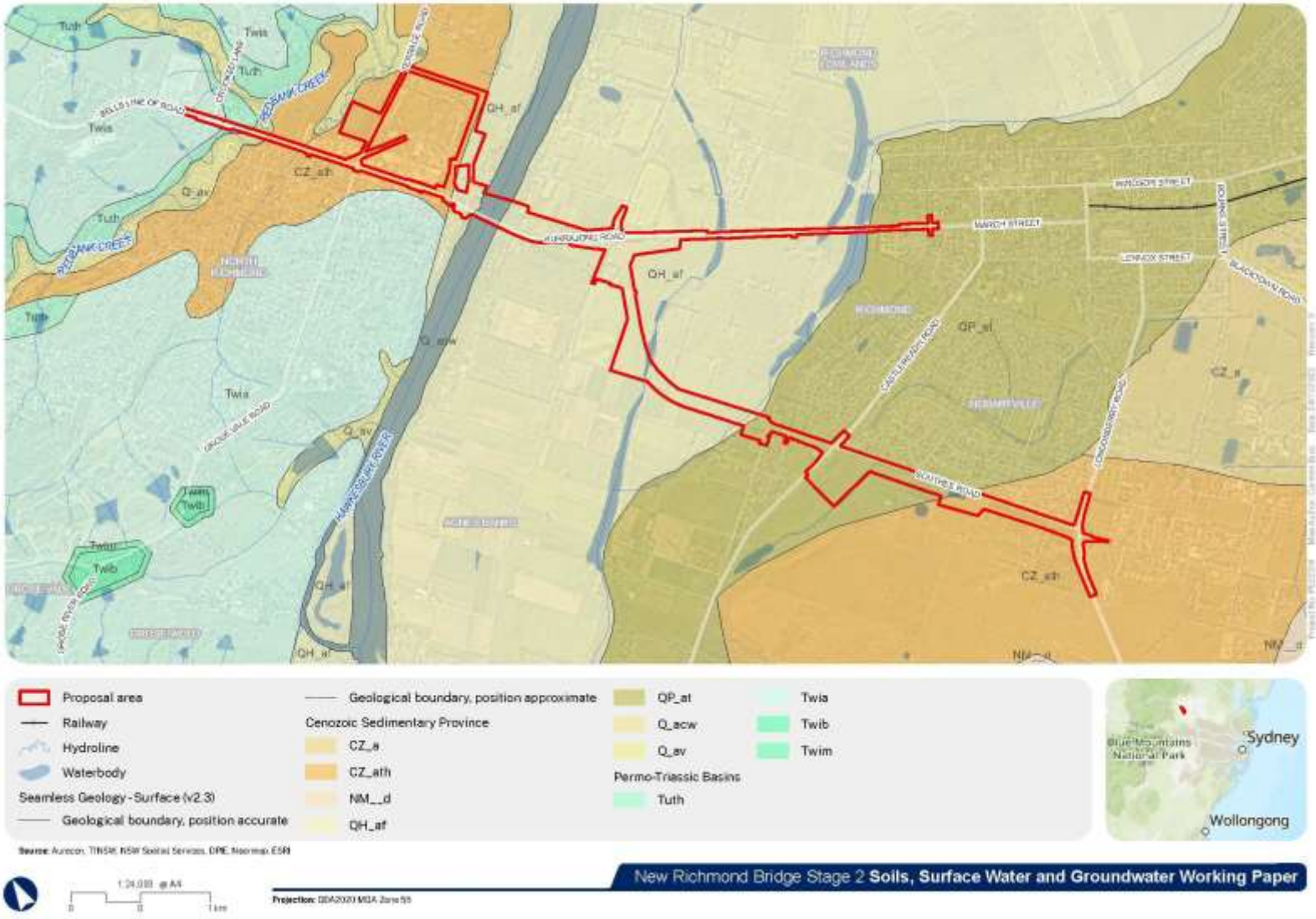

Figure 4-10 Regional seamless geology

4.7 Hydrogeology

4.7.1 Hydrogeological landscapes

Hydrogeological landscapes (HGLs) were identified using the eSPADE portal (eSPADE, 2023., 'NSW Soil and Land Information', NSW Government, available at: <https://www.environment.nsw.gov.au/eSpade2Webapp/>.). The mapped soil landscapes along the alignment from north to south are:

- Kurrajong (HGL_WSS_1)
- Richmond Lowlands (HGL_WSS_3)
- Londonderry (HGL_WSS_4)

The Kurrajong soil landscape unit is located beneath westbound of the alignment at North Richmond. The unit is characterised by steep hills on Triassic shale and occasional sandstone with incised gullies. The soils are red, brown and yellow podzolic soils and yellow earths on upper slopes. Down gradient within drainage lines and footslopes, the soils are yellow podzolics. Brown dermosol soils have been developed over the shale.

The Kurrajong HGL is located beneath the northern part of the alignment at North Richmond. Lateral groundwater flow occurs through the unconsolidated alluvial and colluvial sediments on the slopes and plains. The groundwater systems are localised with short residence times and flow restricted to topographical catchments. Water quality is fresh to brackish. This HGL typically have a medium to fast (months to years) response to changes in land management primarily to the short to medium residence time.

The Richmond Lowland soil landscape unit is located beneath the Hawkesbury River floodplain mainly south of the Hawkesbury River, although there is a thin corridor along the northern bank. The unit is characterised by floodplains and terraces on Quaternary alluvium. The landscape feature floodplains, lagoons that typically parallel the Hawkesbury River, terraces and back plains with an elevation less than 10 m AHD and shallow slopes. The soil unit is composed of unconsolidated alluvial gravels, sands, silts and clays of Quaternary age. The soils are classified as:

- Alluvial soils on the floodplain and younger terraces consisting of stratic rudosols,
- Soloths and yellow podzolic soils on older terraces,
- Humic gleys and black earths on the backplains and lagoons.

Groundwater flows within this HGL through the unconsolidated, unconfined alluvial sediments. Following periods of moderate to high rainfall, groundwater may be perched on top of clay lenses within the alluvium. Groundwater quality is fresh to brackish. Groundwater flow tends to follow higher porosity stream channels within the floodplain sediments. Residence times are typically short to medium term and consequently have a medium to fast (months to years) response to changes in land management.

The Londonderry soil landscape unit is located in the south-eastern part of the alignment beneath Richmond at a slightly high elevation to the floodplain sediments. The unit is composed of unconsolidated alluvial gravels, sands, silts and clay and overlies the Wianamatta Shale. The landscape features flat terrace tops, alluvial plains and drainage lines. The Londonderry soil unit is distinguished from the Richmond Lowland soil landscape because it is an older Tertiary alluvium in comparison to the more recent Quaternary alluvial deposit of the Richmond Lowland. The soils are characterised as brown and yellow soloths, yellow and brown podzolic soils on the Londonderry Clay terraces and plains.

A summary of the hydrogeologic landscapes along the alignment are presented in Table 4-4 and Figure 4-11.

Table 4-4 Soil landscape summary

Soil Landscape	Common Constraints	Land salinity	Water flow
Kurrajong	Mass movement, seasonal waterlogging, salinity and sheet erosion	Land salinity is moderate and associated with seeps/springs and drainage lines in lower parts of the landscape. Salt export is low and high dilution occurs with local runoff. Water electrical conductivity is generally low but can become elevated where the drainage lines intersect shale.	Surface water infiltrates the steep hills and flows down gradient laterally on top of clay lenses. Water also infiltrates vertically through fractures within the shale and sub-horizontally along shale laminations.
Richmond Lowlands	Flooding, foundation hazard and streambank erosion	Land salinity is moderate and associated with seeps/springs where groundwater discharges. Seasonally salt accumulates at the edges of lagoons and drainage lines as water levels fluctuate.	Surface water infiltrates through the alluvium and flows laterally along clay lenses. The water discharges either into streams or the Hawkesbury River or as springs at the base of terraces.
Londonderry	Localised salinity, widespread waterlogging, localised flooding, widespread gully erosion, localised sheet erosion, localised mass movement, impermeable subsoils and localised rill erosion.	Land salinity is low and associated with drainage lines. Minor deposits of salts accumulate at the base of terraces. Water electrical conductivity is moderate. Where the Londonderry Clay Formation is absent saline groundwater can upwell into the alluvium releasing significant amounts of salts	Surface water infiltrates through the alluvium and flows laterally along clay lenses. Saline groundwater within the underlying shale can upwell into the alluvium.

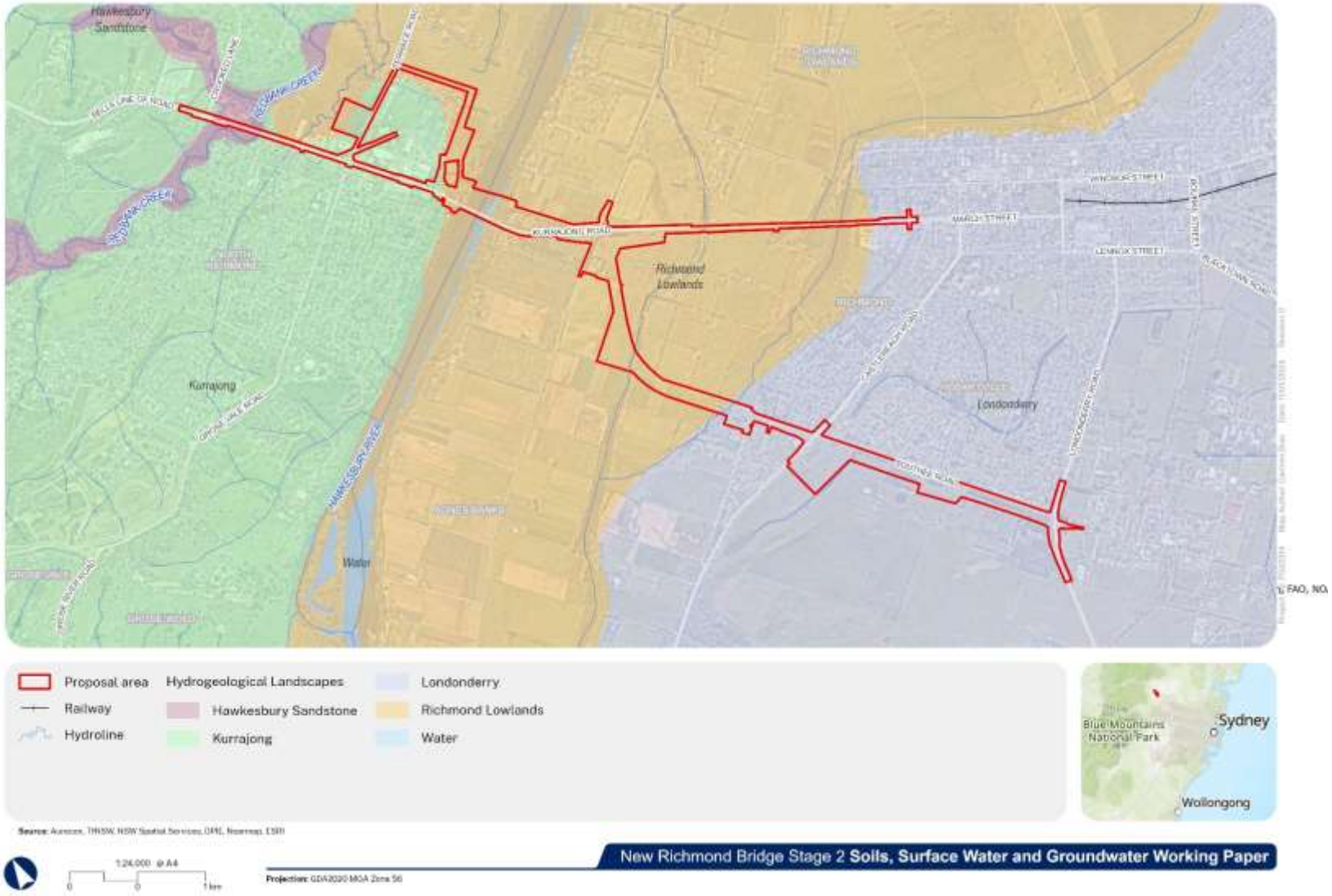

Figure 4-11 Hydrogeologic landscapes

4.7.2 Aquifers

Groundwater along the alignment is contained with unconfined, colluvial and alluvial aquifers, with deeper bedrock aquifer within the Wianamatta Shale. Within the Greater Metropolitan Region Groundwater Water Sharing Plan these alluvial aquifers are referred to as the Sydney Basin Central Groundwater source and the Hawkesbury Alluvium groundwater source (NoW, 2011., 'Water Sharing Plan for the Greater Metropolitan Region Groundwater Sources – Background Document', NSW Office of Water, dated July.

Groundwater within the Hawkesbury Alluvium is typically of good to moderate quality and a valuable water resource predominately for stock and domestic, agriculture and irrigation purposes. The unconsolidated sediments are composed of gravel, sands, silt and clay and underlie the Hawkesbury River and adjacent floodplain. The elevation of the floodplain is on average 10 m AHD. The unit is mostly underlain by a basal clay that where present, prevents the upwelling of groundwater from the underlying shale. Groundwater flow typically follows the gradient of the topography within coarser lenses of the alluvium. Clay lenses are present within the alluvium that periodically cause some groundwater to be perched. Clay is also at the base of elongated lagoons that parallel the Hawkesbury River. Slightly elevated above the floodplain at the edge of the Richmond township are Tertiary aged terraces composed of overbank deposits that are less permeable than the floodplain sediments due to the higher clay content. Recharge to the Hawkesbury Alluvium is predominately via leakage from the Hawkesbury River (a losing stream), direct rainfall infiltration and, in some areas, upwelling from the underlying shale. Discharge is via flow to the Hawkesbury River (gaining stream) and at the base of terraces. The water table is typically shallow and less than five m bgl.

At the proposed area, Wianamatta Shale underlies the alluvium, forming a fractured rock bedrock aquifer. Groundwater flow within the Wianamatta Shale is poor due to the limited pore space and poor connectivity of the bedding planes. The majority of groundwater flow is via saturated fractures and joints although these features can locally reduce groundwater flow, if infilled with iron oxide. The bulk hydraulic conductivity is typically low. Regionally the Wianamatta Shale forms an aquitard reducing groundwater infiltration to the underlying Hawkesbury Sandstone. Locally the shale is confined with an upward pressure head causing groundwater to discharge into the overlying alluvium in areas, where there is no basal clay beneath the alluvium. Groundwater quality within the shale is highly variable but is typically brackish or saline due to the presence of marine salts. The shale aquifer is characterised by low yields, limited storage and poor groundwater quality. The elevated salinity levels cause the groundwater within the shale to be corrosive to building materials. Site specific salinity data retrieved as part of the DSI is outlined in Section 2.4.4 of the DSI.

Aquifer Productivity

The study area's groundwater landscape has been declared as a "highly productive" source along the northern alignment, and "lesser productive" along the southern end of the alignment, within an alluvial water source. This is based on the Groundwater Productivity in NSW Map (NSW Government, 2008), outlined in Figure 4-12. Under the AIP, productive groundwater sourced has declared thresholds for Level 1 minimal impact considerations, provided in Appendix A and Table 9-1. These thresholds are concerned with water table levels, groundwater pressure and water quality. The minimal impact considerations for highly productive groundwater source thresholds, relevant to the northern end of the alignment has been outlined in Table 9-2. Less productive minimal impact considerations are relevant to the southern end of the alignment.

These considerations outline a range of mitigation measures that must be followed in order to uphold groundwater level, quality and pressure. The proposal's impact and relevant mitigations are discussed in Section 6.1.8 and Section 7.1, respectively. Whilst governed by the AIP, The NSW Groundwater Quality Protection Policy further outlines additional beneficial use categories for groundwater, based on salinity thresholds (NSW Government, 1998). This policy characterises groundwater uses based on water quality (salinity) and the presence/absence of contamination. This seeks to uphold groundwater quality and its management through the application of beneficial use classes of groundwater resources, derived from the minimal impact conditions in the NSW AIP.

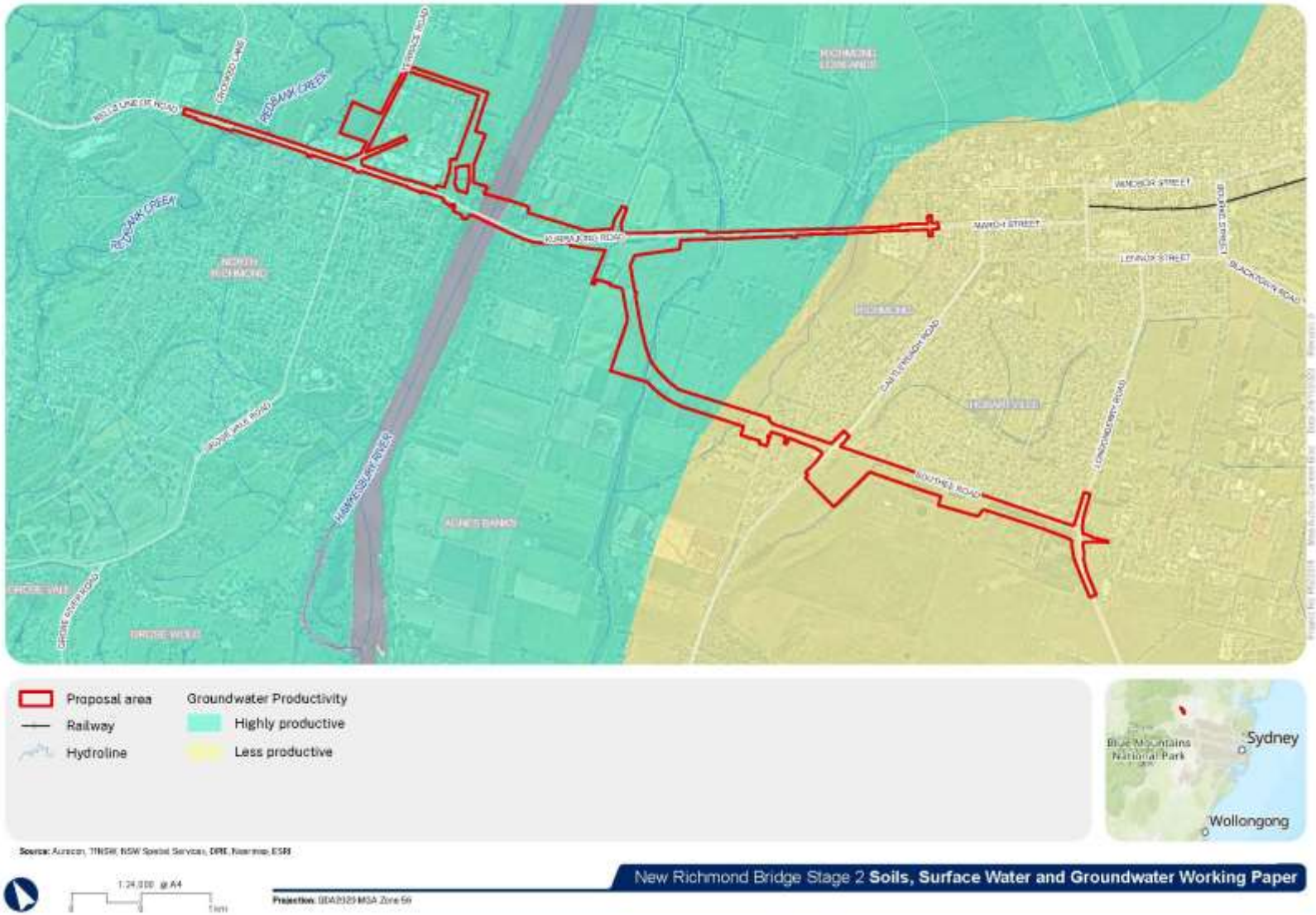

Figure 4-12 Groundwater productivity

4.7.3 Groundwater users

A search of the National Groundwater Information System (NGIS) database conducted on the 8th of November 2023, identified 39 registered bores within 700 m of the proposal area (Bureau of Meteorology, 2023., 'Australian Groundwater Explorer', Australian Government, available at: <http://www.bom.gov.au/water/groundwater/explorer/map.shtml>. From these 39 bores, 27 were found to report hydrogeologic conditions. A summary of these bores is presented in

Table 4-5 Summary of hydrogeologic conditions in registered groundwater bores and are shown on Figure 4-13. The purpose of most registered bores were for water supply (11) and stock and domestic use (6), with other registered purposes being irrigation (2), monitoring bore (3), commercial and industrial (1) and other (4).

Table 4-5 Summary of hydrogeologic conditions in registered groundwater bores

Bore ID	Bore Depth	Year Drilled	Purpose	Screen Interval	SWL (m bgl)	Lithology	
GW106853	150	2004	Water Supply	-	24.5	-	-
GW100756	19.4	1996	Irrigation	14.0-19.0	8.0	0.0-2.4	Topsoil
						2.4-14.6	Sand
						14.6-19.4	Gravel
GW019913	18.8	1962	Water Supply	-	5.7	0.0-0.91	Loam
						0.91-2.46	Sandy Clay
						4.26-18.59	Sandy Gravel
						18.59-18.89	Shale
GW100073	24	1995	Water Supply	22.0-24.0	12.0	0.0-1.2	Soil
						1.2-21.0	Sand
						21.0-23.5	Sandy Gravel
						23.5-24.0	Sandstone
GW069134	19	1995	Other	13.8-17.3	5.5	0.0-5.5	Loam
						5.5-18.2	Gravel
						18.2-19.0	Shale
GW100001	24	1993	Water Supply	21.0-24.0	12.0	0.0-0.7	Clay
						0.7-15.8	Loam
						15.8-19.0	Sand
						19.0-22.8	Gravel
						22.8-24.0	Shale
GW110213	14	2008	Stock and Domestic	9.0-14.0	3.5	0.0-5.0	Clay
						5.0-9.0	Sand
						9.0-13.5	Sandy Gravel
						13.5-14.0	Shale
GW109371	22.9	2008	Other	21.0-22.4	11.4	0.0-19.0	Sandy Clay
						19.0-22.2	Gravel
						22.2-22.9	Shale
GW106614	16	2004	Water Supply	14.0-15.5	3.5	0.0-1.0	Topsoil
						1.0-11.0	Sand
						11.0-15.0	Sandy Gravel
GW103499	12	1966	Water Supply	3.3	-	-	-
GW061564	22.2	1986	Water Supply	19.8-22.2	13.7	0.0-13.7	Silt
						13.7-22.2	Sandy Gravel
GW102317	14.6	1999		12.0-14.0	6.0	0.0-0.9	Sand

Bore ID	Bore Depth	Year Drilled	Purpose	Screen Interval	SWL (m bgl)	Lithology	
			Water Supply			9.0-15.0	Sandy Gravel
GW100707	12	1996	Other	8.5-12.0	7.0	0.0-3.0	Clay
						3.0-9.0	Sand
						9.0-12.0	Gravel
GW103213	13	2000	Commercial and Industrial	10.85-12.35	1.4	0.0-3.8	Clay
						3.8-7.5	Loam
						7.5-12.5	Gravel
						12.5-13.0	Shale
GW103250	11.6	1995	Other	8.0-11.0	5.0	0.0-0.7	Silty Sand
						7.0-8.5	Gravely Sand
						8.5-11.6	Sandy Gravel
GW103070	23.2	2000	Water Supply	21.2-22.7	13.2	0.0-11.0	Silty Clay
						11.0-12.5	Sandy loam
						12.5-15.2	Clay
						15.2-22.7	Gravel
						22.7-23.2	Shale
GW102166	24.2	1998	Stock and Domestic	22.4-23.7	11.7	0.0-1.5	Sand
						1.5-9.5	Clay
						9.5-9.6	Sand
						9.6-16.4	Clay
						16.4-18.4	Gravel
						18.4-21.0	Sand
						21.0-22.0	Shale
						22.0-23.1	Sandstone
						23.1-23.7	Gravel
						23.7-24.2	Shale
GW103531	15.5	2000	Water Supply	13.0-15.0	8.0	0.0-1.0	Topsoil
						1.0-7.0	Sandy Loam
						7.0-10.0	Sand
						10.0-15.0	Sandy gravel
						15.0-15.5	Shale
GW102491	38.1	1995	Monitoring bore	-	9.0	0.0-0.6	Topsoil
						0.6-38.1	Sandstone
GW114826	4.0	2011	Monitoring bore	-	NA	0.0-3.7	Clayey Sand
						3.7-4.0	Clay
GW114828	4.6	2011	Monitoring bore	-	NA	0.0-0.5	Silty Sand
						0.5-0.8	Clay
						0.8-3.4	Clayey sand
						3.4-4.5	Clay
GW114827	4.5	2011	Monitoring bore	-	NA	0.0-0.9	Silty Sand
						0.9-3.6	Clayey Sand
						3.6-4.5	Clay
GW106045	144.0	2003	Water Supply	-	14	0.0-3.0	Clay
						3.0-13.0	Shale
						13.0-34.0	Sandstone
						34.0-42.0	Sand
						42.0-144.0	Sandstone
GW109217	66.0	2008	Stock and Domestic	-	30	-	-
GW108514	54.0	2006		32.0-36.0	7.0	0.0-7.0	Clay

Bore ID	Bore Depth	Year Drilled	Purpose	Screen Interval	SWL (m bgl)	Lithology	
			Stock and Domestic			7.0-11.0	Sandstone
						11.0-12.0	Shale
						12.0-24.0	Sandstone
						24.0-28.0	Sandy Clay
						28.0-54.0	Sandstone
GW100788	150.0	1997	Irrigation	125.0-149.0	31.0	0.0-2.0	Topsoil
						2.0-14.0	Shale
						14.0-19.0	Sandstone
						19.0-21.0	Siltstone
						21.0-45.0	Quartz
						45.0-46.0	Siltstone
						46.0-62.0	Quartz
						62.0-65.0	Siltstone
						65.0-80.0	Quartz
						80.0-117.0	Sandstone
						117.0-121.0	Quartz
						121.0-150.0	Sandstone
GW110557	16.5	2009	Stock and Domestic	12.5-16.5	5.0	0.0-1.0	Topsoil
						1.0-9.5	Clayey Sand
						9.5-16.5	Gravel

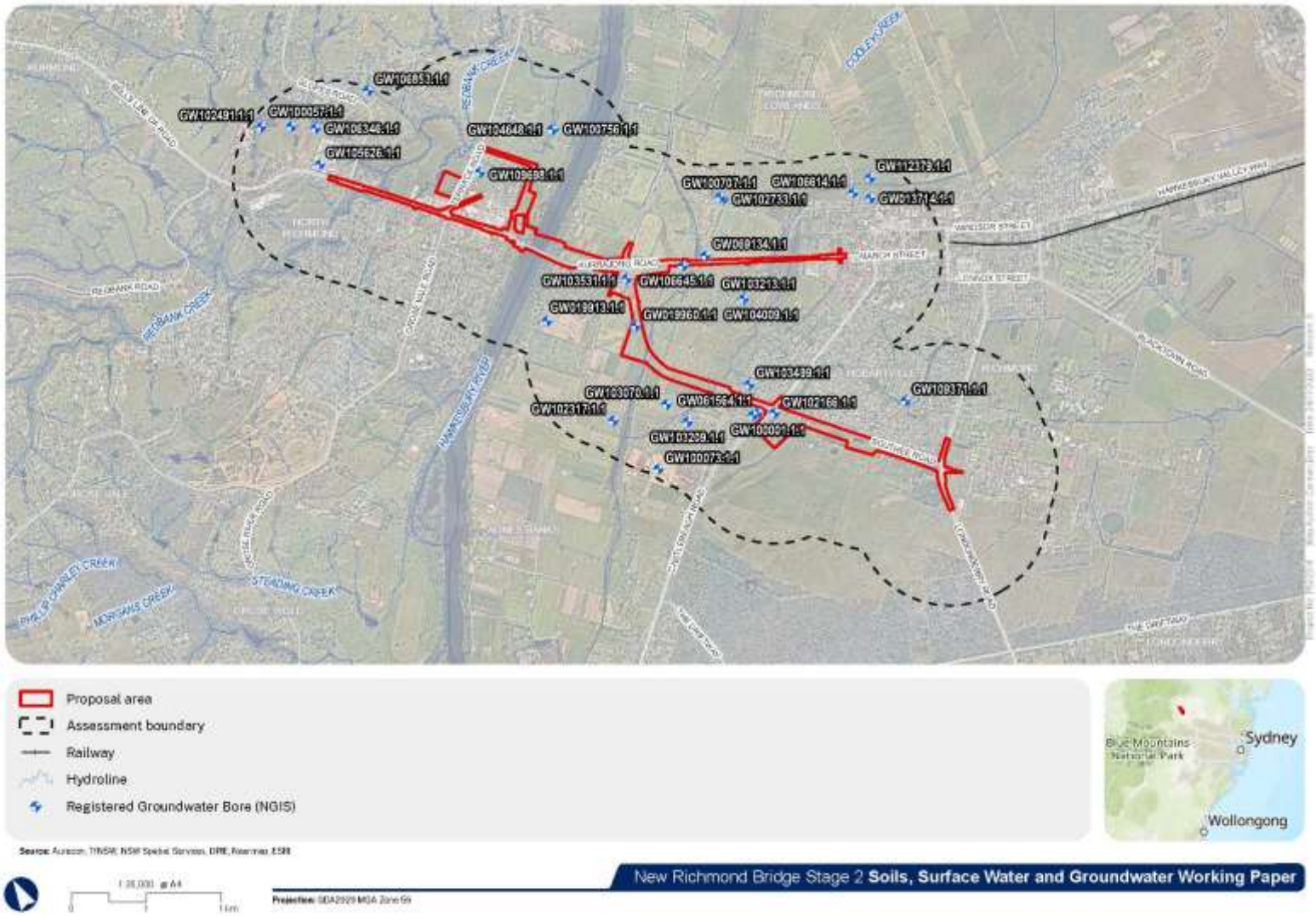

Figure 4-13 Relevant registered groundwater bores

Groundwater monitoring

Aurecon conducted geotechnical investigations as part of the Richmond Bridge Stage 2 project Concept Design. A number of boreholes were drilled, with the installation of ten groundwater monitoring wells. The borehole construction details are presented in Table 4-6 Monitoring wells deployed and their location is shown on Figure 4-14, with locations being:

- BH108 – adjacent to Southee Road
- BH117 – adjacent to Inalls Lane
- BH119 - adjacent to Inalls Lane
- BH121 – in privately owned farmland along Inalls Lane
- BH125 – in privately owned farmland south of Kurrajong Road
- BH127 – adjacent to Kurrajong Road and Old Kurrajong Road
- BH129 – in privately owned farmland along Kurrajong Road
- BH137 – adjacent to Bells Line of Road

BH208 – adjacent to Inalls LaneBH121 was drilled twice, with two separate wells deployed to target the layered aquifers. BH121s was screened in the deeper, sandy gravel and BH121b in the shallower sandy, silty clay. After BH121 was drilled the landholder declined further site access.

Table 4-6 Monitoring wells deployed

Location	Easting	Northing	Date Drilled	Screened depth (m bgl)	Standing water level (m bgl) (1)	Screened lithology	
BH108	290044.6	6279316.9	13/09/2023	1.0-5.0	0.03	1.0–3.9 m bgl	Clayey sand
						3.9–5.5 m bgl	Silty clay
BH117	289459.5	6280005.2	17/08/2023	1.0-8.8	0.57	1.0–2.0 m bgl	Clayey sandy silt
						2.0–4.5 m bgl	Silty clay
						4.5–5.5 m bgl	Sandy clay
						5.5–8.0 m bgl	Clayey sand
						8.0–8.8 m bgl	Sand
BH119	289275.9	6280181.5	06/09/2023	2.2-13.5	1.52	2.2–9.9 m bgl	Sand
						9.9–12.9 m bgl	Sandy gravel
						12.9–13.5 m bgl	Siltstone
BH121a (2)	289260.7	6280957.2	31/07/2023	8.5-13.5	-	8.5-9.5 m bgl	Sand
						9.5-13.5 m bgl	Sandy gravel
BH121b (2)	289338.1	6281149.4	31/07/2023	2.8-5.8	-	2.8-3.6 m bgl	Silty clay
						3.6-5.8 m bgl	Clay
BH125	288954.9	6281458.3	21/09/2023	1.2-13.7	4.24	1.2–2.2 m bgl	Silty clayey sand
						2.2–10.5 m bgl	Silty sand
						12.0–13.7 m bgl	Gravelly sandy clay
BH127	288749.5	6281682.4	18/09/2023	1.6-12.5	5.06	1.6–3.5 m bgl	Clayey silty sand
						3.5–12.5 m bgl	Sand
BH129	289284.6	6280172.5	06/10/2023	1.0-13.0	9.98	1.0–2.5 m bgl	Silty clay
						2.5–5.8 m bgl	Sandy silty clay

Location	Easting	Northing	Date Drilled	Screened depth (m bgl)	Standing water level (m bgl) [1]	Screened lithology	
						5.8-8.7 m bgl	Clayey sand
						8.7 -10.5 m bgl	Sand
						10.5-12.9 m bgl	Sandy cobbles
						12.9-13.0 m bgl	Sand
BH137	290044.6	6279316.9	29/09/2023	2.7-18.0	5.72	2.7–9.2 m bgl	Silty sand
						9.2–9.9 m bgl	Silty clayey sand
						12.0–17.0 m bgl	Sand with cobbles
						17.0-18.0 m bgl	Siltstone
BH208	289459.5	6280005.2	13/09/2023	1.0-12.4	1.42	1.2-1.5 m bgl	Clay
						1.5-1.7 m bgl	Clayey sand
						1.7-8.8 m bgl	Sand
						8.8-13.3 m bgl	Clayey sand
						10.3-10.5 m bgl	Gravelly sand
						10.5-12.4 m bgl	Sandy gravel
						12.4-13.5 m bgl	Siltstone

Notes:
1. Shallowest standing ground water level recorded over groundwater monitoring between from 4th December 2023 to 16th July 2024.
2. No monitoring data available for BH121a and BH121b locations due to land access constraints.

Groundwater bores, along with depths to groundwater strike, and recorded groundwater levels, are presented in Figure 4-15.

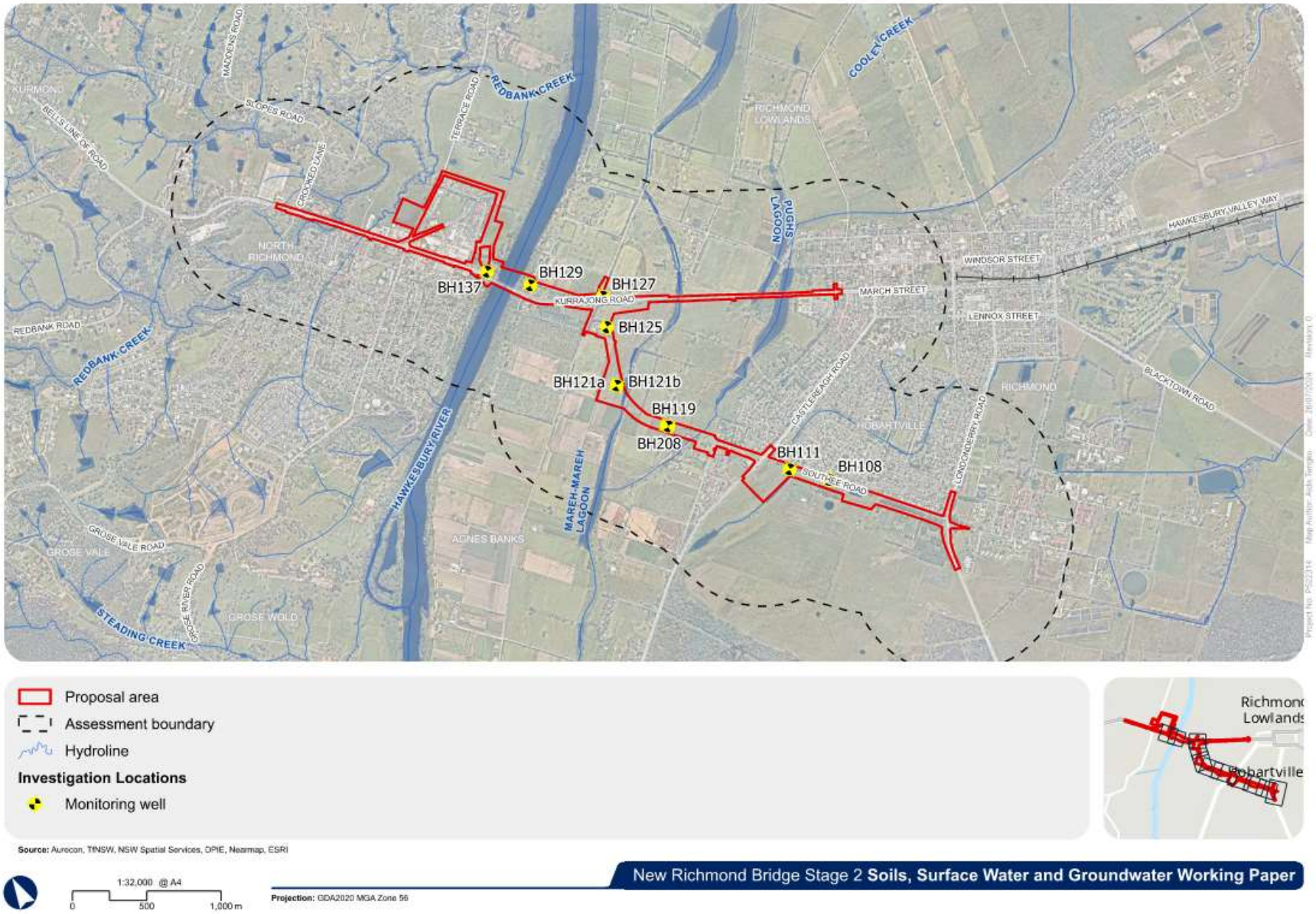

Figure 4-14 Groundwater monitoring wells

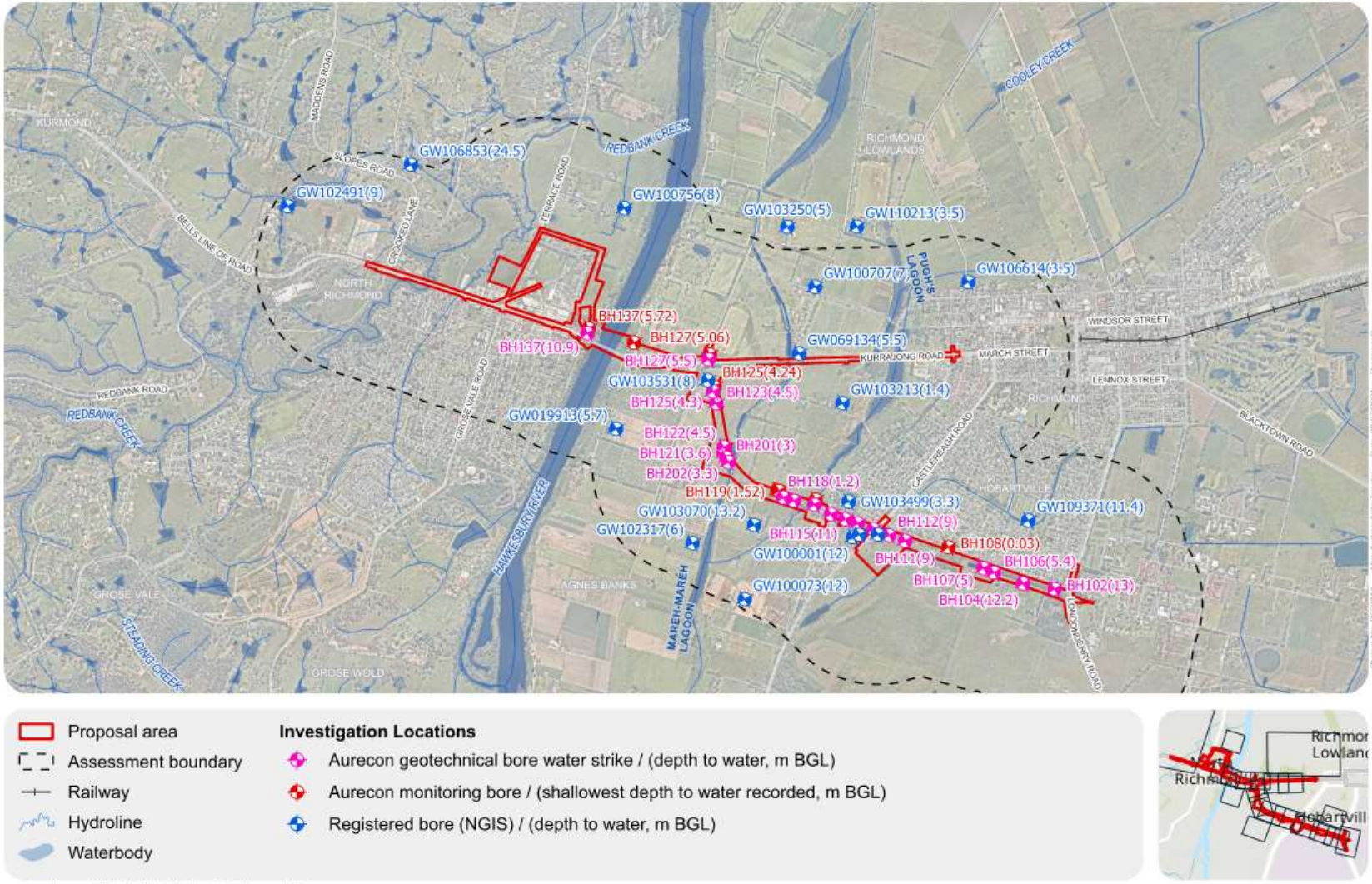

Figure 4-15 Groundwater bores and water depths

Groundwater quality

Groundwater quality is largely impacted by the hydrogeological landscape, surrounding land use activities, surface and groundwater connectivity and influence of human aquifer interferences. Hence, groundwater quality can be quantified by assessing salinity to assess the beneficial use category as well as contamination and other physiochemical parameters.

Groundwater within the proposal area is generally defined as fresh (< 1000 mg/L). Deeper groundwater from within the shale tends to be more saline than groundwater within the overlying alluvium. Salinity values recorded on the registered bore logs ranged from 90 – 700 mg/L, as shown in Table 4-7. Regionally, high salinity values have been recorded, limiting the potential uses of groundwater. However, site specific data collected as part of contamination investigations concluded that electrical conductivity (EC) ranged between 711 µS/cm (BH129) and 1,060 µS/cm (BH137), indicating fresh to slightly saline groundwater.

Table 4-7 Registered groundwater bores salinity data

Bore ID	Year Drilled	Latitude	Longitude	Salinity (mg/L) (at depth where relevant)
GW100073	1995	33.602	150.723	90
GW069134	1995	33.591	150.735	220
GW100001	1993	33.602	150.732	120
GW110213	2008	33.586	150.743	220
GW109371	2008	33.606	150.7430	240
GW106614	2004	33.593	150.748	550
GW103213	2000	33.595	150.736	250
GW103250	1995	33.584	150.739	110
GW103070	2000	33.598	150.727	184
GW102166	1998	33.602	150.734	90
GW103531	2000	33.590	150.729	200
GW110557	2009	33.584	150.7412	400
GW102491	1995	33.568	150.716	340
GW106045	2003	33.570	150.729	2000 (66.0-76.0)
				1150 (96.0-97.0)
				640 (132.0-134.0)
GW108514	2006	33.569	150.726	3100 (32.3-32.6)
				4700 (48.3-48.7)
GW100788	1997	33.571	150.730	3.49 (31.0-33.0)
				3.23 (60.0-65.0)
				250 (120.0-150.0)

Groundwater quality was monitored at two proposal monitoring wells (BH129 and BH137), in October 2023. Groundwater field parameters and chemical contaminants are presented in Table 4-8, along with a comparison of the adopted guidelines. Concentrations of metals, except zinc, nickel and copper, were detected in groundwater samples below the limit of reporting. The detection of zinc, nickel and copper within groundwater is attributed to naturally occurring elevated metal concentrations derived from the Wianamatta Shale based on local professional experience. Additionally samples collected as part of the DSI to address AEC's (2023), recorded concentrations of BTEXN, TRH, VOC/SVOCs, phenols, OCPs/OPPs and PFAS were recorded below the laboratory limit of reporting and/or adopted human health and ecological assessment criteria.

Additional groundwater sampling was undertaken and reported in the Geotechnical Interpretive Report for details related to groundwater aggressivity results from groundwater samples collected at the monitoring well locations. The exposure classification for concrete piles was mild and BI for buried concrete elements. The exposure classification for steel piles ranged from mild to moderate except for one sample (BH117), which classification was labelled as severe.

Table 4-8 Physiochemical groundwater quality criteria

Analyte	Units	Water Quality Guidelines		Sample ID	
		ANZG (2018) Freshwater 95% LOSP Toxicant DGCs	ANZG (2018) Freshwater 99% LOSP Toxicant DGCs	BH129	BH137
Field Parameters					
pH		6.5-8.5	6.5-8.5	5.60	5.78
Temperature	℃	-	-	18.6	19.7
Electrical conductivity	µS/cm	2,200	-	711	1,060
Reduction Potential (ORP)	mV	-	-	-71.4	-18.4
Dissolved Oxygen (DO)	mg/L	-	-	0.73	0.80
Laboratory Analysis					
Total BTEX	µg/L	-	-	<1	<1
Arsenic (III)	µg/L	2.4	-	<1	<1
Cadmium	µg/L	0.2	0.06	<0.1	<0.1
Chromium (III+VI) (filtered)	µg/L	0.4	-	<1	<1
Copper (filtered)	µug/L	1.4	1	2	<0.1
Lead (filtered)	µg/L	3.4	1	<1	<1
Mercury (filtered)	µg/L	0.6	0.06	<0.1	<0.1
Sum of PFAS	µg/L	-	-	<0.01	<0.01
PFOS	µg/L	-	-	<0.01	<0.01
Nickel	µg/L	11	8	4	8
Zinc (filtered)	µg/L	8	2.4	16	35

Note: Guideline exceedances are highlighted in red.

In situ pH indicated slightly acidic groundwater conditions, outside of the 95% species protection under ANZG guidelines. Electrical conductivity indicated fresh to slightly saline groundwater and ORP indicated that groundwater is under reducing conditions. Copper, nickel and zinc concentrations exceeded the adopted the ecological assessment criteria for freshwater 95% and 99% species protection. These concentrations, representing the existing environment, were attributed to naturally occurring elevated metal concentrations that are found in soils derived from the Wianamatta Shale.

Groundwater levels

Groundwater levels throughout the proposal area, within the alluvium, are expected to be shallow due to the proximity and hydraulic connection with the Hawkesbury River. Groundwater recharge varies seasonally (highest in summer and lowest in winter) and groundwater levels fluctuate accordingly.

Standing water levels from the registered bores within the groundwater study area are presented in

Table 4-9 Registered groundwater bores with standing water levels. These levels ranged from 1.4 - 24.5 m bgl, monitored between 1966 and 2004 (WaterNSW, 2023., ‘Real-time Data’, available at: <https://realtimedata.waternsw.com.au/water.stm>.

(Woolacotts Consulting Engineers, 2021., ‘Centre of Excellence in Agricultural Education (CoE) Soil and Groundwater Assessment’

Recent standing groundwater levels are included in Table 4-11. The levels provided were recorded at the date of installation. There is no time series data available, or long term level monitoring for these locations.

Table 4-9 Registered groundwater bores with standing water levels

Bore ID	Year Drilled	Latitude	Longitude	Standing Water Level (from construction log) (m bgl)
GW106853	2004	-33.570067	150.71934	24.5
GW100756	1996	-33.578619	150.730383	8.0
GW019913	1962	-33.58926	150.721993	5.7
GW100073	1995	-33.60152	150.723475	12.0
GW069134	1995	-33.591029	150.735473	5.5
GW100001	1993	-33.601698	150.732084	12.0
GW110213	2008	-33.586494	150.743428	3.5
GW109371	2008	-33.606128	150.743036	11.4
GW106614	2004	-33.592567	150.748021	3.5
GW103499	1966	-33.599816	150.733104	3.3
GW061564	1986	-33.60176	150.732549	13.7
GW102317	1999	-33.597185	150.722404	6.0
GW100707	1996	-33.588213	150.738823	7.0
GW103213	2000	-33.594773	150.73625	1.4
GW103250	1995	-33.584425	150.739325	5.0
GW103070	2000	-33.598127	150.726688	13.2
GW102166	1998	-33.602316	150.73366	11.7
GW103531	2000	-33.58962	150.729143	8.0
GW102491	1995	-33.568427	150.710604	9.0

During the geotechnical investigation conducted for the proposal, 20 boreholes and 1 test pit intersected groundwater during drilling**Error! Reference source not found.**. The depth and elevation of these water strikes are detailed in Table 4-10.

Table 4-10 Groundwater strike results from geotechnical investigations

Bore ID	Easting (m)	Northing (m)	Groundwater strike during drilling	Date of groundwater strike	
			Depth (m bgl)	Level (m AHD)	
BH102	290522.0	6278767.9	13.00	12.33	01/09/2023
BH104	290365.0	6278899.8	12.20	12.79	04/09/2023
BH106	290238.6	6279053.3	5.40	16.86	08/09/2023
BH107	290195.1	6279111.0	5.00	17.09	11/09/2023
BH111	289847.6	6279513.9	9.00	11.79	13/09/2023
BH112	289777.0	6279596.0	9.00	11.52	14/09/2023
BH113	289709.0	6279679.4	5.00	16.86	23/08/2023
BH114	289639.1	6279762.6	11.70	8.05	22/08/2023
BH115	289583.6	6279825.5	11.00	9.42	18/08/2023
BH116	289520.1	6279900.0	9.00	9.41	07/08/2023
BH117	289459.5	6280005.2	1.5	9.33	17/08/2023
BH118	289309.0	6280144.0	1.20	9.62	25/08/2023
BH121	289120.7	6280583.0	3.60	7.57	24/07/2023
BH122	289141.1	6280614.2	4.50	6.79	02/08/2023
BH123	289238.9	6280882.0	4.50	6.55	20/09/2023

Bore ID	Easting (m)	Northing (m)	Groundwater strike during drilling	Date of groundwater strike	
			Depth (m bgl)	Level (m AHD)	
BH125	289260.7	6280957.2	4.30	6.79	21/09/2023
BH127	289338.1	6281149.4	5.50	6.96	18/09/2023
BH137	288749.5	6281682.4	10.09	2.41	29/09/2023
BH201	289122.3	6280546.4	3.00	7.89	04/08/2023
BH202	289118.8	6280516.4	3.30	7.31	07/08/2023
TP109	289358.8	6280092.6	1.40	8.92	04/10/2023

The location of monitoring bores used to monitor groundwater levels and quality, conducted in November 2023, are outlined in Figure 4-14 and tabulated in Table 4-11 Installed groundwater wells recorded standing water levels

Table 4-11 Installed groundwater wells recorded standing water levels

Bore ID	Easting (m)	Northing (m)	Standing Water Level (1)	
			(m bgl)	(m AHD)
BH108	290044.6	6279316.9	0.03	20.94
BH117	289459.5	6280005.2	0.57	10.18
BH119	289275.9	6280181.5	1.52	9.03
BH121a (2)	289120.7	6280584.4	-	-
BH121b (2)	289121.9	6280583.1	-	-
BH125	289260.7	6280957.2	4.24	7.28
BH127	289338.1	6281149.4	5.06	6.89
BH129	288954.9	6281458.3	9.98	6.16
BH137	288749.5	6281682.4	5.72	5.44
BH208	289284.6	6280172.5	1.42	9.00

Notes:
1. Shallowest standing ground water level recorded over groundwater monitoring between from 4th December 2023 to 16th July 2024.
2. No monitoring data available for BH121a and BH121b locations due to land access constraints.

It must be noted that these levels provide a discrete, single point data, with a limited understanding of the long-term range of water table fluctuations. This includes the potential impact that seasonal variation, flooding and dry weather events may have on the water level and subsequent impact on the proposal and is discussed in further detail in Section 6.

4.8 Surface water and groundwater interaction

Groundwater naturally interacts with surface water in ponds, rivers, streams and lagoons, at Mareh-Mareh Lagoon, Pughs Lagoon and the Hawkesbury River. This interaction can result in groundwater being recharged or discharged depending on the hydraulic gradients. Along the Hawkesbury River floodplain, groundwater can be rapidly recharged in times of flood. This is due to the flood waters spreading out across the floodplain and infiltrating into the unconsolidated alluvium. Seasonal recharge of the alluvial aquifer occurs when Mareh-Mareh and Pughs Lagoons contain water and recharge the Hawkesbury Alluvium, although recharge is somewhat restricted due to the presence of clay at the base of the lagoons.

There is little surface water interaction with the Kurrajong HGL other than rainfall infiltration and runoff recharge since this HGL is elevated above the floodplain overlying Wianamatta Shale. The Londonderry HGL receives sporadic recharge from large flood events when flood levels rise above the Tertiary aged river terraces, although recharge is restricted due to the high clay content. The Richmond Lowland HGL receives constant recharge from leakage from the Hawkesbury River and seasonal recharge from flood events.

Surface water infiltration to the Richmond HGL is moderate to high due to the relatively high permeability of the sands and gravel within the unit.

The infiltration of low salinity surface water from the Hawkesbury River and flood events dilutes the salt content within the Hawkesbury Alluvium. Conversely upwelling of saline groundwater from the Wianamatta Shale increases the groundwater salt load. Groundwater within the Kurrajong HGL moves relatively slowly through the landscape accumulating salt as it moves through the soil and bedrock increasing the salt load of the Hawkesbury Alluvium as it discharges down gradient.

4.9 Sensitive receiving environments

4.9.1 GDEs

GDEs are communities of plants, animals and other organisms whose extent and life processes are dependent on groundwater such as wetlands. A search of the BoM's Groundwater Dependent Ecosystem Atlas identified a range of aquatic GDE's within close proximity of the proposal area (Bureau of Meteorology, 2023., 'Groundwater Dependent Ecosystems Atlas', Australian Government', available at: <http://www.bom.gov.au/water/groundwater/gde/map.shtml>. These aquatic GDEs are summarised in Table 4-12, with their locations shown in Figure 4-16 and Figure 4-17, respectively. These GDEs were linked to a range of aquatic floodplain wetlands as well as the Hawkesbury River and identified as possessing moderate – high GDE potential.

These ecosystems are rated on their GDE potential and Inflow Dependent Ecosystem (IDE) likelihood. GDE potential describes an ecosystem's potential to interact with groundwater. IDE likelihood describes the probability that the ecosystem is accessing water in addition to rainfall. A value of less than six, indicates the ecosystem is more likely to rely solely on rainfall and is therefore not considered groundwater dependent.

Six types of GDEs have been identified in Australia:

- terrestrial vegetation that is partially dependent on shallow groundwater,
- wetlands such as paperbark swamp forests and mound springs,
- river baseflow systems where groundwater discharge, provides significant baseflow component to the river,
- aquifer and cave ecosystems where life exists independent of sunlight,
- terrestrial fauna, both native and introduced species, that rely on groundwater as a source of drinking water,
- estuarine and near-shore marine systems, such as coastal mangroves, salt marshes and seagrass beds, which rely on the submarine discharge of groundwater.

Table 4-12 Aquatic Groundwater Dependent Ecosystems in and around the proposal area

Name	Ecosystem Type	GDE Potential	IDE Likelihood	Approximate Distance from Proposal Area (m)	Groundwater Management Zone
Pughs Lagoon	Wetland - Floodplain	High / Moderate	10	0	Greater Metropolitan Region Groundwater Sources – Sydney Basin – Central, Greater Metropolitan Region Groundwater Sources – Hawkesbury Alluvium
Hawkesbury River	River – Connector	High / Moderate	10 / 6	0	Greater Metropolitan Region Groundwater Sources – Hawkesbury Alluvium
-	Wetland - Floodplain	Moderate	5	0	Greater Metropolitan Region Groundwater Sources – Hawkesbury Alluvium

Name	Ecosystem Type	GDE Potential	IDE Likelihood	Approximate Distance from Proposal Area (m)	Groundwater Management Zone
-	Wetland - Floodplain	High	10	>1000	Greater Metropolitan Region Groundwater Sources – Hawkesbury Alluvium
Yarramundi Lagoon	Wetland - Floodplain	High	8	>2500	Greater Metropolitan Region Groundwater Sources – Hawkesbury Alluvium
Gross River	Wetland - Floodplain	Moderate	9	>2800	Greater Metropolitan Region Groundwater Sources – Hawkesbury Alluvium
Bakers Lagoon	Wetland - Floodplain	High	9	>3500	Greater Metropolitan Region Groundwater Sources – Hawkesbury Alluvium

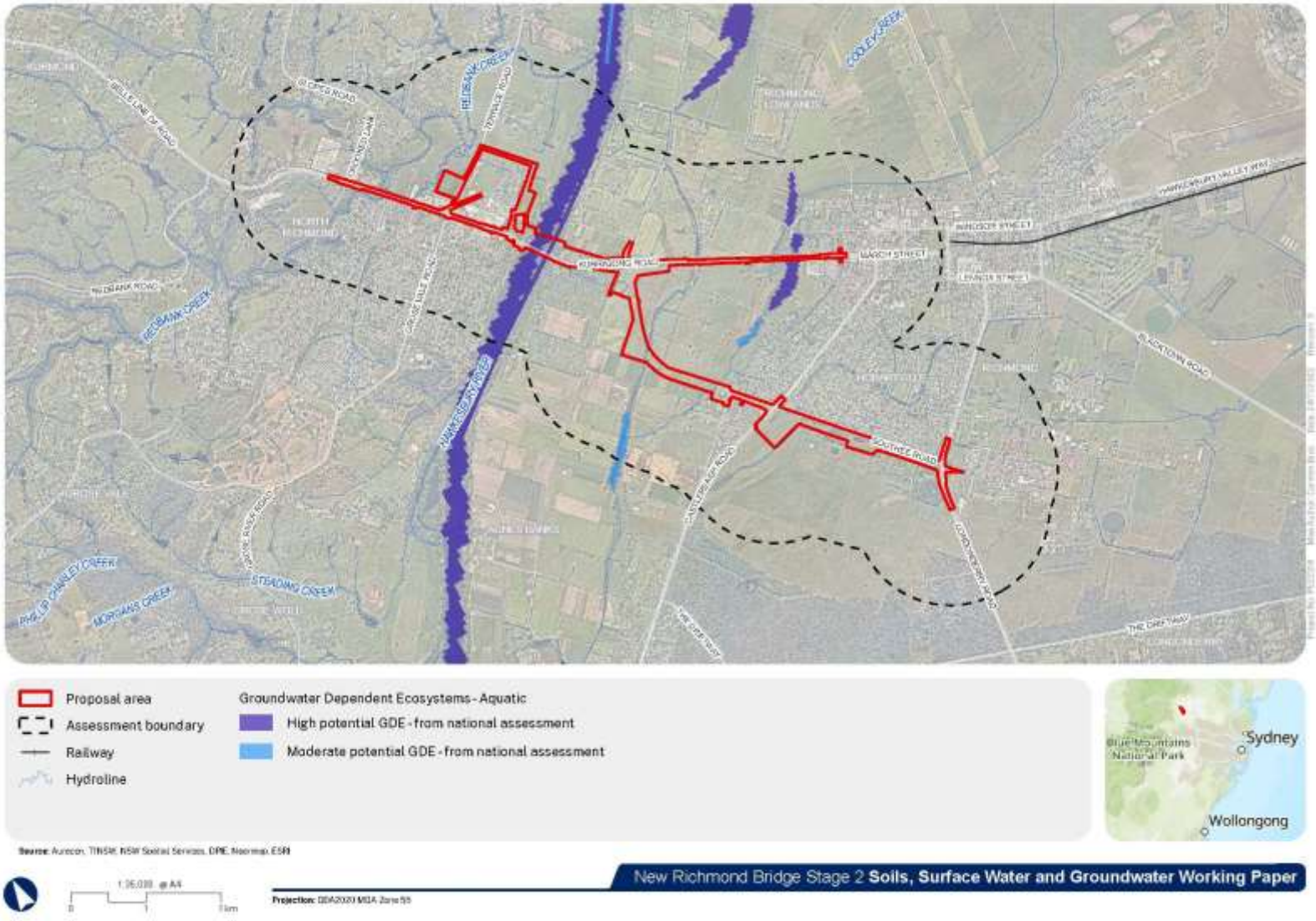

Figure 4-16 Aquatic groundwater dependent ecosystems

Terrestrial GDEs identified within the BoM's Atlas are summarised in Table 4-13.

Table 4-13 Terrestrial Groundwater Dependent Ecosystems

Ecosystem Type	GDE Potential	IDE Likelihood	Approximate distance from Proposal Area (m)	Groundwater Management Zone
Cumberland Shale Plains Woodland	High / Moderate	10 / 9 / 8 / 7	>100	Greater Metropolitan Region Groundwater Sources – Sydney Basin – Central, Greater Metropolitan Region Groundwater Sources – Sydney Basin – Blue Mountains Sandstone, Greater Metropolitan Region Groundwater Sources – Sydney Basin – Nepean Sandstone, Greater Metropolitan Region Groundwater Sources – Sydney Basin – Richmond Sandstone,
Cumberland Shale Sandstone Transition F	High / Moderate	10 / 9 / 8 / 7 / 6	>200	Greater Metropolitan Region Groundwater Sources – Sydney Basin – Central, Greater Metropolitan Region Groundwater Sources – Sydney Basin – North Greater Metropolitan Region Groundwater Sources – Sydney Basin – Richmond Sandstone,
Costal Freshwater Lagoon	High	9 / 10	>800	Towamba River Unregulated and Alluvial
Cumberland River Flat Forest	High	10 / 9 / 8 / 6	>800	Greater Metropolitan Region Groundwater Sources – Sydney Basin – Central, Greater Metropolitan Region Groundwater Sources – Sydney Basin – Blue Mountains Sandstone, Greater Metropolitan Region Groundwater Sources – Sydney Basin – Nepean Sandstone, Greater Metropolitan Region Groundwater Sources – Sydney Basin – Richmond Sandstone, Greater Metropolitan Region Groundwater Sources – Hawkesbury Alluvium

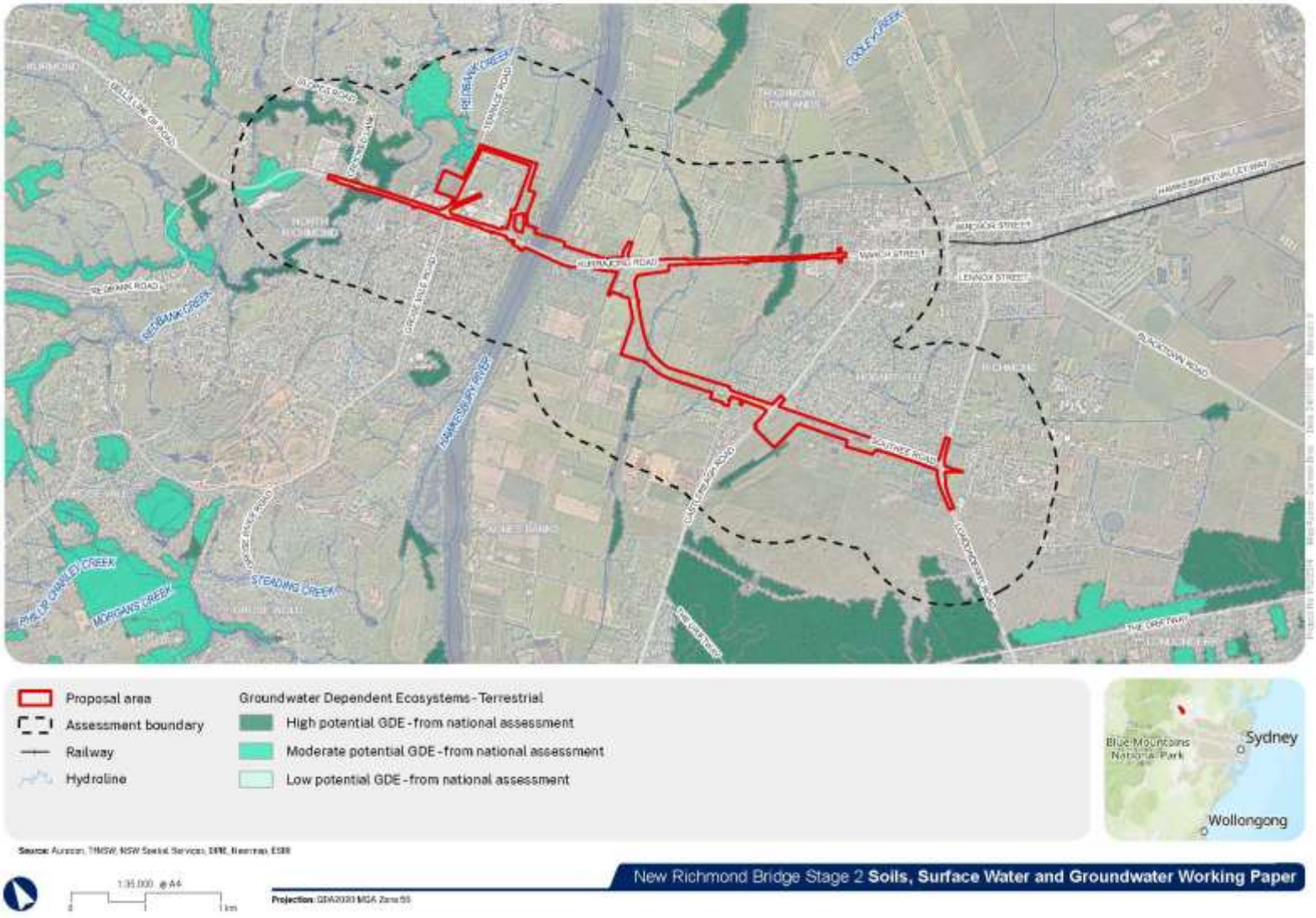

Figure 4-17 Terrestrial groundwater dependent ecosystems

4.9.2 Wetlands

The proposal area is not located on any land mapped as coastal wetlands, littoral rainforests, coastal environment, or coastal use areas. However, the proposal area and study area are located within the 'proximity area for coastal wetlands' mapped under the Resilience and Hazards State Environmental Planning Policy 2021. Figure 4-18 shows the indicative boundary, proximity area and catchment boundaries of the wetlands in relation to the proposal.

According to the Department of Climate Change, Energy, the Environment and Water, no wetlands within the study area have been identified as nationally important (DCCEEW, 2021).Council of Standards Australia, 2004., 'Australian Standard; The Storage and Handling of Flammable and Combustible Liquids'.

Department of Agriculture and Water Resources, 2013., 'Guidelines for Groundwater Quality Protection in Australia: National Water Quality Management Strategy'.

Department of Agriculture and Water Resources, 2018., 'National Acid Sulfate Soils Guidance: A Synthesis'.

Department of Agriculture and Water Resources, 2018., 'National Water Quality Management Strategy'.

Department of Climate Change, Energy, the Environment and Water, 2020., 'PFAS National Environmental Management Plan 2.0'.

Department of Climate Change, Energy, the Environment and Water, 2021., 'Directory of Important Wetlands in Australia', Australian Government, available at: <https://pmst.awe.gov.au/#/map?lng=131.52832031250003&lat=-28.6905876542507&zoom=5&baseLayers=Imagery,ImageryLabels>. Section 2.8 of the Resilience and Hazards SEPP states that development consent must not be granted to development on land wholly or partly identified as 'proximity area for coastal wetlands' unless the consent authority is satisfied that the proposed development would not impact on the biophysical, hydrological or ecological integrity of the adjacent coastal wetland or the quantity or quality of surface water and groundwater flows to the adjacent coastal wetland. While the REF is being assessed under Division 5.1 of the EP&A Act and development consent is not required, this assessment assesses the potential impacts from the proposal on these wetlands and identifies appropriate management measures.

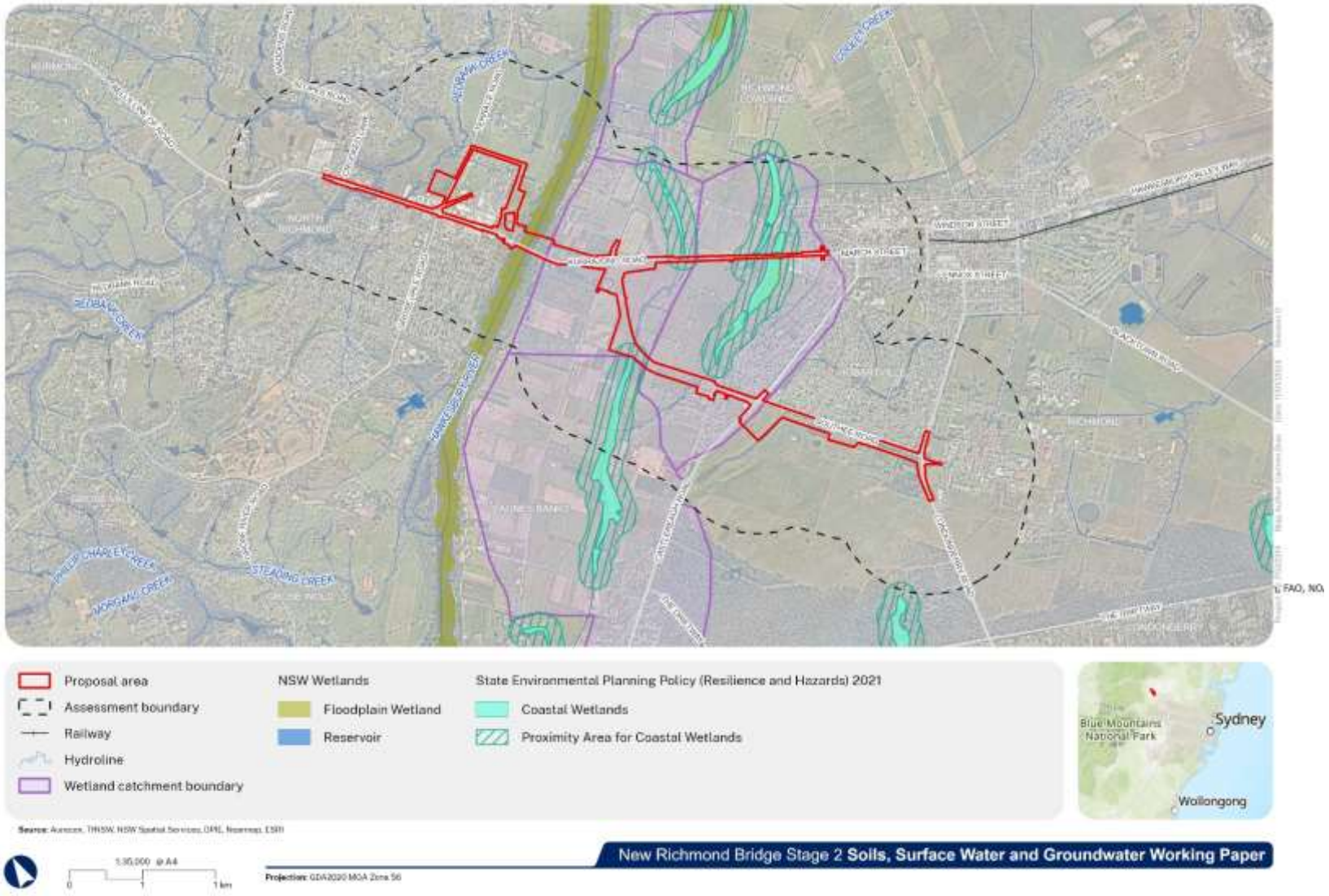

Figure 4-18 Mapped coastal wetlands

4.9.3 Key Fish Habitats

A desktop review of the NSW Department of Primary Industries Fisheries mapping tool has identified the Hawkesbury River and Redbank Creek as key fish habitats intersected by the proposal footprint. The Hawkesbury River has further been identified as holding ‘good’ freshwater fish community status, with no indication of housing species of threatened freshwater fish.

5 Construction Methodology

Detailed work methodologies would be identified by the construction contractor, with the currently assumed methodologies detailed below. The construction of the proposal is expected to take approximately two-and-a-half to three years, conditions permitting. The proposal area has been proposed to include a five-metre buffer from the edge of the design to account for vegetative clearance boundaries and environmental controls. This footprint includes all work, construction activity areas and any laydown areas for ancillary facilities or storage of equipment and machinery.

The construction of the proposal has been separated into early works and main construction works. Additionally, the staging of such works is proposed in Section 0.

The main construction constraints relevant to this report include, but are not limited to:

- keeping the road open during construction,
- existing utilities and services, including high voltage and low voltage electricity, optic fibre, water mains, gas, sewer,
- drainage systems to be maintained, adjusted, or constructed,
- roads, bridges (Stage 2A only) and retaining structures to be constructed
- safe access for pedestrians, cyclists and site teams during construction,
- management and protection of sensitive receiving environments,
- management and separation of waste types for disposal.

5.1 Early Works

Early work activities prior to Stage 2A would include the upgrade of the handrail on the western (upstream) side of the existing bridge, for safe public access during main construction work. This would be carried out as night work and involve the following activities:

- establishment of traffic control (single lane closure on Richmond Bridge and closure of pedestrian access across the bridge),
- removal of existing handrail,
- installation of new handrail,
- demobilisation of traffic control.

In addition, prior to construction of both stages, geotechnical, contamination and utility investigations throughout the proposal area would be carried out as early work.

5.2 Main Construction Works

The main construction works would consist of the following activities:

- site establishment,
- work zone establishment,
- earthworks,
- roadwork,
- bridgework (Stage 2A only),
- drainage work,
- finishing work.

5.2.1 Site establishment

During both Stage 2A and Stage 2B, the work zone would be established to prepare subject areas for bulk earthworks for site establishment. This would include topsoil stripping, hardstand construction, establishing temporary traffic control systems along the full length of the existing roadway to separate site and public traffic zones.

Each area of the site would be established during both stages of the proposal prior to the introduction of bulk earthworks for that area. This would include the clearing of necessary trees and mulching, the potential removal of redundant utilities and relocation of existing services, the establishment of temporary security and pedestrian fencing, setup of ancillary facilities with temporary means of access and the installation of construction water quality and sediment control measures.

During construction of Stage 2B, noise walls would be constructed between Southee Road and the bypass between Castlereagh Road and Londonderry Roady as early as possible during construction. The noise walls would be pile driven.

5.2.2 Earthworks

Earthworks would be a key component of both stages of the proposal, particularly with the introduction of embankments across the floodplain to raise the existing road along the extent of the bypass within Stage 2A.

Earthworks methodology would involve the treatment of embankment foundations, importation of fill, construction of the new fill embankment and excavation for cuttings and swales. These bulk earthwork activities would establish the foundation for the roadworks and bridgeworks.

Temporary construction dewatering may be required where excavations, bridge pylons (Stage 2A only) or other structures intersect the water table. This may occur during earthworks being completed for road cuts along the floodplain, for the installation of basins, swales/drainage lines, or during the rerouting of services. The piling bridgeworks during Stage 2A are proposed to be bored piles with temporary cut off cofferdams. The design and method of implementation of the cofferdam would be finalised during detailed design however emphasis would be placed on methodologies that limit the volume of water required to be dewatered and thus any associated impacts.

5.2.3 Roadworks

The methodology for roadworks during both stages of the proposal would include the:

- removal and demolition of existing pavement (where required),
- installation of intelligence transport systems (ITS) and traffic control signals (TCS) networks,
- construction of the pavement layers including the subbase and asphalt layers,
- construction of retaining walls,
- conversion of the existing bridge to an active transport connection, including installation of the handrail on the downstream side of the bridge,
- tie-ins to existing pavement at existing road tie-ins.

A shared pathway along the western-side of the existing Kurrajong Road has been proposed as part of Stage 2A of the proposal. This would be constructed in conjunction with roadworks.

5.2.4 Bridgeworks

During Stage 2A, the new, four-lane bridge and the two bypass bridges are proposed to be constructed offline.

New four-lane bridge of the Hawkesbury River

Typical bridge approach construction activities during Stage 2A would include:

- ground preparation including earthworks
- bored piling to provide foundations to support structural elements where required
- for cast in-situ elements, erection of formwork, placement of steel reinforcing and pouring concrete
- for pre-cast elements, lifting, placing and securing precast components
- stitching, joining and other similar processes to join structural elements together
- backfilling and compaction of engineered fill or concrete
- installation of the road layers including sub-base, base and surfacing layer as well as sub-surface drainage.

On both sides of the Hawkesbury River, abutments would be constructed to support the bridge structure. On the North Richmond abutments, additional retaining walls would be required to minimise impacts to Hanna Park.

Construction of the abutments would include:

- clearing of vegetation within the bridge construction footprint
- importation of general and select fill
- completion of earthworks to create temporary level working platforms
- installation of five piles of about 900 millimetres in diameter under each abutment by boring to the required depth, placing a steel reinforcement cage in the hole then placing concrete in each pile
- construction of the abutment walls and retaining structures for the bridge approaches including placement of beams
- backfilling and compaction of engineered fill.

From land, six piers (including the piers closest to the water) and scour protection would also be constructed. This would include:

- construction of piles by piling rigs and installation of temporary pile casing as required
- installation of the pile cap, pier column and headstock by formwork and cast in-situ reinforced concrete
- attachment of longitudinal access platforms to the headstock to provide access for mortar pad construction and bearing placement.

The same longitudinal access platforms could be re-used during bridge deck substructure construction.

For the seven bridge spans over land, girder erection and finishing works could include activities such as pre-cast girder delivery, establishment of temporary structures, girder installation, and pouring of the bridge deck. The construction methodology and staging would be further developed during detailed design.

Water-based construction associated with the proposal would include construction of four piers in the Hawkesbury River. Activities associated with pier construction could include piling from barges, girder construction, deck and finishing work, and scour protection for piers. The construction methodology and staging would be further developed during detailed design.

Barges would be moored in suitable locations downstream of the new bridge to facilitate the piling and installation of the piers and headstocks. Transportation of the barges is expected to be from further downstream of the Hawkesbury River near Windsor. Material and girder transportation is expected to be from land via existing roads.

Bypass bridges

The construction work for the two new bridge approaches and abutments along the Richmond bypass would be the same as the four-lane bridge over the Hawkesbury River.

The land-based construction components associated with the two bridges would include construction of the abutments and bridge piers, with the exception of the two piers within the existing waterway for bridge no. 1 only. The pile caps and piers for bypass bridge no. 1 would be constructed from a temporary rock platform, with the piles being bored and trimmed, once temporary cofferdams are constructed around the pile bent. In addition, temporary walkways would be established on the outside edge of the bridge to allow for workers to access on foot. Land-based construction would be the same as for the four-lane bridge.

Girder erection and finishing works would involve similar activities to those required for the four-lane bridge. For these bridges, girders would be installed by a crawler crane adjacent to the bridges. In addition, temporary walkways would be established on the outside edge of the bridge to allow for workers to access on foot.

The final order and sequence of construction would be confirmed during detailed design.

5.2.5 Drainage work

Drainage work during both stages of the proposal would include the construction of culverts, installation of drainage pits and pipes, the construction of permanent swales and basins and construction of drainage outlets to waterways.

Four sediment basins have been proposed within the extent of Stage 2A. These basins are proposed to have an invert depth of 2 m, be unlined and act as sumps for operational runoff and direct discharge. No additional water quality basins would be provided as part of Stage 2B.

In addition, there are two existing private ponds within Western Sydney University land within the bypass alignment between Castlereagh Road and Londonderry Road. Both ponds do not currently receive runoff from the road network. The pond near the bypass / Castlereagh Road intersection would be relocated during Stage 2A and the pond near Hill Avenue would be relocated during Stage 2B.

Drainage swales are another component of design, the deepest of which is proposed along the southern bypass, at an assumed depth of 2.6 m bgl, with an assumed maximum proposed cut to be 3 m, for the purpose of this assessment. This takes into account surface finishing works and fill material used for structural establishment impacting the excavation depth.

5.2.6 Finishing work

Finishing works would occur at the end of the main construction activities for both stages of the proposal in all work zones. This would include the stabilisation of permanent sites and demobilisation of work zones. These activities would encompass the:

- installation of road furniture (including lighting, safety barriers, signage and guideposts),
- pavement marking,
- installation of urban design treatments and features,
- landscaping work,
- removal of all remaining temporary work such as traffic control barriers, ancillary facilities and lighting,
- rehabilitation work would include batter protection and landscaping plus reinstatement of all disturbed areas.

5.3 Construction Zoning

Initial staging would undergo early work, site preparation activities. This would be excluded from the main phase of construction works. These activities would be divided into six distinct construction zones and used to distinguish impacts:

- Area 1: New four-land bridge over the Hawkesbury River (Stage 2A only)
- Area 2: North Richmond (Stage 2A and Stage 2B)
- Area 3: Kurrajong Road between Old Kurrajong Road and Chapel Street (Stage 2A only)
- Area 4: Bypass between Kurrajong Road and Londonderry Road (Stage 2A and Stage 2B)
- Area 5: Bypass between Drift Road and Castlereagh Road (Stage 2A only)
- Area 6: Bypass/Londonderry Road intersection (Stage 2B only).

These zones are detailed in Figure 5-1.

5.3.1 Area 1 – New Hawkesbury River Bridge (Stage 2A only)

The new four-lane bridge would be constructed offline, except for the western abutment work (which would be constructed as part of Area 2). To tie-in with adjoining sections of the proposal, the bridge would be constructed prior to Area 2 (North Richmond) and Area 3 (Kurrajong Road between Old Kurrajong Road and Chapel Street).

5.3.2 Area 2 – North Richmond (Stage 2A and Stage 2B)

This area would undergo the construction of the western abutment of the new bridge, including the northern retaining wall and part of the southern retaining wall. Area 2 would also include extensive ancillary facilities for construction phase laydown, on the eastern side of the industrial area. A share path would be extended along Bells Line of Road and connect to parklands on the Hawkesbury River foreshore.

Bells Line of Road would be widened between the new bridge and its intersection with Terrace Road and Grose Vale Road as part of Stage 2A. It would be widened between the Terrace Road / Grose Vale Road intersection and west of Charles Street and near the Crooked Lane intersection as part of Stage 2B.

5.3.3 Area 3 – Kurrajong Road between Old Kurrajong Road and Chapel Street (Stage 2A only)

This would initially involve the construction of a temporary roundabout at Kurrajong Road / Chapel Street intersection to allow for vehicle turnaround. The westbound carriageway, including work up to the eastern abutment of the new bridge and the shared path tie-in, would be constructed offline while existing traffic movements are maintained on Kurrajong Road. This area would include an ancillary facility extending from the Hawkesbury River foreshore to Old Kurrajong Road.

5.3.4 Area 4 – Bypass between Kurrajong Road and Londonderry Road (Stage 2A and Stage 2B)

The bypass between Kurrajong Road and Londonderry Road, including the two floodplain bridges, would be constructed offline, as follows:

- Bypass between Kurrajong Road and Castlereagh Road – Stage 2A
- Bypass between Castlereagh Road and Londonderry Road – Stage 2B.

This area would house a number of ancillary facilities, located on the floodplain at the Bypass / Kurrajong Road intersection, at Inalls Lane / Drift Road intersection and on farmland at Castlereagh Road / Southee Road intersection. Two basins have been proposed along Inalls lane (one near each bypass bridge), as well as at the Castlereagh Road / Southee Road intersection. The private Western Sydney University pond near the bypass / Castlereagh Road intersection would be relocated during Stage 2A and the pond near Hill Avenue would be relocated during Stage 2B.

5.3.5 Area 5 – Bypass between Drift Road and Castlereagh Road (Stage 2A only)

Works on the bypass between Drift Road and Castlereagh Road would be constructed offline during Stage 2A, including most of the new bypass / Castlereagh Road roundabout and the new bypass / Drift Road intersection arrangement. On Inalls Lane between the Drift Road intersection and where Inalls Lane is truncated by the new bypass, work would be completed under traffic control.

5.3.6 Area 6 – Bypass / Londonderry Road Intersection (Stage 2B only)

Following the offline construction of the new bypass between Castlereagh Road and Londonderry Road during Stage 2B, traffic would be switched onto the bypass and the Southee Road / Londonderry Road intersection would be closed. The bypass / Londonderry Road / Vines Drive intersection would operate in a temporary four-way intersection arrangement without traffic signals before the new signals are commissioned.

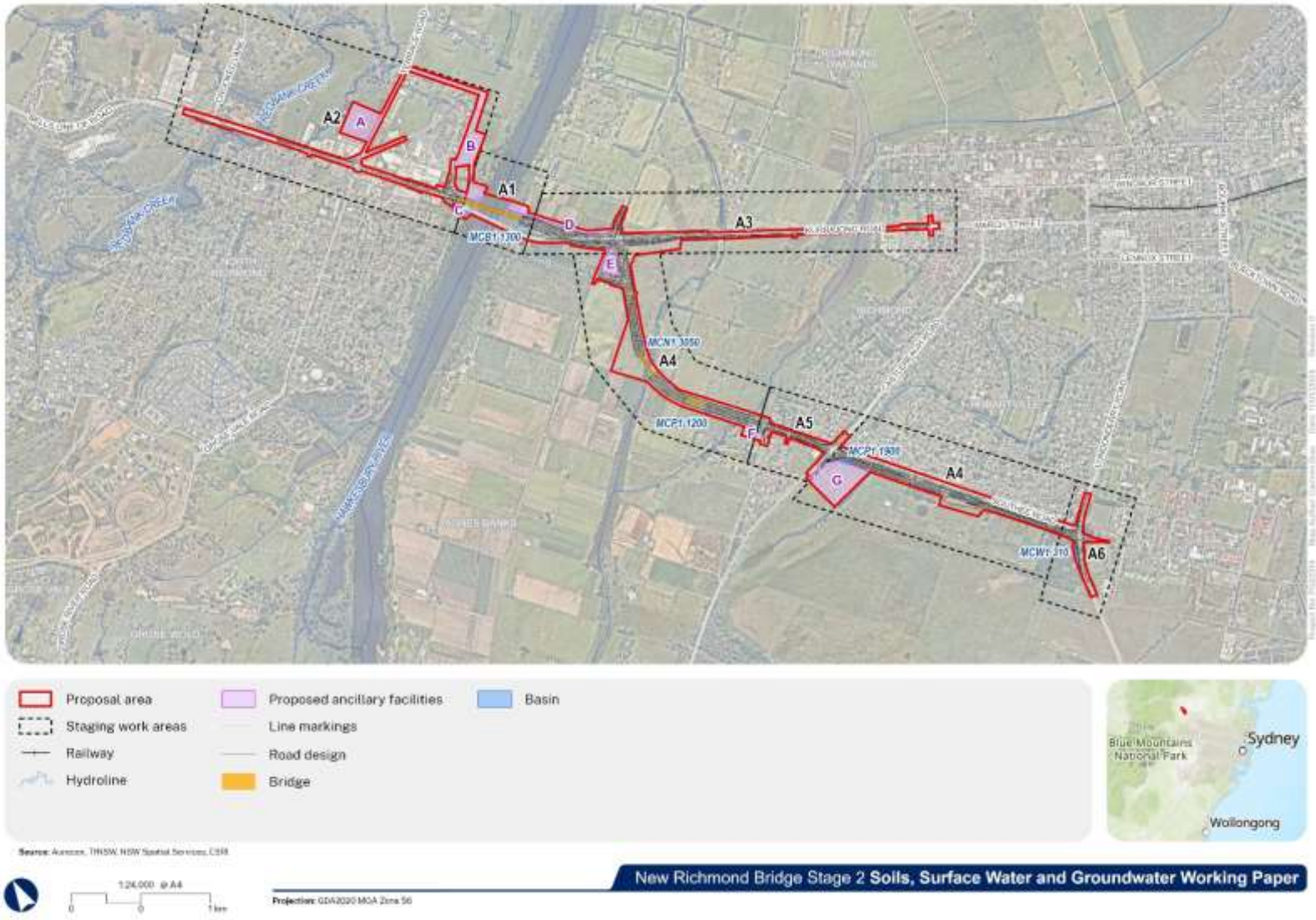

Figure 5-1 Construction stage zoning

6 Impact Assessment

Soils, surface water and groundwater may be potentially impacted by the proposal, during both construction and long-term operational phases

The potential construction and operational impacts are discussed in Sections 6.1 and 6.2, respectively.

6.1 Potential Construction Impacts

6.1.1 Ancillary facilities and stockpiles

Ancillary facilities would be temporary sites, developed for the sole purpose of facilitating construction and be returned to pre-existing conditions or rehabilitated once construction is complete. The facilities would include:

- site offices, car parking, sheds, workshops and storage,
- areas for material delivery and storage, including the three bridges structural elements,
- stormwater capture and treatment locations,
- stockpile locations for materials spoil and mulch.

Proposed ancillary facilities are presented in Figure 1-1a-b.

Most project ancillary facilities are located on flat land, reducing the risk of soil erosion. Additionally, the distance from sensitive receptors considers their location low risk. Exceptions have been highlighted below.

Area 2 (North Richmond) would house the majority of the ancillary facilities for the proposal. These facilities are clustered around the eastern commercial and residential zone:

- north side of Terrace Road, perpendicular to Terrace Road,
- through the existing Hanna Park
- along the Hawkesbury River foreshore.

North Richmond is of higher elevation, set above the flood zone, reducing the risk of inundation and spills travelling downstream from laydown areas during wet weather or flooding events. The proposed ancillary facilities on the foreshore of the Hawkesbury River are at a higher risk of erosion during establishment, due to the nature of alluvial, Londonderry soil group possessing a high streambank erosion hazard and waterlogging characteristic.

Area 3 (Kurrajong Road between Old Kurrajong Road and Chapel Street upgrade) would face similar erosion and sedimentation risks, as Ancillary Facility D has been proposed on the steep, southern foreshore of the Hawkesbury River. The topography presents a significant constraint for erosion and sediment control on the banks of the Hawkesbury River. The construction of foreshore ancillary facilities would be required on both sides of the river for bridge construction, necessitating significant disturbance in close proximity to the river. The steepness of the riverbanks would limit the feasibility to construct sediment basins in those locations.

If not managed correctly under wet conditions, an increased sediment load has the potential to enter the Hawkesbury River. Additionally, runoff travelling from laydown areas and into the sensitive receiving environments may be accelerated by the steep foreshore. This risk can be managed, as explained in Section 7.1.

The southern end of Area 3 is of relatively flat topography, reducing the risk to sensitive receptors. However, this facility is located on the floodplain, and is at risk during flooding events. This could pose a risk to surface water as fuel, chemicals and waste stored here may mobilise downstream.

Area 4 (Bypass between Kurrajong Road and Londonderry Road) would house Ancillary Facility E, adjacent to the Kurrajong Road / Bypass intersection. This facility would face similar runoff concerns during flooding events, however, is generally stable with no adjacent wetlands or tributaries. Ancillary Facility F is proposed opposite Drift Road. On the downslope side, there exists a tributary off the coastal wetlands, which may pose

a runoff risk if stockpiles are not appropriately stabilised during wet weather or flooding events. Ancillary Facility G is located adjacent to the Castlereagh Road, adjacent to an intermittent pond (WSU001). This pond has not been recognised as a coastal wetland or sensitive environment and is proposed to be relocated as part of the works.

Stockpile management and flood management measures are discussed in Section 7.1.

6.1.2 Concrete/asphalt activities

The major components of the proposal that would require concreting activities include:

- bridge pylons and footings,
- shared paths and pedestrian footpaths,
- structures including kerbing and in-situ culverts,
- road pavements.

These materials would be transported to the site and stored temporarily at ancillary sites during construction. Concreting transport and pouring operations that undergo poor handling, storage, and disposal, may lead to soil and water pollution. Polluted runoff may increase pH, totally suspended solids, total dissolved solids, as well as impact levels of aluminium, iron, magnesium oxides and alkalinity. Many of the large associated concrete structures would be pre-cast, alleviating much of this risk.

However, the pouring of concrete for piers in the Hawkesbury River and at the two floodplain bridges or surrounding the coastal lagoons and connected tributaries are at the highest risk of spills which may impact the sensitive environments including the Hawkesbury River and the coastal lagoons adjacent to the proposal footprint. Cofferdams would be used to prevent water infiltrating during pouring to produce sealed structures. The activity of pouring concrete poses a spill risk, that would be managed in line with mitigations presented in Section 7.2.

The appropriate storage of pre-cast concrete structures and asphalt at ancillary facilities would be required in line with chemical, stockpile and fuel storage, mentioned above, to reduce the risk of polluted runoff entering receiving environments.

6.1.3 Vegetation removal and earthworks

Vegetation removal would be required in areas within the construction footprint. Substantial earthworks would also be required across the floodplain to elevate the proposal area to improve access during flooding. Some site levelling, minor cuts for draining lines and basins, and large filling is to be employed for the roadworks. Excavation of drainage and underground utility trenches/ channels and foundations for overhead infrastructure is also anticipated.

Earthworks and vegetation removal could cause sediments to be mobilised during construction. Londonderry (GHL_WSS_4) and Richmond Lowlands (HGL_WSS_3) soil groups are characterised as possessing erosion and waterlogging risks, a key concern on the steep slopes adjacent to the Hawkesbury River. Across the floodplain, the flattened slopes reduce the velocity of water movement and associated risk of scouring producing polluted runoff. If not managed correctly under wet conditions, an increased sediment load could enter nearby waterways and coastal wetlands. Similarly, under dry and windy conditions, sediments could become airborne causing localised dusty conditions which may enter the water cycle. Sedimentation risks could be exacerbated by offsite ‘clean’ runoff entering the construction site with higher flows reducing the performance of onsite management measures. Temporary drainage would be required in numerous locations to divert offsite runoff away from construction areas and direct onsite dirty runoff to sediment management measures. Protocols to reduce erosion and sedimentation would be prepared by the contactor in accordance with mitigations outlined in Section 7.2.

Vegetation removal would be minimised to mitigate impacts to terrestrial groundwater dependent ecosystems in accordance with section 5.1 of the Biodiversity Assessment Report. This may change the availability and condition of these ecosystems, impacting the quality, pressure, and level of the localised

water table. Vegetation removal may further alter surface to groundwater interactions and the condition of soils post removal.

6.1.4 Works on waterfront land

The proposal is located at the edges of Pughs Lagoon, tributaries connecting to Mareh-Mareh Lagoon and across the Hawkesbury River and Redbank Creek. Additionally, a range of unnamed drainage lines and intermittent waterbodies exist along the floodplain and Southee Road, which would be considered as work on waterfront land. Works would be required within waterfront land, as defined by Water Management Act (2000). These works include the installation of bridge footings and pylons, culverts, drains and outlets, as well as the road alignment running through unnamed, intermittent waterbodies along Southee Road and within proximity of coastal wetlands. Works within waterfront land have the potential to directly or indirectly impact adjacent waterways by modifying the bed and banks, concentrating or changing flow paths which may lead to erosion or polluting the waterway through activities within close proximity to the waterway. The highest risk works include:

- Hawkesbury River bridge works. The steep embankments are highly erodible and may be destabilised during construction.
- The establishment of ancillary facilities on steep, erodible slopes of the Hawkesbury River, with the potential to be established, scoured and polluted runoff into the Hawkesbury River, increasing turbidity and reducing water quality within a KFH.
- The in-water pier to be installed in the tributary connecting to Mareh-Mareh may lead the sediment and other pollutant mobilisation during construction, heightened during major weather events including flood.
- As the alignment remains within the ‘proximity boundary’ of identified coastal wetlands and connected tributaries, adjacent receiving environments may accept direct and indirect surface runoff from the site footprint, with the potential to contain pollutants and sediments reducing water quality.

6.1.5 Spills and incidents

There is potential to contaminate soils, surface and groundwater through spills and incidents occurring during construction. This could be a result of the inappropriate storage of hazardous materials, toppling of bunds and basins during significant rainfall events or during the refuelling of plant and machinery. Water resources could become contaminated via these spills, which may involve petrol, diesel, hydraulic fluids and lubricants. The location of potential spills may increase the associated impact, particularly if a leak or incident occurs over the unconfined alluvial aquifer, on exposed surfaces, adjacent to or over water and in proximity to drainage lines. Unmanaged stockpiling may also introduce contaminants through leachates entering surface and groundwater resources during run-off events. Contaminants may be mobilised during these scenarios if not appropriately contained.

The risk of spills and leaks impacting local waterways may be exacerbated by during flood events at ancillary facilities along the floodplain (Area 4). Flooding would exacerbate hazard for erosion and sedimentation associated with the bridge construction over the Hawkesbury River (including abutments, piling and ancillary facilities on both sides of the river) and across the floodplain. Hence, appropriate wet weather and flood mitigation controls would need to be implemented, to provide appropriate on-site water and contamination management.

6.1.6 Earthworks

The majority of the proposal would introduce fill material to raise the embankment for the floodplain bypass above the current surface level. Spoil or waste material would be created from the proposed minor earthworks. Laboratory analysis of selected soil samples collected from fill materials/surface soils and sediments, as part of the Stage 2 DSI, returned concentrations of some COPCs above the limit of laboratory reporting and ANZG guideline values. On this basis and with considerations to the proposed concept design and future land use, Aurecon considers that the proposal area represents localised risks of soil waste impacting ecological and human health receptors. Human health and ecological risks can be effectively

managed via the development of appropriate assessment and/or work health and safety (WHS) and environmental management frameworks.

In regard to ecological health, laboratory analysis of selected soil samples collected from fill materials/surface soils returned concentrations of COPCs above the adopted ecological assessment criteria for public open spaces and commercial/industrial land uses. These locations were largely isolated to Old Kurrajong Road, on the edge of the eastern footprint, along Southee Road and in Hawkesbury River sediments. It is considered that potential ecological health risks from COPC may exist across site, and have implications requiring spoil management, separation and disposal. If not properly contained, contaminants may leach from these soils and enter sensitive receiving environments.

6.1.7 Acid Sulfate Soils

Four ASS 'high risk' areas are mapped within the proposal area, as outlined in Section 4.5.2. Based on review of desktop information and observations made during the field investigation, paired with laboratory analysis of selected soil samples collected from natural materials, results indicated that soils collected from the Hawkesbury River and across the floodplain are considered 'low risk' for PASS. Hence, there is potential to encounter and expose PASS. If PASS is exposed, it has the potential to oxidise and form acidic soils and leachates which are harmful to ecological receiving environments and anthropogenic structures. The formation of acidic soils and associated leachates has the potential to damage waterways through the lowering of pH and increasing metal concentrations. This is a concern as the proposal area intersects key fish habitats, coastal wetlands and GDEs. Samples were collected from BH201 and BH202 indicated that the natural soils do not comprise PASS or AASS, as such there is not anticipated impacts associated with Acid Sulfate Soils as a result of dewatering.

6.1.8 Groundwater risks and dewatering

Groundwater across Area 4 (the floodplain) is relatively shallow, typically less than five metres below ground level. Temporary construction dewatering may be required where excavations, such as trenches for utilities, bridge footings or basins, intersect the water table (although it is noted, based on the existing data that this is anticipated to be limited to the cofferdams at the bridge footings within the floodplain lagoons). Dewatering would likely be required to provide dry working conditions during the construction phase with the areas of highest likelihood for dewatering being the cofferdams, which are described in more detail below but a detailed dewatering assessment should be undertaken once the construction methodology is confirmed by the contractor. It is unlikely that dewatering would be required on elevated lands around North Richmond (Area 2) and Hobartville, as the water table is generally lower.

Groundwater is susceptible to climatic and seasonal fluctuations. Hence, these singular data points used to inform this assessment, are not representative to the long-term groundwater levels. A long-term monitoring program is recommended to accurately assess the range of groundwater level fluctuations and likelihood of the proposed basins and road cuts at Areas 2, 3 and 4, to intersect groundwater. There is the potential to disturb land salinity through earthworks, as the entire floodplain possess a moderate land salinity risk. Highly mobile salts pose a risk to buildings and structures in the proposed area, as well as producing saline runoff waste that could migrate into groundwater via recharge. Further, there is a similar risk of exposing and facilitating PFAS migration during excavation activities surrounding water bodies. This is because PFAS is persistent and mobile in the environment, and PFAS has been recorded near the proposal at the Richmond RAAF Defence Base and at Western Sydney University, Hawkesbury Campus. As such, there is potential that soils, surface water and groundwater disturbed due to the proposal could be impacted with PFAS from these sites. PFAS identified in surface water may be introduced to the groundwater through excavation activities facilitating recharge, further discussion of the risks and opportunities relating to PFAS and other contaminants of concern are outlined in the Stage 2 DSI (2023).

To support the construction program, a dewatering assessment would be required to assess where the total amount of dewatering would exceed 3 megalitres per year (ML/year). If the volume of dewatering exceeds 3 ML/year the requirement of a Water Access Licence under the Water Management Act 2000, is triggered and must be sought through the Natural Resource Access Regulator (NRAR). A Dewatering Assessment would be required to calculate the expected groundwater dewatering required however this assessment should be undertaken once a detailed construction methodology is understood, but given the limited extent

of excavations and the use of driven piles across the proposal, dewatering volumes are anticipated to be minimal. These volumes are unlikely to exceed 3 ML/year.

The proposal includes four basins up to a depth of 2 m bgl. The location of these basins are outlined in Figure 1-1a-b. Based on this design, the likelihood of these basins to intersect the water table has been outlined Table 6-1. Based on this design, the depth to invert is assumed at 2 m bgl, this is without a conservative buffer of an additional one metre.

Table 6-1 Proposed basin dimensions and adjacent groundwater levels

Basin Name	Chainage	Volume (m^3)	Bottom of Basin Level (m)	Spillway Level (m)	Top of Basin Level (m)	Natural Ground Level range (m AHD)	Average ground level at basin invert (m AHD)	Borehole location	Approx. Distance from Basin (m)	Standing water level in borehole (m AHD)
BASIN PB 1800W	MCA1 CH1800	385	14.00	15.30	15.60	15.6 – 16.4	16.2	BH129	30	6.16
BASIN PB 3050E	MCN1 CH3050	155	11.00	12.30	12.60	11.0 – 11.4	11.3	BH122	15	6.79
BASIN PB 3550W	MCN1 CH3550	95	11.00	12.30	12.60	10.6 – 10.8	10.7	BH208	20	9.00
BASIN PB 4300W	MCN1 CH4300	510	18.70	20.40	20.80	20.4 – 21.0	20.75	BH112	30	11.52

Note. Potential locations for groundwater strikes are outlined in red.

Of the basins to be constructed only BASIN PB 3550W is anticipate to be constructed to a depth close to the recorded groundwater level. However, the groundwater level is still 1.7 m beneath the invert level of the basin, and as such is unlikely to require dewatering. Although unlikely, there may be unrecorded seasonal fluctuations in groundwater level that may cause the groundwater level to rise and intercept the base of the basin. Prior to construction, additional monitoring of the nearby monitoring wells should be undertaken to determine the likelihood of groundwater interception. Even if the groundwater level is lower than the base of the basin, standard construction environmental controls should be implemented to prevent short term construction impact to groundwater (i.e. contamination from construction chemical spills).

Additionally, road cuts have been proposed along the alignment, with the potential to impact local groundwater levels. These cuts, including chainage from north to south, has been outlined in Table 6-2.

Table 6-2 Proposal area excavation locations

Proposed Excavation Approximate Chainage	Locality	Component	Approximate Max Invert Level (m)	Local GW level (m bgl)	Location	Approx. Distance from excavation (m)
180-240	Bells Line of Road	Road cut	0.4	24.5	GW106853	600
420-440	Bells Line of Road	Road cut	0.4	24.5	GW106853	700
2,900-2,800	Kurrajong Road	Swale	2.04	10.09	BH137	120
3,040-3,100	Inalls Lane	Swale	2.37	3.7	BH221	50
3,100-3,380	Inalls Lane	Swale	**1.5**	3.00	BH201	50
				1.2	BH118	50
3,880-4,200	Southee Road	Swale	1.5	11.6	BH115	50
5020	Old Kurrajong Road	Swale	0.9	12.2	BH104	50
MCD1	Bells Line of Road	Road cut	2.2	10.09	BH137	50
MCQ1	Old Kurrajong Road	Road cut	3.0	4.3	BH125	20
MCP1	Old Kurrajong Road	Swale	1.5	5.5	BH127	0

Note. Potential locations for groundwater strikes are outlined in red.

Additionally, groundwater dewatering may be required for piling works, dewatering of cofferdams, the installation of noise walls and where services are required to be realigned.

- Piles (for bridge and noise walls) are expected to be bored which would cause only minimal displacement of groundwater given the small spatial footprint of each pile (0.75 m diameter each) and the wide spacing between each pile (4 m apart) and the reduced need for deep excavations. This piling arrangement would have a short term impact to localised groundwater conditions, but as there is no permanent barrier to groundwater flow, conditions would return to equilibrium post installation. For the realignment of services, the methodology and local groundwater levels would largely impact the potential for dewatering. Open trenching would post more of an erodibility and dewatering risk, as opposed to trenchless utility installation.

- Cofferdams, that may be used to construct the floodplain bridges would have an initial volume of surface water that would be required to be removed along with groundwater that may seep vertically upwards. The cofferdams should be constructed using shoring methodologies that limit the volume of groundwater that enters the cofferdam. The cofferdam would then be filled with fill material to allow for the construction of the piles. Any effects of the cofferdam dewatering would be limited to the timespan that they are open and actively dewatering, with conditions anticipated to return to equilibrium once active dewatering ceases. With appropriate shoring and the construction methodologies, the volume of water required to be removed can be greatly reduced.

It is considered that the construction dewatering would have low impacts on the sensitive receptors of registered bores and GDEs. This is based on the data provided above that outline that only the relocated WSU basins are likely to intercept shallow groundwater during construction and are intended to replicate the existing environment post construction, with groundwater levels and surface/ groundwater interactions returning to equilibrium soon after construction. The cofferdams would intercept a great depth of groundwater but by utilising appropriate construction methodologies the extent of dewatering can be limited. Additionally, all dewatering activities would only be temporary and are likely to be staged to further reduce the cumulative impacts, with groundwater levels expected to return to pre-construction levels once dewatering is completed as no long term changes are being installed, constructed or implemented that would impede the flow of groundwater or alter its quality. However, the presence of floodplain wetlands, including high priority GDEs, within proximity of the proposal, would likely require further assessment in line with management controls derived from the Aquifer Interference Policy ‘s minimal impact considerations for Level 1 and 2. Temporary dewatering during construction could potentially exceed the minimal impact considerations under a “worst-case” scenario, hence, protocols detailed in Appendix A should be followed. This should also involve an assessment of the impact to local abstraction bores used by groundwater uses.

Given that marginally elevated concentrations of heavy metals (although likely representative of natural background conditions) were detected in groundwater across the proposal area, it is considered that groundwater management may be required to manage potential human health and/or ecological risks where dewatering is necessary, and disposal required. This should be re-assessed prior to construction commencing, as to assess whether dewatering and water treatment or discharge would be required. Given the proposal area comprises various risk levels with regard to ASS, dewatering management would need to address potential risks associated with exposing/oxidising ASS during dewatering activities and the impact on disposal.

Groundwater infiltrated into pits, sumps and basins would be dewatered and need to be appropriately disposed of, or where possible, be reused beneficially to reduce the potable water demand of the proposal. Management and disposal of potentially contaminated groundwater is essential in protecting the health and quality of surrounding waterways and environment. Discharge options would depend upon the water quality at discharge and intended source. The disposal options include discharge to stormwater, discharge to the environment (such as Hawkesbury River), discharge to sewer under appropriate licensing conditions or using a liquid waste disposal subcontractor. Water treatment may be required prior to discharge to meet quality requirements and should be assessed against the proposal’s water quality objectives. Hence, disposal via a licenced contractor would likely be most suitable to avoid activities associated with treatment and licencing.

Disposal of groundwater to waterways would not require a Construction Water Quality Discharge Assessment, to be completed prior to construction in accordance with the EPA’s Assessing and managing water pollution from road works and the Draft Guideline for Assessing the Impacts of Treated Water Discharge from Water Quality Treatment Controls.

Dewatering volume assessments to be completed once detailed construction methodologies are understood, would determine the approximate extraction limits, confirming whether the proposal would be subject to obtaining a WAL. Future assessments would determine whether the proposal is likely to extract greater than 3 ML per year of groundwater and its drawdown effects on short and long-term levels, pressure and quality relevant to management conditions presented in the AIP. Dewatering assessments should be undertaken at detailed design phase due to an increased certainty of construction methodology, the timing of open excavations and up to date groundwater level information. This enable a more accurate assessment of groundwater take to be provided.

6.1.9 Surface water discharges

Discharges from any proposed sediment basins, sumps and low points would be assessed as part of a Construction Water Quality Discharge Assessment, to be completed during detailed design. The assessment would be undertaken in accordance with the EPA's Assessing and Managing Water Pollution from Road Works and the Draft Guideline for Assessing the Impacts of Treated Water Discharge from Water Quality Treatment Controls (TFNSW, 2020).

The DSI identified COPC, particularly heavy metals and PFAS, in surface water that exceed the adopted ecological assessment criteria for freshwater 95% and 99% species protection. Given these concentrations, surface water must be managed to minimise the risk of migrating existing and proposal introduced contaminants (including hydrocarbons through onsite spills). This migration may pose ecological health risks, reducing water quality, as well as human health risk during construction, as receiving waterways may be used recreationally and for aquaculture.

There is potential for surface waters to infiltrate site boundaries during earthworks, especially along the floodplain and during rainfall events. This would result in greater volumes of water being considered as "site" water, which must be managed and/or treated prior to discharge.

With appropriate mitigations, impacts on surface water quality are expected to be manageable.

6.1.10 Water use

During construction, the proposal would require potable and non-potable water and generate wastewater. This includes the consideration of:

- volumes and potential sources of water required for construction,
- volumes of wastewater generated and potential options for management and disposal,
- potential impacts on other water users and water supply infrastructure,
- potential impacts from the disposal of wastewater.

Potential non-potable water supply options include the use of on-site water sources. This source must be located within the proposal area or on a property already impacted by the proposal area, as agreed by the relevant landowner.

Another option is to take groundwater, from a registered bore with existing licensed extraction volumes and within 5 km of the proposal area. This would require a WAL and assessments pertaining to maintaining water quality, pressure, and levels long-term. Potable water would be required for worker facilities and concrete production and, potentially, as a source for dust suppression.

Wastewater from construction amenities would be disposed of at a licensed wastewater facility. Opportunities to reuse water generated from dewatering should it arise should be evaluated at detailed design and a procedure outlining its use documented in the Dewatering Management Plan.

6.1.11 Summary of potential construction impacts

A summary of the potential construction impacts for soils, surface water and groundwater are presented in Table 6-3. Potential receptors, the significance, residual impacts are detailed.

Table 6-3 Summary of potential construction impacts for soils, surface water and groundwater

Activity / Event	Description of Impact	Receptor/s	Significance	Mitigation Measures	Residual impacts
Ancillary facilities and stockpiles	The ancillary facilities are located on the embankments of the Hawkesbury River. These facilities face a high erodibility risk, due to the nature of Londonderry alluvial soils. Additionally, materials stored within the ancillary facilities may enter waterways via wind or sediment-laden stormwater runoff, degrading water quality within the Hawkesbury River. This has also been identified as a concern at ancillary facilities located on the floodplain and in proximity to coastal wetlands and connected tributaries.	Surface water quality, Sensitive receptors, wetlands, aquatic GDEs, KFH	Medium (Possible, moderate)	See mitigation measures for W1 (Construction – Soil erosion, scour, sedimentation, and water pollution) and W2 (Construction– Contamination of surface water) in Table 7-1.	Low
Concrete/Asphalt activities	Concrete transport and pouring operations may lead to soil and water pollution (increase in pH, TSS, TDS and minor levels of aluminium, iron and magnesium oxides) as a result of cement laden runoff not being completely contained or being accidentally released to surface waters. This is of highest risk at the Hawkesbury River and floodplain bridges, where cofferdams would be used for pile formation. Poor cement handling, storage and disposal practices can also contribute to these impacts.	Surface water, Sensitive receptors, Wetlands, Aquatic GDE, KFH	Low (Unlikely, minor)	See mitigation measures for W1 (Construction – Soil erosion, scour, sedimentation, and water pollution) and W4 (Construction – water pollution from accidental spills) in Table 7-1.	Low
Vegetation removal and earthworks	Clearing the proposal area of vegetation and topsoil, where necessary, would increase the risk of soil erosion in all soil types. Excavations further exposes surface area of soils and subsoils, increasing erosion risk. Additionally, access tracks may be needed within the proposal area. The susceptibility of Richmond and Londonderry soil landscapes to mass movement, seasonal waterlogging, salinity and erosion, increases the erosion risk and sedimentation offsite, particularly on steep slopes adjacent to the Hawkesbury River. During wet weather events, sediment-laden stormwater runoff could discharge into the Hawkesbury River or coastal lagoons where surfaces are not stabilised. The runoff may have elevated total dissolved solids (TDS), total suspended solids (TSS) and nutrients	Surface water quality, Sensitive receptors, Aquatic GDE (Pughs Lagoon and Hawkesbury River), KFH	Medium (Likely, moderate)	See mitigation measures for W1 (Construction – Soil erosion, scour, sedimentation, and water pollution) in Table 7-1.	Low

Activity / Event	Description of Impact	Receptor/s	Significance	Mitigation Measures	Residual impacts
	(phosphorous and nitrogen), which may impact surrounding GDEs, KFHs and wetlands.				
Works on waterfront land	The proposal crosses the Hawkesbury River and other minor waterways. Any construction activities including clearing, earthworks or installation of bridge, culvert or drainage outlet structures could cause direct geomorphological changes to the waterway or indirect erosion through changes in local overland flow paths, new discharge points as well as water quality impacts through accidental mobilisation of pollutants into the waterway.	Surface water and groundwater, Sensitive receptors:, Wetlands, Aquatic GDE	Medium (Possible, moderate)	See mitigation measures for W1 (Construction – Soil erosion, scour, sedimentation, and water pollution) and W3 (Construction – Works over water, on waterfront land and adjacent to wetlands) in Table 7-1.	Low
Spills and incidents	Potentially harmful chemicals (e.g. hydrocarbons, oil and grease, heavy metals) could accidentally be released to the surface water environment during construction spills, refuelling and inappropriate storage or handling. Leakage from construction worker facilities or wastewater collection points could runoff into soils and receiving waterways. This could contaminate exposed soils or mobilise contaminated soils and liquids into local watercourses which could result in water quality impacts. Contaminants could leach into groundwater sources and contaminate the alluvial aquifer. Spillage of waste or construction materials during transportation could lead to macro pollutants including plastics, construction material, wastage being conveyed in surface water runoff to nearby drainage pathways and downstream waterways. This is a particular concern during flooding or high rainfall weather events.	Surface water and groundwater Sensitive receptors, Wetlands, Aquatic GDE	Medium (Unlikely, major)	See mitigation measures W2 (Construction– Contamination of surface water) and W4 (Construction – water pollution from accidental spills in Table 7-1.	Low
Earthworks	There are a range of cuts, with minor earthwork removal that may be required. Spoil or waste material may be created, which must be managed in line with contaminants of potential concern identified throughout the site. Such earthworks must ensure drainage lines are not impacted by sedimentation, and the disturbance of contaminants of potential concern.	Surface water and groundwater Sensitive receptors, Wetlands, Aquatic GDE	Medium (Unlikely, major)	See mitigation measures for W6 (Construction – Encountering contaminated or adverse substances) and W7 (Construction – Waste containment and management) in Table 7-1.	Low

Activity / Event	Description of Impact	Receptor/s	Significance	Mitigation Measures	Residual impacts
Acid Sulfate soils	There is potential to encounter and expose PASS, as a low likelihood has been identified through the DSI, but a higher likelihood through state-wide mapping. Disturbance of acid sulfate soils may cause acid generation as discussed in Section 4.5.2. Four high priority areas have been identified that could contain acid sulfate soils in the proposal area. The presence of ASS can accelerate corrosion due to the presence of acidic substances in the surrounding soil. Cracking of concrete structures can also be accelerated. If PASS is exposed, it has the potential to oxidise and form acidic soils and leachates which are harmful to ecological receiving environments and anthropogenic structures.	Surface water and groundwater Sensitive receptors, Wetlands, Aquatic GDE	High (Likely, moderate)	See mitigation measures for W6 (Construction – Encountering contaminated or adverse substances) and W7 (Construction – Waste containment and management) in Table 7-1.	Low
Groundwater risks and dewatering	Excavation works for basins and swales have the potential to intersect the water table, although this is considered unlikely consideration of dewaterig has been included along with liquid waste treatment or disposal. This has the potential to impact groundwater quality, pressure and levels, as well as GDEs and must be managed in line with the Aquifer Interference Policy and relevant Groundwater Water Sharing Plan. There is the potential to disturb land salinity as the entire floodplain possess a moderate land salinity risk. Highly mobile salts pose a risk to buildings and structures in the proposed area, as well as producing saline runoff waste that could migrate into groundwater via recharge. Risk of exposing and causing PFAS migration may similarly occur through land and groundwater disturbance. The risk of aquifer interference and discharges to groundwater is deemed to be very low to low. As such the water table should not be significantly affected by this proposal and the risk of changes to water availability to groundwater users is therefore also deemed to be very low –to low. The risks of ASS and contamination to groundwater are deemed to be moderate. Therefore, taking a conservative approach, the risk to water quality and	Groundwater - quality Sensitive receptors: Aquatic, Terrestrial GDEs, Groundwater Users	Medium(Likely, moderate)	See mitigation measures for W5 (Construction – Groundwater dewatering and quality) in Table 7-1.	Low

Activity / Event	Description of Impact	Receptor/s	Significance	Mitigation Measures	Residual impacts
	becoming unsuitable for groundwater users is also deemed to be moderate.				
Surface water discharges	Surface water discharges may impact on water quality of adjacent receiving environments and cause increased erosion and scouring without appropriate measures in place.	Surface water Sensitive receptors, Wetlands, Aquatic GDE	Medium (Unlikely, moderate)	See mitigation measures for W1 (Construction – Soil erosion, scour, sedimentation, and water pollution), W2 (Construction– Contamination of surface water) and W3 Construction – Works over water, on waterfront land and adjacent to wetlands) in Table 7-1.	Low
Water use	During construction, the proposal would require potable (via mains water supply via Sydney Water approval) and non-potable water (via mains water supply and/or stormwater water captured onsite) and generate wastewater. Water demand for the overall proposal is only indicative at this stage, however given its nature and scale, the proposal would not be expected to be water intensive. Water use during construction would be minor and largely used for dust suppression and for the construction of the widened carriageway (e.g. compaction). The water requirement would vary, dependent on material sources and methodologies applied by the construction contractor, and weather conditions.	Surface water	Low (Rare, minor)	Not applicable.	Low

6.2 Potential Operational Impacts

Following construction and the implementation of relevant mitigation strategies, there may remain long term residual impacts to soils, surface water and groundwater.

6.2.1 Groundwater recharge and quality

The proposal would result in an increase of impervious surfaces, due to the expansion of the road footprint and inclusion of the shared pathway. This may lead to a reduction in groundwater recharge, due to an increase in stormwater runoff that is no longer directly discharged to the ground and infiltrated into the underlying aquifers. Drainage lines and basins surrounding the Hawkesbury River (Area 1, and northern section of 3) may eventually feed into the Hawkesbury River, with North Richmond (Area 2) feeding into the established stormwater system. Across the floodplain, these basins and swales would be used to filter road runoff prior to release into the surrounding environment.

Additionally, the raising of the surface for the road alignment may potentially surcharge the ground and alter surface and groundwater pathways across the floodplain (Area 4). The weight of the elevated bypass is likely to impact porosity over time. This may impact aquifer properties and GDEs, however is considered to be low impact due to the small scale of the lift and the relative small area of raised surface compared to the total area of the surficial aquifer. In areas classified as high risk for salinity, activities that modify the movement or relative height of groundwater could cause or exacerbate surface expressions of salinity. Subgrade compaction for road construction is a potential factor that could impact localised salinity, potentially reducing the lifespan of structures.

During the operational phase, this is only expected to have a negligible to low impact on groundwater levels, quality and pressure, with low ongoing impacts on inflow and groundwater dependent ecosystems or registered groundwater supply users.

6.2.2 Scour and erosion

Increased stormwater discharge volumes, frequency and flow rates associated with an increase in impervious surfaces may result in an increased risk of erosion in the receiving unlined waterways.

The relative increase in runoff would be negligible to the Hawkesbury River and Redbank Creek, due to their significant catchment areas. During operation, exposed surfaces would be landscaped or vegetated to reduce the risk of ongoing scouring, erosion and sedimentation into receiving environments. Similarly, the catchments draining to Pughs Lagoon and Mareh-Mareh Lagoon and their connecting unnamed drainage lines were reviewed (refer Figure 4-18). The proposal was deemed to only represent a small proportion of their respective catchments being modified into impervious surface. Changes in runoff volumes to the receiving waterways are therefore likely to be negligible and as such, erosion impacts associated with the increased flow unlikely to occur.

There is also potential for scour to occur at existing and new discharge points as result of concentrated flow and increased velocities or disturbance of the main waterway flow within the receiving waterways. Such discharge points are to be designed with effective dissipation and/or scour protection measures accounting for flow velocity in order to minimize scour and erosion. The presence of vegetated swales and sediments basins would provide some stormwater retention and reduce runoff rates during frequent storm events.

6.2.3 Water quality

Road runoff may contain pollutants associated with vehicular movement and normal use due to leaks, spills, and accidents. Expected contaminants include hydrocarbons (petrol, diesel, and grease), metals and suspended solids. Additionally, rainfall runoff from hardstands may lead to increases in nitrogen concentrations (associated with atmospheric deposition) in discharges and gross pollutants may end up in

drainage systems as a result of littering by road users. Contaminants may enter the waterways and groundwater if not managed appropriately.

In accordance with the TfNSW WSUD guideline, a risk based approach considering the sensitivity of receiving waters was applied when developing the proposed stormwater quality treatment strategy and selection of treatment measures for different zones of the Proposal.

Within the areas discharging to the lagoons, road runoff would be treated during operation by a series of swales and operational basins along the main bypass route and proposed bridge crossings. The overtopping of these basins during severe weather events or flooding may contribute to short term reductions in adjacent receiving environment's water quality objectives.

For areas in North Richmond, no treatment is proposed for road catchments. The road widening will replacing existing urban landuse in those areas and as such stormwater runoff volumes and pollutant loads would not change significantly. On this basis, ongoing stormwater quality will be more-or-less consistent with urban stormwater runoff and stormwater quality impacts associated with the Proposal are likely to be negligible.

The shared path proposed adjacent to Kurrajong Road has been deemed a low pollution risk associated with no vehicular movement and as such no treatment was proposed for this pavement.

A preliminary MUSIC model was developed based upon the concept design, to assess the performance of the proposed stormwater treatment strategy on reducing total suspended solids (TSS), total nitrogen (TN) and total phosphorous (TP) loads to receiving environments. The proposed strategy includes vegetated swales that provide initial primary treatment by removing coarse suspended sediments. Also, permanent water quality basins are proposed at the outlets of concentrated discharge locations i.e. at the end of bridges and intersections. Currently, sedimentation basins are proposed, but bioretention basins may be considered during later stages of design.

Pre and post development imperviousness are captured in Table 6-4. Pre development impervious areas were identified by reviewing aerial imagery of the Proposal area and calculated using geospatial software. The Proposal is expected to increase the imperviousness of the proposal area from 20% and 23% to 56% and 69% for Stage 2A and 2B respectively.

Table 6-4 Comparison of imperviousness pre and post development

Stage	Total (ha)	Imperviousness Area (ha)		Imperviousness Fraction	
		Pre-development	Post-development	Pre-development	Post-development
2A	22.637	4.45	12.67	20%	56%
2B	8.115	1.91	5.64	23%	69%

A summary of the preliminary MUSIC modelling results for key combined sub-catchment areas are presented in Table 6-5. While no pollutant load targets were set for the project, the load reduction has been presented to demonstrate performance for each zone. The results indicate that overall, TSS) and TP loads generated from pavements would be reduced by around 55% and 44% respectively. A minor amount of TN (14%) is also predicted to be removed. A higher level of treatment (78% and 61% for TSS and TP respectively) is achieved along the bypass areas draining to the ponds and wetlands within the floodplain which are likely to be more sensitive to pollutant loading than other areas.

Motor vehicle accidents/collisions may also lead to petrol, diesel, oil spillage or leaks. These incidents may contaminate exposed soils or mobilise contaminated soils and liquids into local watercourses, degrading water quality and GDE health. The risk would be higher where discharges occur from new road pavements directly into Hawkesbury River or the freshwater wetlands.

Spill containment and oil/water separation facilities should be considered within the proposed operational water quality basins, based upon the risk associated with discharge directly to waterways and the likelihood of spreading contamination during spills and ongoing runoff events. Hence, the risk surrounding the Hawkesbury River and associated activities are of high risks to water quality, accounted for in spill containment mitigations. Other areas, are considered to be of lower risk given the potential for swales and longer drainage lines to be blocked (e.g. sand bags) should a major spill occur.

With the proposed stormwater quality treatment measures in place, the proposal is likely to result in a slight increase in pollutant load to receiving waters. However, with consideration to footprint of the project within the broader catchment, the proposal is unlikely to significantly influence water quality within the Hawkesbury-Nepean River or other local waterways within the study area. As such, the proposal is likely to contribute to working towards improving or maintaining the WQOs over time.

Table 6-5 MUSIC Modelling – Preliminary Results

Pollutant	Source Load (With proposal no treatment)	Residual Load (With proposal with treatment)	Pollutant Reduction (%)
Discharges within North Richmond – no treatment			
Flow (ML/yr)	12.8	12.8	0
Total Suspended Solids (kg/yr)	3,340	3,340	0
Total Phosphorus (kg/yr)	5.58	5.58	0
Total Nitrogen (kg/yr)	29.3	29.3	0
Gross Pollutants (kg/yr)	365	365	0
Discharges within the floodplain wetlands and pond catchments – treated by swales and sediment basins			
Flow (ML/yr)	84.6	83	1.8
Total Suspended Solids (kg/yr)	23,500	5,190	78
Total Phosphorus (kg/yr)	42.5	16.7	61
Total Nitrogen (kg/yr)	204	158	22
Gross Pollutants (kg/yr)	2,130	290	86
Discharges to urban drainage around Hobartville and WSU – treated by swales			
Flow (ML/yr)	14.1	14.2	-0.2
Total Suspended Solids (kg/yr)	4,120	1,810	56
Total Phosphorus (kg/yr)	7.16	4.07	43
Total Nitrogen (kg/yr)	33.3	28.1	16
Gross Pollutants (kg/yr)	375	137	64
Discharges to Londonderry Road drain within Rickabys Creek catchment – treated by a swale			
Flow (ML/yr)	11.1	11.1	0
Total Suspended Solids (kg/yr)	3,480	900	74
Total Phosphorus (kg/yr)	5.94	2.5	58
Total Nitrogen (kg/yr)	26.3	21.7	18
Gross Pollutants (kg/yr)	315	54.4	83

6.2.4 Salinity

The majority of the proposal (across the floodplain) is deemed of a moderate soil salinity risk aside from North Richmond where it is deemed as low. Groundwater salinity is highest on the eastern section of the floodplain, and adjacent to Richmond, largely away from Area 3 where the proposal is not expected to intersect groundwater. Soil, and relative groundwater salinity, has a moderate potential to impact and degrade pavement stability, road furniture and concrete structures in the long term. This would be managed through appropriate design of structures and use of withstanding materials, prioritising appropriate drainage for salt movement. The proposal is not anticipated to result in any further impacts to soil salinity in the surrounding area.

6.2.5 Soil properties

Upon construction completion, exposed or disturbed surfaces would be stabilised. Embankments and areas in the road reserve would be landscaped in accordance with the proposal's landscaping plan. This would limit erosion and scouring.

The site largely possesses a low ASS risk probability, with the potential to impact structural foundations in the long term. Acidic soils may corrode concrete, iron and steel structures, limiting the lifespan of proposal structures. Additionally, the site is under investigation by the EPA as a PFAS contaminated zone. There is potential for concrete works to impact soil properties locally, increasing alkalinity through leaching during inundation events. However, these impacts are likely to be negligible and are unlikely to impact the region significantly due to the nature of surrounding urban developments.

6.2.6 Summary of potential operational impacts

A summary of the potential operational impacts for soils, surface water and groundwater are presented in Table 6-5.

Table 6-6 Summary of potential operational impacts for soils, surface water and groundwater

Activity / Event	Description of Impact	Receptor/s	Significance	Mitigation Measures	Residual impacts
Groundwater recharge and quality	The proposal would increase areas with impermeable surfaces, thereby slightly reducing overall recharge to underlying aquifers following rain events. The introduction of grassed swales would enable some recharge to occur. Surface water runoff, stormwater and other associated drainage channels are not expected to interact with groundwater or aquifers across the proposal's alignment during operation. The overall reduction is unlikely to produce an effect that would constitute aquifer interference, within the aquifer interference framework, therefore the potential impacts are considered to be negligible.	Groundwater – levels and quality Sensitive receptors: Aquatic, Terrestrial GDEs, Groundwater Users	Low (Unlikely, minor)	See mitigation measures for W8 (Soil erosion, scour, sedimentation, and water pollution) in Table 7-1.	Low
Scour and erosion	Scour and erosion could potentially occur where surface water is discharged into the waterways due to increased stormwater runoff volume entering the drainage network or increases in concentrated flows at discharge points. However, as per the drainage design, new outlets would be designed appropriately with dissipation and or scour protection, to minimise souring and erosion.	Surface water – erosion and scouring Sensitive receptors: Aquatic GDEs	Medium (Unlikely, moderate	See mitigation measures for W8 (Operation– Soil erosion, scour, sedimentation, and water pollution) in Table 7-1.	Low
Water quality	Heavy metals, hydrocarbons, oils and grease and other contaminants may be mobilised by runoff into waterways and potentially leach into surface water and groundwater via outlets and swales. There is also potential for motor vehicle accidents/collisions that may leak petrol, diesel, oils and metals from cars onto road surfaces which may lead to contaminants being mobilised into drainage lines and receiving waterways. These incidents could potentially lead to contamination of local waterways. Terrestrial GDEs downstream of the proposal on the banks of the Hawkesbury River, may also be impacted by surface water contamination and seepage to the groundwater system.	Surface water Groundwater Sensitive receptors: Wetlands, Aquatic GDE	Medium (Possible, moderate	See mitigation measures for W8 (Operation– Soil erosion, scour, sedimentation, and water pollution) and (W9(Operation – Contamination of surface water) in Table 7-1.	Low

Activity / Event	Description of Impact	Receptor/s	Significance	Mitigation Measures	Residual impacts
Salinity	The proposal exists within a moderate soil salinity risk, aside from North Richmond where it is deemed as low. Soil, and relative groundwater salinity, has a moderate potential to impact and degrade pavement stability, road furniture and concrete structures in the long term. This would be managed through appropriate design of structures and use of withstanding materials, prioritizing appropriate drainage for salt movement. The proposal is not anticipated to result in any further impacts to soil salinity in the surrounding area.	Surface water Groundwater Sensitive receptors: Wetlands, Aquatic GDE	Low (Unlikely, minor)	See mitigation measures for W10 (Operation – Soil Properties) in Table 7-1.	Low
Soil properties	The site largely possesses a low ASS risk probability, with low likelihood to impact structural foundations in the long term. There is potential for concrete works to impact soil properties, increasing alkalinity through leaching during inundation events. However, this is unlikely to impact the region significantly due to the nature of surrounding urban developments.	Surface water Groundwater Sensitive receptors: Wetlands, Aquatic GDE	Low (Rare, minor)	See mitigation measures for W10 (Operation – Soil Properties) in Table 7-1.	Low

6.3 Cumulative Impacts

Potential proposal impacts may be minor in isolation however these impacts may become more substantial when nearby proposals are considered. These cumulative impacts consider the proposed impacts of proposals that are currently under development, or at the planning state that may also influence the assessment of this proposal's potential impacts.

The cumulative impact assessment was prepared in accordance with the *Cumulative Impact Assessment Guidelines for State Significant Projects* (DPE, 2022). Proposals with the potential for cumulative impacts with the proposal were identified through a review of publicly available information and environmental impact assessments from the following data source:

- DPE's Major Projects register
- Transport for NSW Projects Map.

The relevant key proposals to be considered and their potential cumulative impacts in relation to soils, surface and groundwater are summarised in Table 6-6.

Cumulative impacts have the potential to arise from the interaction of the proposal with other proposals in the local area. There are no to negligible impacts expected to arise from other proposals. There is likely to be no on-going groundwater extraction from the Hawkesbury Alluvium, only during construction, hence any impacts from the proposal are considered negligible on this activity.

Table 6-7 Summary of relevant key proposals and potential cumulative impacts

Project	Details	Project status	Distance/interface	Cumulative impacts
New Richmond Bridge and traffic improvements - Stage 1	Upgrading about 3.8 kilometres of The Driftway between Londonderry Road and Blacktown Road to improve safety, flood resilience and cater for future traffic growth.	Currently in construction	Approximately 1km south of the proposal	Similarly with the proposal, the potential impacts may include: ■ Mobilisation of sediments in natural waterways ■ Concreting activities may degrade surface water and soil quality ■ Groundwater ingress during earthworks. With appropriate mitigation measures, it is assumed no cumulative impacts are anticipated.
Hawkesbury-Nepean Valley Flood Risk Management Strategy	A long-term plan to reduce flood risk in the most flood exposed region in New South Wales, the Hawkesbury-Nepean Valley.	Currently in planning	The proposal in situated within the Hawkesbury – Nepean floodplain	Would likely have positive impacts in the long term. No cumulative adverse impacts are anticipated.
Richmond System Wastewater Upgrade	The Richmond System Wastewater Upgrade is a program of work for the Richmond wastewater network and the Richmond Water Resource Recovery Facility, to double the treatment capacity.	REF approved, in delivery, expected to complete by 2026	Approximately 2km west of the proposal	Richmond System Wastewater Upgrade REF (Sydney Water, 2021) provides mitigation measures including: ■ Minimising groundwater ingress during detailed design ■ Water quality monitoring program ■ Spill kits and bunding potential contaminants and storing them on waterproof membrane Therefore, cumulative impacts are not anticipated.
Hawkesbury Centre of Excellence	New educational facility within the Western Sydney University (Hawkesbury Campus) site including campus short-term living accommodation.	EIS approved, construction on hold	Approximately 2km south of the proposal.	The Centre of Excellence in Agricultural Education (CoE) Soil and Groundwater Assessment (Woolacotts, 2021) provides mitigation measures such erosion and sediment controls and remediation plan to reduce impacts to soils and water. Therefore, cumulative impacts are not anticipated.

Project	Details	Project status	Distance/interface	Cumulative impacts
South Windsor Liquid Waste Facility Upgrade	Expansion of an existing liquid waste facility (resource recovery facility).	Currently in planning, preparing EIS	Approximately 6km south-east of the proposal.	In the South Windsor Liquid Waste Facility – Proposed Facility Upgrade Scoping Report (EME, 2023) suggests there would be minimal impact to surface water as project doesn't alter development footprint. Therefore, cumulative impacts are not anticipated.
South Windsor Resource Recovery Facility	Construction and use of a resource recovery facility to process up to 150,000 tonnes of construction and demolition waste per year. The proposal also involves bulk earthworks, stormwater works, vehicle parking and landscaping.	Currently in planning, preparing SEARs	Approximately 7km south-east of the proposal.	The project w involve bulk earthworks and landscaping. Potential impacts may include: ■ Mobilising soils into waterways, degrading surface water quality ■ Intercepting groundwater table, degrading groundwater water quality With appropriate mitigation measures, it is assumed no cumulative impacts are anticipated.
Grose River Bridge	Construction of a new road that would connect Grose River Road at Grose Wold with Springwood Road at Yarramundi, including a new bridge across the Grose River.	Currently in planning	Approximately 4km west of the proposal	With appropriate mitigation measures, it is assumed no cumulative impacts are anticipated.
St John of God Richmond Hospital Redevelopment	Construction of upgraded and expanded facilities resulting in an additional 24 beds, partial demolition of existing buildings, retention of Belmont House and integrated open space and landscaping.	Currently in construction and expected to complete by 2024	Approximately 2km west of the proposal	The St John of God Richmond Hospital Environmental Impact Statement for State Significant Development (Mecone, 2020) states the project does not involve changes to groundwater, surface water patterns or soil disturbance. Therefore, cumulative impacts are not anticipated.
Drainage Upgrade Program on Mitchell Drive, Glossodia	Widening of existing road, new kerb and gutter, new stormwater drainage, tree removal/ replacement and new road signs and line markings alond Mitchell Drive.	Completed in late 2023	Approximately 8km south-east of the proposal.	Given distance to the project, no cumulative impacts are anticipated.
Drainage Upgrade Program on Ian Street, Glossodia	Widening of existing road, new kerb and gutter, new stormwater drainage, tree removal/ replacement and new road signs and line markings along Ian Street,	Completed in late 2023	Approximately 8km south-east of the proposal.	Given distance to the project, no cumulative impacts are anticipated.

7 Management of impacts

7.1 Overview of mitigation measures

The following mitigation and management measures are recommended to eliminate or reduce risks associated with potential impacts to the soils, surface water and groundwater during construction and operation phases of the proposal. Environmental mitigation measures, including management, engineering solutions and ongoing monitoring have been developed to minimise impacts to the local environment during construction and operation.

A Construction Environmental Management Plan (CEMP) would be developed by the construction contractor. This document would outline proposal specific construction management measures for soils, surface water and groundwater. The CEMP would be an overarching document, including a range of sub-management plans for specific impact considerations. The CEMP is a plan developed for the construction phase of a proposal to ensure that all contractors and sub-contractors comply with the environmental conditions of approval for the proposal, so that environmental risks are managed appropriately. It would be a 'live' document with the capacity to be updated if conditions encountered differ from expected conditions.

The following documents are to be prepared to support the CEMP:

- Construction Soil and Water Management Plan (CSWMP)
  - Groundwater Management Plan (GMP)
  - Soil and Surface Water Management Plan (SSWMP)
    - Erosion and Sediment Control Plans

Strategic Environmental and Engineering Consulting has developed an Erosion and Sedimentation Management Report (ESMR), detailing the basis for erosion and sedimentation management based on the concept design (Strategic Environmental and Engineering Consulting, 2023., 'New Richmond Bridge Stage 2 Erosion and Sedimentation Management Report – Revision A'.

Sydney Water, 2021., 'Richmond System Wastewater Upgrade Review of Environmental Factors'
TfNSW, 2020., QA Specification G38; Soil and Water Management. The ESMR including preliminary Erosion and Sediment Control Plans are included in Appendix C. Whilst the design is subject to change with further revisions, this report has been used to inform a range of mitigation measures described below.

Residual impacts to the environment including soils, surface water and groundwater due to the proposal would be managed throughout the long-term operational phase via the OEMP which would contain response plans to manage any on-going monitoring and reporting requirements, spillages, or incidents.

7.2 Mitigation measures

A summary of mitigation measures to reduce the potential impacts on each activity for detailed design, construction and operation phase is presented in Table 7-1. As discussed previously, the construction phase measures are also applicable to decommissioning.

Table 7-1 Mitigation measures for proposal construction and operation

ID	Impact	Mitigation Measure	Responsibility	Timing
W1	Construction – Soil erosion, scour, sedimentation, and water pollution	A Soil and Water Management Plan (SWMP) would be prepared and implemented as part of the CEMP. The SWMP would identify all reasonably foreseeable risks relating to soil erosion and water pollution and describe how these risks would be addressed during construction. This SWMP would be reviewed by a soil conservationist on the TfNSW list of Registered Contractors for Erosion, Sedimentation and Soil Conservation Consultancy Services. This plan would include requirements for a construction water quality monitoring program, to be implemented during construction. This would be prepared in accordance with the TfNSW Guideline for Construction Water Quality Monitoring and EPA publication "Approved Methods for the Sampling and Analysis of Water Pollutants in NSW. This plan would provide guideline levels and trigger values in accordance with ANZG discharge criteria and environmental performance criteria. Where feasible water captured onsite would be re-used to minimise discharge offsite. Discharge and reuse of waters would be undertaken in accordance with TfNSW Water Discharge and Reuse Guideline DMS-SD-024 or relevant EPL requirements if one applies. Mitigation measures outlined in these documents may include, but are not limited to: ■ Early installation, where possible, of drainage systems and stormwater diversions to direct clean water away from construction sites, ■ Temporary cross drainage to transfer clean water through and/or around site during construction, ■ Sedimentation traps and basin to manage runoff from site to sensitive receiving environments, ■ Use of sediment fencing and/or hay bales to reduce sediment run-off, ■ Covering earthworks stockpiles with geofabric, polymer or wetting to reduce the risk of airborne particles leaving the construction site, ■ Wetting down temporary construction roads and stockpiles with water carts or polymer for dust suppression, ■ Installation of scour protection measures, such as rock armouring to prevent souring at discharge points ■ Reuse of surface water captured onsite for dust suppression	TfNSW/ Contractor	Detailed design / preconstruction / during construction

ID	Impact	Mitigation Measure	Responsibility	Timing
		The preliminary ESMR and Erosion and Sedimentation Control Plan (ESCP) produced for the proposal would be updated during the detailed design phase to refine erosion and sedimentation controls. A final ESCP would be developed by the construction contractor and would include the requirement to implement progressive ESCPs in line with changing site conditions.	TfNSW/ Contractor	Detailed design / preconstruction / during construction
		Where possible, construction stage sediment basins would be positioned within the permanent water quality control basins. Permanent basins should be constructed early in the construction program including the permanent outlet structures. During design development, the lining of basins, swales and drains would-be considered to limit the likelihood of erosion, scouring, dewatering required and/or reduce heaving. This would improve the practical application of sediment basins, improving water quality at discharge points. These basins maybe potentially vegetated, slowing the velocity of water and improving water quality through filtration vegetation. The potential to employ High Efficiency Sediment Basins (HES), that automatically dose chemical coagulants and flocculants for treatment should be investigated at the outset of construction.	TfNSW/ Contractor	Detailed design / preconstruction / during construction
W2	Construction–Contamination of surface water	Regular visual water quality checks (include for turbid plumes and hydrocarbon spills or slicks) would be carried out when working in or near waterways. Construction water quality monitoring would be undertaken upstream and downstream of the proposal area to ensure that controls and site practices are effective at maintaining current water quality conditions. Monitoring would be undertaken in accordance with the Guideline for Construction Water Quality Monitoring (RTA, undated) and developed as part of the CEMP. The frequency of monitoring would be adjusted with consideration to the sensitivity of the potentially impacted waterway and risk of the activity with increased monitoring required for the proposed piling works and disturbance within water front land of the mapped coastal wetlands.	Contractor	During construction
		The construction methodology, access and onsite water management should take into account the potential the project has to be impacted by salinity or to exacerbate local salinity issues. To minimise the risk of salinity impacting pavement stability and local environments: ■ Immediately implement diversion and drainage structures to divert surface water away from road assets ■ Investigate the use of drainage blankets in the road sub-base layer to help intercept elevated water tables	TfNSW/ Contractor	Detailed design / preconstruction

ID	Impact	Mitigation Measure	Responsibility	Timing
		Stockpiles site locations would be confirmed during detailed design and where applicable, managed in accordance with Environmental Procedure Management of Wastes on Roads and Maritime Services Land (RMS, 2014) and the Stockpile Site Management Guideline (RMS, 2015). This would consider measures to manage cross contamination within a stockpile area. and pay consideration to the flood risk at ancillary locations across the site. Stockpiles should attempt to be stored above the floodplain, on higher grounds of North Richmond ancillary facilities. This would reduce the risk of topping and polluting runoff during rainfall or flood events. Further consideration of how to manage stockpiles, material laydown and chemical storage with respect to floodwaters would be undertaken by the construction contractor.	TfNSW/ Contractor	Detailed design / during construction
		A Construction Water Quality Discharge Assessment is to be completed during detailed design. These assessments must be conducted in accordance with the EPA's Assessing and Managing Water Pollution from Road Works and the Draft Guideline for Assessing the Impacts of Treated Water Discharge from Water Quality Treatment Controls (TfNSW 2020).	TfNSW/ Contractor	Detailed design
W3	Construction – Works over water, on waterfront land and adjacent to wetlands	Works on the Hawkesbury River foreshore and surrounding Pughs Lagoon, Mareh-Mareh Lagoon and associated tributaries would be undertaken with consideration to the design and construction considerations described in the *Guidelines for instream works on waterfront land*, Department of Primary Industries, Office of Water, July 2012, *Guidelines for watercourse crossings on waterfront land,* Department of Primary Industries, Office of Water, July 2012 and in accordance with relevant TfNSW specifications and guidelines. Works in close proximity to the existing lagoons on Kurrajong Road and across the floodplain, invites a high level of environmental protection due to the proximity of Coastal Wetlands. Enhanced controls including silt curtains and a higher frequency monitoring regime shall be undertaken for piling works and other disturbance activities within the Hawkesbury River and within waterfront land of the mapped coastal wetlands.	TfNSW/ Contractor	Detailed design / during construction
W4	Construction – water pollution from accidental spills	A site-specific emergency spill plan shall be developed and include spill management measures in accordance with relevant codes of practice and EPA guidelines. This would address protocols to be implemented in the event of a spill, including initial response and containment, notification requirements to emergency services (where necessary) and relevant authorities (including Transport and EPA officers). Spill kits shall be deployed across the site, at regular intervals for use. All staff would be made aware of the location of the spill kit and trained in its use.	Contractor	Preconstruction / during construction

ID	Impact	Mitigation Measure	Responsibility	Timing
		The refuelling and maintenance of plant and equipment would be undertaken in a designated bunded ancillary facilities area, where possible. Vehicle wash downs and concrete washouts would be carried out within designated sealed bunded areas at construction ancillary facilities or carried out off-site. The storage of chemicals and fuel at ancillary facilities, and re-fuelling areas, should be prioritised on elevated lands, of North Richmond and Hobartville, where possible. Where possible, chemicals and vehicles would be moved onto higher ground at the end of each shift or in the event of severe rainfall and flooding events, to reduce the risk of spills if containment bunds are beached.	Contractor	During construction
		The appropriate storage of concrete and asphalt, as well as other fuel and chemicals at ancillary facilities would be tracked as part of Material Safety Data Sheets (MSDS) and general chemical management according to the CEMP. The bunding of chemical storage zones, and availability of spill kits would reduce the migratory impacts of potential spills.	Contractor	During construction
W5	Construction – Groundwater dewatering and quality	In the event that groundwater/ aquifer dewatering must occur to lower the groundwater table and reduce or prevent groundwater ingress into excavations, then potential impacts on GDEs must be quantitatively assessed as part of the dewatering assessment. A Dewatering Assessment is to be conducted in further design phases. This assessment would infer the need for a construction Dewatering Management Plan (DMP). Quantitative assessment must Be undertaken in accordance with the NSW AIP. On this condition, TfNSW would be advised to undertake further studies demonstrating that the River Condition Index (RCI) category of the highly connected surface water source (for alluvial groundwater sources) would not be impacted in the long-term. The high connectivity of surface and groundwater resources is exasperated within with alluvial floodplain and high groundwater levels. The NSW RCI is a long-term assessment reporting tool, used to determine long-term river condition. This index utilises a range of indicators including water quality, river form and surrounding vegetation to inform a river condition category assessment. Monitoring, potential mitigation and/or remediation measures may be required during operation to demonstrate progress towards these standards. If the predicted impact does not prevent the long-term viability of the relevant water-dependent asset, then the impacts shall be considered as acceptable by the Minister.	TfNSW / Contractor	Detailed design / during construction

ID	Impact	Mitigation Measure	Responsibility	Timing
		Outlined in either the CEMP or DMP (if deemed necessary during dewatering assessments), the following construction mitigation conditions should be considered: ■ Site Environmental Coordinator or representative must contact the waste disposal contractor and receiving facility to determine the correct analytical suite and documentation required before water is transported. ■ All liquid waste must be characterised with the documentation made available to both the waste disposal contractor and receiving facility. ■ All produced water must be collected and stored in a sealed, bunded or similar storage vessel. ■ Daily inspections of the stored water must be made and include the following items: – Date/time and location of dewatering, – Estimated inflow rate, – pH, – Turbidity, – Signs of visible oil or fuel (hydrocarbon) sheen, – Any unusual odour, colour. slime or foamy scum.	TfNSW / Contractor	Detailed design / preconstruction / during construction
		The locations of basins and ancillary facilities spread across the floodplain, are subject to flooding and inundation from localised high groundwater levels. Particularly, basin MCP1 1200 and MCN1 3050 are at risk due to their proximity to local water features and low elevation. MCP1 1900 lies adjacent to an intermittent waterbody, with high localised groundwater and likely biodiversity value. The locality of these basins should be considered in future design phases.	TfNSW	Detailed design
		The depth of swale drains along the floodplain extend to approximately a maximum of 1 m bgl along Inalls Lane. There is a high risk of ongoing groundwater infiltration into an unlined swale, impacting water quality treatment. The lining of swales and raising structures along the floodplain where groundwater levels are in close proximity should be considered to prevent intersecting groundwater during operation.	TfNSW	Detailed design

ID	Impact	Mitigation Measure	Responsibility	Timing
W6	Construction – Encountering contaminated or adverse substances	The CEMP must include consideration of the risk of exposing acid sulfate soils during bridge piling works or by earthworks near the floodplain lagoons. At a minimum, there must be consideration of: ■ Requirements for monitoring water quality and spoil management, with intermittent PASS testing to ensure compliance. ■ Requirements for further investigation at locations where excavations have been introduced during detailed design where site specific testing was not completed. ■ Protocols for PASS or ASS management, including a protocol for its management and potential treatment or disposal. This may include a methodology for onsite PASS testing, subsequent treatment protocols with agricultural lime ($CaCO_3$), leachate containment plans and waste classification segregation for disposal options. The liming rate for neutralisation shall be calculated as part of the acid base accounting analysis. ■ Unexpected finds protocols related to PASS or ASS.	Contractor	Preconstruction / During construction
		During detailed design and/or prior to commencing construction, additional soil, sediment, groundwater and/or surface water assessments should be conducted to further evaluate the potential risks to human health and the environment and inform potential remedial extents, detailed waste management advice, acid sulfate soil risks, and dewatering requirements. This may include (but is not limited to) the areas where data gaps were reported in the DSI; sediment conditions within the Hawkesbury River and surrounding lagoons; areas mapped as comprising ASS and where excavations may take place greater than 1 m bgl; and areas where localised dewatering is proposed. The requirement for further investigation at the study area will primarily be determined by areas of proposed ground disturbance and/or dewatering where associated environmental media may represent an exposure risk to onsite receptors. Based on the results of the additional assessment, a project wide Remediation Action Plan may require preparation to detail appropriate remediation and management options at the study area to facilitate construction spoil management. Any additional investigations should also consider detailed design changes to alignments and areas of stripping, grubbing and deeper excavations, compared to concept design.	TfNSW/ Contractor	Detailed design / During construction
		Fill imported to site must undergo supplier validations to ensure contaminations of potential concern are not being introduced to site, or that the material may not have adverse impacts on characteristics of the existing environment.	Contractor	During construction

ID	Impact	Mitigation Measure	Responsibility	Timing
W7	Construction – Waste containment and management	Waste classes would be reviewed during detailed design to confirm expected spoil volumes, waste classifications, options for reuse onsite and/or appropriate disposal mechanisms. These waste classes would be used during construction to appropriately segregate wastes, preventing cross contamination and for onsite reuse of offsite disposal classification.	TfNSW/ Contractor	Detailed design / Preconstruction / During construction
W8	Operation– Soil erosion, scour, sedimentation, and water pollution	As much as possible, construction stage sediment basins would be positioned within the permanent water quality control basins. Therefore, these permanent basins would need to be constructed as early works including the permanent outlet structures. These systems would be designed to reduce pollutant loads to the waterway in the long term, through the minimisation of earthworks and use of appropriate treatment devices such as basins, culverts basins and grassed swales, where appropriate. These facilities should consider mechanisms for spill containment and oil and water separation, to reduce contaminate runoff from the upgraded road polluting receiving environments.	TfNSW/ Contractor	Detailed design
W9	Operation – Contamination of surface water	A Construction Water Quality Discharge Assessment is to be completed as part of the SSWMP for construction. During detailed design, preliminary assessments using MUSIC modelling can be used to infer environmental design. These assessments must be conducted in accordance with the EPA's Assessing and Managing Water Pollution from Road Works and the Draft Guideline for Assessing the Impacts of Treated Water Discharge from Water Quality Treatment Controls (TfNSW 2020).	TfNSW/ Contractor	Detailed design / preconstruction
W10	Operation – Soil Properties	The road and landscaping design should take into account the potential for the project to be impacted by salinity or to exacerbate local salinity issues. To minimise the risk of salinity impacting pavement stability, road furniture and concrete structures, measures may include: ■ Design and construct concrete structures for aggressive soils, where necessary ■ Consideration of the use of drainage blankets in the road sub-base layer to help intercept elevated water tables, ■ Include diversion and drainage structures to divert surface water away from road assets, ■ Planting deep-rooted vegetation upslope of roads to help drawn down groundwater tables, ■ Planting of salt-tolerant species in areas of moderate risk.	TfNSW/ Contractor	Detailed design / preconstruction / during construction

8 Conclusion

This report includes a desktop review of available information and review of the geotechnical and contamination investigations undertaken for the proposal, to identify the potential risks to soils, surface water and groundwater. Recommendations for management and mitigation measures have been made to eliminate or manage the potential impacts. Most of the identified potential impacts are expected to occur during the construction phase.

The primarily identified impacts during construction include erosion and sedimentation impacts and contamination risks from, spills and incidents. Vegetation removal and earthworks may destabilise soils enhancing erosion and increasing the sediment load in stormwater run-off. There is a risk from potential ASS, to cause the acidification of groundwater that could be exposed during excavation works. Dewatering may be required during construction, however, dewatering would be temporary and short in duration. At the completion of temporary construction and dewatering, groundwater levels would be expected to return to pre-construction levels.

During the operational phase, potential impacts are expected to be minor but could include a slight reduction in groundwater recharge due to an increased impervious pavement surface area, scouring and erosion of receiving environments from runoff and an increase in surface water contamination from road surfaces.

To minimise potential impacts to soils, surface water and groundwater, a site-specific overarching Construction and Environmental Management Plan (CEMP) would be prepared by the construction contractor. This would outline specific mitigation and management measures to eliminate or reduce potential impacts to the environment. The CEMP would be a 'live' document, with the capacity to be updated if site conditions encountered differ from the expectation. The following documents are to be prepared to support the CEMP:

- Construction Soil and Water Management Plan (CSWMP)
  - Groundwater Management Plan (GMP)
  - Soil and Surface Water Management Plan (SSWMP)

Additionally, the construction methodologies would consider:

- Stockpile site locations, material laydown and chemical storage to prevent water pollution.
- Site-specific emergency spill plans to address accidental spills and leaks of hydrocarbons and other chemicals.
- Management of works within waterfront land in accordance with the principles described in relevant DPIE waterfront land guidelines (instream works and watercourse crossings)
- Areas where vegetation has been removed for the purpose of construction, laydown areas and compounds, is expected to be rehabilitated and replanted with native vegetation.

The stormwater system would be designed to reduce TSS and sediment bound heavy metal and nutrient loads to the receiving waterways. Given the proposal area is only a small proportion of both the local waterway catchments and Hawkesbury Nepean catchment, the proposal is likely to have a negligible long-term impact on the receiving waterways with the proposed management measures in place

All new outlets would be designed with appropriate scour protection and/or dissipation measures.

With the implementation of the proposed management and mitigation measures, the proposal is expected to have acceptable and minimal impacts on the existing soil, surface water and groundwater landscape. These measures would drive environmental values during both the construction and operation phases.

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A

Appendices

Appendix A – Aquifer Interference Policy Guidelines

Table 9-1 Minimal impact considerations for a highly productive aquifer

Groundwater System	Highly Productive Groundwater Sources
Water Table	1. Less than or equal to 10% cumulative variation in the water table allowing for typical climatic “post-water sharing plan” variations, 40 m from any: High priority groundwater dependent ecosystem High priority culturally significant site; listed in the schedule of the relevant water sharing plan; or A maximum of a 2 m decline cumulatively at any water supply work. If more than 10% cumulative variation in the water table, allowing for typical climatic “post-water sharing plan” variations, 40 m from any: High priority groundwater dependent ecosystem; or High priority culturally significant site; listed in the schedule of the relevant water sharing plan then appropriate studies would need to demonstrate to the Minister’s satisfaction that the variation would not prevent the long-term viability of the dependent ecosystem or significant site. If more than 2 m decline cumulatively at any water supply work, then make good provisions should apply.
Water Pressure	1. A cumulative pressure head decline of not more than 40% of the “post-water sharing plan” pressure head above the base of the water source to a maximum of a 2 m decline, at any water supply work. 2. If the predicted pressure head decline is greater than requirement 1. above, then appropriate studies are required to demonstrate to the Minister’s satisfaction that the decline would not prevent the long-term viability of the affected water supply works unless make good provisions apply.
Water Quality	1. (a) Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40 m from the activity; and (b) No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity. Redesign of a highly connected surface water source that is defined as a “reliable water supply” is not an appropriate mitigation measure to meet considerations 1. (a) and 1.(b) above. (c) No mining activity to be below the natural ground surface within 200 m laterally from the top of high bank or 100 m vertically beneath (or the three-dimensional extent of the alluvial material - whichever is the lesser distance) of a highly connected surface water source that is defined as a “reliable water supply”.

Groundwater System	Highly Productive Groundwater Sources
	(d) Not more than 10% cumulatively of the three-dimensional extent of the alluvial material in this water source to be excavated by mining activities beyond 200 m laterally from the top of high bank and 100 m vertically beneath a highly connected surface water source that is defined as a “reliable water supply”. 2. If condition 1. (a) is not met then appropriate studies would need to demonstrate to the Minister’s satisfaction that the change in groundwater quality would not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works. If condition 1. (b) or 1.(d) are not met then appropriate studies are required to demonstrate to the Minister’s satisfaction that the River Condition Index category of the highly connected surface water source would not be reduced at the nearest point to the activity. If condition 1. (c) or (d) are not met, then appropriate studies are required to demonstrate to the Minister’s satisfaction that: there would be negligible riverbank or high wall instability risks, during the activity’s operation and post closure, level banks and landform design should prevent the Probable Maximum Flood from entering the activity’s site; and, low-permeability barriers between the site and the highly connected surface water source would be appropriately designed, installed and maintained to ensure their long-term effectiveness at minimising interaction between saline groundwater and the highly connected surface water supply.

Table 9-2 Minimal impact considerations for a low productivity aquifer

Groundwater System	Less Productive Groundwater Sources
Water Table	1. Less than or equal to 10% cumulative variation in the water table allowing for typical climatic “post-water sharing plan” variations, 40 m from any: High priority groundwater dependent ecosystem High priority culturally significant site, listed in the schedule of the relevant water sharing plan; or a maximum of a 2m decline cumulatively at any water supply work unless make good provisions should apply. 2.If more than 10% cumulative variation in the water table, allowing for typical climatic “post-water sharing plan” variations, 40 m from any: High priority groundwater dependent ecosystem; or High priority culturally significant site, listed in the schedule of the relevant water sharing plan then appropriate studies would need to demonstrate to the Minister’s satisfaction that the variation would not prevent the long-term viability of the dependent ecosystem or significant site. If more than 2 m decline cumulatively at any water supply work, then make good provisions should apply.
Water Pressure	1. A cumulative pressure head decline of not more than 40% of the “post-water sharing plan” pressure head above the base of the water source to a maximum of a 2 m decline, at any water supply work. 2. If the predicted pressure head decline is greater than requirement 1. above, then appropriate studies are required to demonstrate to the Minister’s satisfaction that the decline would not prevent the long-term viability of the affected water supply works unless make good provisions apply.
Water Quality	1. (a) Any change in the groundwater quality should not lower the beneficial use category of the groundwater source beyond 40m from the activity; and (b) No increase of more than 1% per activity in long-term average salinity in a highly connected surface water source at the nearest point to the activity. Redesign of a highly connected surface water source that is defined as a “reliable water supply” is not an appropriate mitigation measure to meet considerations 1. (a) and 1. (b) above. (c) No mining activity to be below the natural ground surface within 200 m laterally from the top of high bank or 100 m vertically beneath (or the three-dimensional extent of the alluvial material - whichever is the lesser distance) of a highly connected surface water source that is defined as a “reliable water supply”. 2. If condition 1. (a) is not met then appropriate studies would need to demonstrate to the Minister’s satisfaction that the change in groundwater quality would not prevent the long-term viability of the dependent ecosystem, significant site or affected water supply works. If condition 1. (b) is not met then appropriate studies are required to demonstrate to the Minister’s satisfaction that the River Condition Index category of the highly connected surface water source would not be reduced at the nearest point to the activity. If condition 1. (c) is not met, then appropriate studies are required to demonstrate to the Minister’s satisfaction that: there would be negligible riverbank or high wall instability risks,

Groundwater System	Less Productive Groundwater Sources
	during the activity's operation and post closure, levee banks and landform design should prevent the Probable Maximum Flood from entering the activity's site; and low-permeability barriers between the site and the highly connected surface water source would be appropriately designed, installed and maintained to ensure their long-term effectiveness at minimising interaction between saline groundwater and the highly connected surface water supply.

Appendix B – Erosion and Sedimentation Management Report

SEEC

New Richmond Bridge Stage 2

Erosion and Sedimentation Management Report

Revision D

Prepared for Aurecon and Transport for NSW

02 September 2024

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Document Certification

This report has been developed based on agreed requirements as understood by SEEC at the time of investigation. It applies only to a specific task on the nominated lands. Other interpretations should not be made, including changes in scale or application to other projects.

Any recommendations contained in this report are based on an honest appraisal of the opportunities and constraints that existed at the site at the time of investigation, subject to the limited scope and resources available. Within the confines of the above statements and to the best of my knowledge, this report does not contain any incomplete or misleading information.

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SEEC

02 September 2024

Version Register

Version	Date	Author	Reviewer	Notes	Other
Rev A	20/12/2023	AM	LO	Issued as Rev A for review	
Rev B	12/07/2024	AM/LO	BJ	Issued as Rev B for review (80% concept design)	
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Rev D	02/09/2024	AM/LO	TfNSW	Issued as Rev D (80% concept design). Amended to reflect TfNSW comments.	

TABLE OF CONTENTS

1 INTRODUCTION 4
1.1 Proposal Identification 4
1.2 About the Proposal 4
1.2.1 Proposal Background 4
1.2.2 Proposal Overview 4
1.3 Purpose and Scope of This Report 11
1.4 Structure of This Report 11
1.5 Limitations 12
2 METHODS AND BACKGROUND 13
2.1 Site Inspection 13
2.2 Documentation and Review 13
2.3 Design Standards and Guidelines 13
3 SITE CONDITIONS 14
3.1 Climate 14
3.2 Topography 14
3.3 Soils - General 15
3.4 Acid Sulfate Soils 16
3.5 Salinity 19
3.6 Surface Water 21
3.6.1 Catchments and Receiving Waters 21
3.6.2 Existing Drainage 21
3.6.3 Discharges During Construction 21
3.7 Flooding 21
3.8 Groundwater 23
3.9 Biodiversity 23
3.10 Existing Services 25
3.11 Land Availability 25
3.12 Erosion Hazard 25
4 PESA 27
4.1 Background 27
4.2 Sub-Catchment Sediment Basin Assessment 27
4.3 Assessment 30
5 MANAGEMENT MEASURES 32
5.1 Sediment Basins 32
5.1.1 Design Standards 32
5.1.2 Fencing of Construction-Phase Basins 32
5.1.3 High-Efficiency Sediment Basins 32
5.2 Onsite and Offsite Water Separation 33
5.3 Assessment of Feasibility of Erosion and Sediment Controls 34
5.4 Proposal-Specific Management Measures 40
6 CONCLUSIONS 45
7 REFERENCES 47
8 APPENDICES 48
8.1 Appendix A: Concept Erosion and Sediment Control Plan (ESCP) 48

1 INTRODUCTION

1.1 Proposal Identification

Transport for NSW (Transport) proposes to upgrade Bells Line of Road / Kurrajong Road between Crooked Lane, North Richmond and Old Kurrajong Road, Richmond and construct a new bypass south of Richmond town centre. This is known as New Richmond Bridge and traffic improvements – Stage 2 (the proposal). The new route between Richmond and North Richmond would provide a minimum five per cent annual exceedance probability (AEP) flood resilience (equivalent to the 1 in 20 chance per year flood event). The proposal is about 50 kilometres north-west of the Sydney Central Business District (CBD) and about 33 kilometres north-west of Parramatta. It is in the Hawkesbury City Council local government area (LGA).

The proposal would be delivered in two stages, known as Stage 2A and Stage 2B. Should this REF be determined, and the already committed funding by the Australian Government and NSW Government released, Stage 2A would be constructed. This is expected to be complete by 2029. The timing of Stage 2B would be subject to available funding and Transport will continue to seek funding in upcoming State and Federal budgets to deliver the rest of the upgrades.

Stage 2A of the proposal includes a new four-lane bridge over the Hawkesbury River about 30 metres downstream of the existing Richmond Bridge, widening of Bells Line of Road through North Richmond to provide two lanes in each direction between the new bridge and the Terrace Road / Grose Vale Road intersection and a new bypass to the south of the Richmond town centre. The bypass would extend about 1.7 kilometres across the floodplain between the Kurrajong Road / Old Kurrajong Road intersection and Castlereagh Road / Inalls Lane / Southee Road intersection. Stage 2A of the proposal would also provide an active transport corridor between North Richmond and Richmond. This would include a new shared path on the southern side of Kurrajong Road between Old Kurrajong Road and Chapel Street and the conversion of the existing Richmond Bridge into an active transport connection across the Hawkesbury River.

Stage 2B of the proposal includes widening of Bells Line of Road between the Terrace Road / Grose Vale Road intersection and west of Charles Street and at its intersection with Crooked Lane. The bypass would also be extended 1.3 kilometres east from Castlereagh Road to Londonderry Road and would be a new road alignment to the south of Southee Road. Southee Road would connect to the bypass opposite Valder Place. The Londonderry Road / bypass / Vines Drive intersection would also be upgraded.

1.2 About the Proposal

1.2.1 Proposal Background

Richmond Bridge is currently operating at capacity during peak periods and future traffic demand in the area will increase, driven by residential development west of the Hawkesbury

River and background traffic growth. This is expected to further increase congestion and travel times along this arterial corridor.

Richmond Bridge is closed in moderate flood events when flood levels reach about eight metres Australian Height Datum (AHD), which is at about the 50 percent AEP flood level. Since 2020, Richmond Bridge has closed multiple times due to flooding. The closure of this bridge results in disruption to travel between North Richmond and Richmond and disrupts regional traffic using the Bells Line of Road corridor.

The Australian Government and NSW Government are funding traffic improvements between North Richmond and Richmond including a new bridge over the Hawkesbury River. This initiative is part of a wider program of traffic improvements between North Richmond and Richmond which includes previous intersection improvements at three key intersections on the approach to the existing Richmond Bridge, including Bells Line of Road / Gross Vale Road intersection in North Richmond as well as Kurrajong Road / Old Kurrajong Road intersection and March Street / Bosworth Street intersection in Richmond. The proposal builds on the previous intersection improvements and is being carried out as part of a wider program of traffic improvements between Richmond and North Richmond which is being delivered in two stages (Stage 1 and Stage 2). They are:

- **Stage 1** involves upgrading The Driftway between Londonderry Road and Blacktown Road to improve safety and flood resilience. This project has been separately determined by Transport and is being delivered separately to the proposal.
- **Stage 2** is the proposal and it aims to improve traffic efficiency, flood resilience, active transport connections and safety of the road network between Richmond and North Richmond.

1.2.2 Proposal Overview

The key features of Stage 2A of the proposal would include:

- A new four-lane bridge over the Hawkesbury River (about 360 metres long) about 30 metres downstream of the existing bridge, with two eastbound and two westbound lanes and the road level at a height to provide a five per cent AEP flood immunity.
- Widening of Bells Line of Road and Kurrajong Road to two lanes in each direction from the Terrace Road / Grose Vale Road intersection in North Richmond to just east of the Kurrajong Road / Old Kurrajong Road intersection in Richmond.
    - a new two-lane bypass south of Richmond town centre (one lane in each direction) between the Kurrajong Road / Old Kurrajong Road intersection and just east of the Castlereagh Road / Inalls Lane / Southee Road intersection, including:
    - a three-way signalised intersection connecting Kurrajong Road and the new bypass, including closure of the existing northern and southern legs of Old Kurrajong Road at Kurrajong Road.

  - a two-way gated emergency driveway access connecting the northern leg of Old Kurrajong Road and Kurrajong Road, to be opened during flood evacuation events.
  - a 150-metre-long bridge over a tributary to Mareh-Mareh Lagoon (near Inalls Lane).
  - a 120-metre-long bridge over the floodplain parallel to Inalls Lane.
  - a roundabout at the Castlereagh Road / Inalls Lane / bypass intersection, with a local road connection to Southee Road.
  - local road connections to Yarramundi Lane and Victoria Place from the bypass.
  - truncation of Inalls Lane near Mareh-Mareh Lagoon, with local road connections to Inalls Lane from the bypass via Yarramundi Lane and near Drift Road.
  - closure of the existing Drift Road intersection with Inalls Lane, with a new local road connection to Drift Road from the bypass.
  - footpaths along the southern side of the bypass between Drift Road and Castlereagh Road and on each side of the roundabout.
- An upgraded active transport network between Richmond and North Richmond, including:
  - a new shared path along the southern side of Kurrajong Road between the existing Richmond Bridge and Chapel Street, Richmond, a distance of about two kilometres, connecting to existing paths along March Street, Richmond.
  - conversion of the existing Richmond Bridge and approaches into an active transport only connection.
  - active transport connections from the existing Richmond Bridge through Hanna Park to an upgraded shared path on the northern side of Bells Line of Road until east of the Bells Line of Road / Terrace Road / Grose Vale Road intersection.
- Retention of bus stops along Bells Line of Road and Kurrajong Road.
- New drainage infrastructure, including swales and water quality basins.
- Utilities connections and upgrades (including electrical, gas, water and telecommunications).
- New intelligent transport systems including closed-circuit television (CCTV) cameras to monitor traffic flow and assist with emergency management.
- New maintenance access to the three new bridge structures.
- Permanent retaining walls near the approach to the new four-lane bridge in North Richmond and along Kurrajong Road near the new shared path.

- Driveway adjustments and tie-ins, including along Bells Line of Road, Beaumont Avenue, Kurrajong Road, Old Kurrajong Road, Inalls Lane, Drift Road and Castlereagh Road.
- Eight new parking spaces on the northern side of Beaumont Avenue, near its intersection with Terrace Road to replace parking spaces removed on Bells Line of Road.
- Finishing works, including kerb and gutters, signs, landscaping, lighting and line marking.
- Construction activities, including:
    - early work, including the establishment of a new compliant handrail on the existing Richmond Bridge.
    - geotechnical, contamination and utility investigations which may be carried out as early work.
    - a temporary roundabout at the Kurrajong Road / Chapel Street intersection.
    - civil earthworks, bridge structural works, retaining walls, drainage work, utilities relocations and tie-in work and adjustments to adjoining sections of road.
    - establishment of temporary ancillary facilities to support construction, including compound sites, site offices, stockpile and laydown locations, temporary access tracks and water quality devices.
    - demolition work for structures and property features that fall in the proposal area.

The key features of Stage 2B of the proposal would include:

- Localised widening of Bells Line of Road to provide a dedicated right-turn lane into Crooked Lane.
- Widening of Bells Line of Road to two lanes in each direction from west of Charles Street to the Terrace Road / Grose Vale Road intersection in North Richmond.
- Additional capacity improvements to the Bells Line of Road / Terrace Road / Grose Vale Road intersection, including an additional eastbound through lane at the intersection.
- An upgraded shared path on the northern side of Bells Line of Road from west of Charles Street to the Terrace Road / Grose Vale Road intersection in North Richmond.
- Extension of the bypass (one lane in each direction) between the Castlereagh Road roundabout and just south of the Londonderry Road / Southee Road intersection, including:
    - a new signalised intersection at the junction of Londonderry Road, the new bypass and Vines Drive.

  - closure of the Southee Road local road connection from Castlereagh Road and closure of Southee Road at Londonderry Road.
  - a new local road connection to Southee Road opposite Valder Place, with left and right turn lanes provided at this intersection.
  - two new bus stops along the bypass near Hill Avenue (one eastbound and one westbound), with a footpath connection to Southee Road.
- Retention of bus stops along Bells Line of Road and Londonderry Road.
- New drainage infrastructure, including swales and a water quality basin on Londonderry Road.
- Noise screening mounds, walls and/or additional attenuation between the bypass and Southee Road along the extended section of the bypass between Castlereagh Road and Londonderry Road.
- Utilities connections and upgrades (including electrical, gas, water and telecommunications).
- New intelligent transport systems at the Londonderry Road / bypass / Vines Drive intersection including closed-circuit television (CCTV) cameras to monitor traffic flow and assist with emergency management.
- Driveway adjustments and tie-ins, including along Bells Line of Road, the bypass and Londonderry Road.
- Finishing works, including kerb and gutters, signs, landscaping, lighting and line marking
- Construction activities, including:
  - geotechnical, contamination and utility investigations which may be carried out as early work.
  - civil earthworks, retaining walls, drainage work, utilities relocations and tie-in work and adjustments to adjoining sections of road.
  - establishment of temporary ancillary facilities to support construction, including compound sites, site offices, stockpile and laydown locations, temporary access tracks and water quality devices.
  - demolition work for structures and property features that fall in the proposal area.

An overview of the proposal (Stages 2A and 2B) is provided in Figure 1-1 and Figure 1-2.

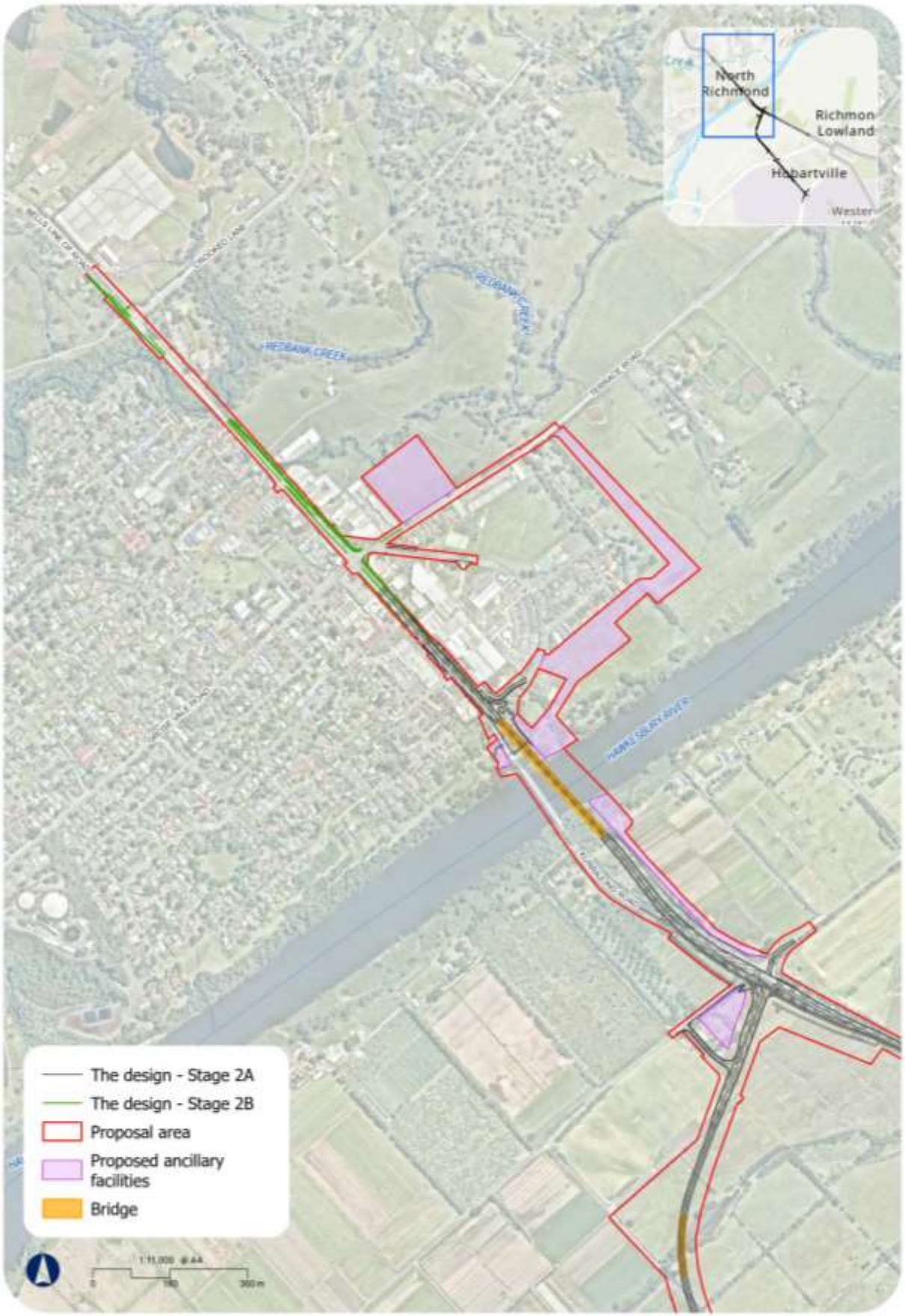

Figure 1-1 – Overview of the proposal (part 1) (Aurecon, 2024).

Figure 1-2 – Overview of the proposal (part 2) (Aurecon, 2024).

1.3 Purpose and Scope of This Report

This report is an Erosion and Sediment Management Report (ESMR).

A Preliminary Erosion and Sedimentation Assessment (PESA) has been undertaken for the proposal following the procedure described in Section 4.1.1 of Transport Procedure PN 143P. A summary of the PESA process is in Section 4 of this ESMR.

The PESA determined that the proposal poses a high risk for erosion and sedimentation control, thereby necessitating the appointment of a Soil Conservation Consultant to prepare an ESMR.

This ESMR has been prepared following the procedures described in Section 4.1 of Transport Procedure PN 143P. The purpose of the ESMR is:

- To develop concept designs for major erosion and sedimentation control measures. Major control measures will include:
    - Up-gradient stormwater diversion to ensure clean water does not enter the construction site.
    - Temporary cross drainage to transfer clean water through and/or around the site through all construction phases,
    - Sedimentation basins, as required, designed in accordance with the sizing criteria in DECC (2008) (Blue Book Volume 2D) (e.g. 80th/85th percentile 5-day rainfall event capture for non-sensitive/sensitive receiving environments – consideration may be given to designing larger sedimentation basins to manage runoff to particularly sensitive receiving environments or for particularly high-risk activities).
- To assess constraints (risks) to the installation and operation of major controls through all construction phases.
- To eliminate risks where possible.
- To design preliminary compensatory measures where risks cannot be eliminated.
- To report the findings in an Erosion and Sedimentation Management Report (ESMR).

During development of this ESMR the entire proposal has been reviewed and determined there would be only minor changes required due to the proposed staging (i.e. Stages 2A and 2B).

1.4 Structure of This Report

This report includes the following sections:

- Section 1 provides an introduction outlining the proposal background and purpose of this report.
- Section 2 describes the methods used for developing this ESMR including site inspection and the applicable Transport standards and guidelines.

- Section 3 provides an assessment of the potential constraints and opportunities that might impact on construction-phase erosion and sediment control.
- Section 4 provides details of the PESA process to determine that this proposal is high risk, necessitating the preparation of this ESMR
- Section 5 assesses the feasibility and appropriateness of implementing standard-practice erosion and sediment controls on the proposal and summarises a series of recommendations to manage or mitigate potential impacts.

Section 5 is accompanied by a Concept Erosion and Sediment Control Plan (ESCP) which is included as Appendix A. This ESCP shows conceptually the setup of key erosion and sediment control measures.

1.5 Limitations

This report has been prepared by Strategic Environmental and Engineering Consulting (SEEC) Pty Ltd on behalf of Aurecon Australia for Transport and may only be used and relied on by Transport for the purpose agreed between Aurecon and Transport for NSW as set out in Section 1.3 of this report.

This ESMR and the accompanying ESCP are for the purposes of proposal planning and are not to be used for construction.

2 METHODS AND BACKGROUND

2.1 Site Inspection

A site inspection was conducted by Andrew Macleod from SEEC in August 2023 to identify and confirm soil and topographical conditions and how they might influence erosion and sediment control during construction.

2.2 Documentation and Review

As part of preparing this ESMR, SEEC conducted a review of:

- The Concept Design prepared by Aurecon (2024), to determine if any inherent design issues might impact on the effective implementation of erosion and sediment controls.
- The proposal boundaries, to ensure that adequate consideration was given to structures such as sedimentation basins when determining land availability.
- Concept construction staging, to determine how this might influence the constructability of structures, and the management of clean offsite water and dirty onsite water at each stage.
- How access from the existing road network might impact on erosion and sediment control.
- Land available during construction to determine if space constraints are likely to impact on the effective implementation and establishment of erosion and sediment controls.
- Site topography, soils, the receiving environment and local setting, to determine how these aspects influence or are impacted by the proposal, and how they might affect the effective implementation of erosion and sediment controls.

Constraints identified in this process have been considered in preparing the Concept ESCP (Appendix A) and comments regarding this are included in Section 5 in this ESMR.

2.3 Design Standards and Guidelines

Erosion and sediment controls in this ESMR (and the accompanying Concept ESCP) have been designed in accordance with:

- The NSW Government publication “Managing Urban Stormwater – Soils and Construction”, Volume 1, 4th Edition (Landcom, 2004) – “the Blue Book Volume 1”
- “Managing Urban Stormwater – Soils and Construction”, Volume 2D, Main Road Construction (DECC, 2008) – “the Blue Book 2D”.

In addition, the Transport Road Design Guide has also been used to inform the design of erosion and sediment controls in this ESMR and the accompanying Concept ESCP in Appendix A.

3 SITE CONDITIONS

3.1 Climate

Bureau of Meteorology (BoM) rainfall statistics for Richmond (UWS Hawkesbury) (station 067021) are contained in Table 3-1. On average, rainfall occurs throughout the year, with no distinct wet or dry season.

Table 3-1 – Monthly rainfall for Richmond (UWS Hawkesbury) (BoM station 067021).

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ann-ual
Rainfall (mm)	96.5	94.5	94.0	67.1	55.8	60.1	45.3	41.8	41.9	57.1	73.6	75.1	801.7
Mean no of days with rain >1mm	7.7	7.5	7.8	6.3	5.5	5.7	4.6	4.8	5.3	6.1	7.2	7.3	75.8

3.2 Topography

Approximately half of the proposal lies on floodplains, levees or banks of the Hawkesbury River, in lands that are subject to flooding (WMA Water, 2022 and TfNSW, 2022). Floodplains are generally flat (slope gradients less than 1%) and include a series of lagoons that act as backswamps or secondary channels for the Hawkesbury River during flood events. River banks and levees are steeper than the floodplains, with slopes around 5 to 50%, but locally steeper over short distances associated with fluvial erosion.

Hillslopes at the edges of the floodplain are moderately inclined with slopes between 10% and 15%. These hillslopes occur as short (<80m long) “jump-ups” that separate the floodplain from high terraces.

In areas above the floodplain elevation, the proposal lies on high terraces that are very gently inclined (slopes less than 4%). These areas are above the level of the 1% Average Exceedance Probability (AEP) flood (WMA Water, 2022 and TfNSW, 2022).

Topography presents a significant constraint for erosion and sediment control on the banks of the Hawkesbury River. An extensive ancillary facility will be required on both sides of the river for bridge construction, necessitating significant disturbance in close proximity to the river. The steepness of the river banks will limit the feasibility to construct sediment basins in those locations.

Away from the river banks, topography does not present a significant constraint for erosion and sediment control.

3.3 Soils - General

Soil and land resource mapping by the NSW Government (accessed via eSpade online portal) shows the proposal lies on a number of landscape units (Figure 3-1). These are noted in Table 3-2 with a summary of the extent of each soil landscape unit relative to the proposal area.

Table 3-2 – Soil landscape units across the proposal area (from NSW Government eSpade portal)

Soil landscape unit	Approximate percent of the proposal area
Clarendon	37%
Freemans Reach	46%
Berkshire Park	1%
Blacktown	9%
Bakers Lagoon	4%
Gymea	2%
Luddenham	1%

Site observations by SEEC during the site inspection confirmed the accuracy of these landscape units. Table 3-3 contains a summary of key features and potential constraints that might influence erosion and sediment control during construction in the three most prevalent soil landscape units.

Table 3-3 –Soil landscape units summary (from NSW Government eSpade portal and Landcom, 2004).

Parameter	Freemans Reach	Clarendon	Blacktown
Soil landscape description	Flood plain on Quaternary alluvium.	High terraces on Tertiary-age alluvium and clays. Generally above the modern day 1% AEP flood.	Low rolling rises and hills on Wianamatta Group shales.
K-factor	0.046	0.059	0.038
Sediment type	Type F (fine) and D (dispersible)	Type F (fine)	Type F (fine) and D (dispersible)
Steep slopes	No	Localised on terrace margins	No

Parameter	Freemans Reach	Clarendon	Blacktown
Seasonal waterlogging	No	No	Localised
Flood hazard	Yes	No	No
Salinity hazard	No	No	Localised
Mass movement hazard	No	No	No
Foundation hazard	Yes	Yes	Localised
Fertility	Moderate	Moderate	Moderate
Sheet erosion hazard	No	Localised	Localised
Streambank erosion hazard	Yes	No	No
Gully erosion hazard	No	No	Localised
Wind erosion hazard	No	Yes (fine sandy and silty subsoils)	Yes (silty topsoils)

3.4 Acid Sulfate Soils

Acid Sulfate Soil Risk Mapping (DLWC, 1997) identified the following (Figure 3-2):

- High risk of acid sulfate material in river bottom sediments
- Low risk of acid sulfate material associated with lagoons on the floodplain
- No known risk of acid sulfate material in all other areas.

A plan to address the risk of acid sulfate soils exposed by bridge piling works or by earthworks near the floodplain lagoons will be required. In addition, sediment basins should not be excavated into areas of known acid sulfate soils due to the risk of exposing sulfidic sediments to oxygen. In areas of no or low probability, the risk can be managed by an unexpected finds protocol.

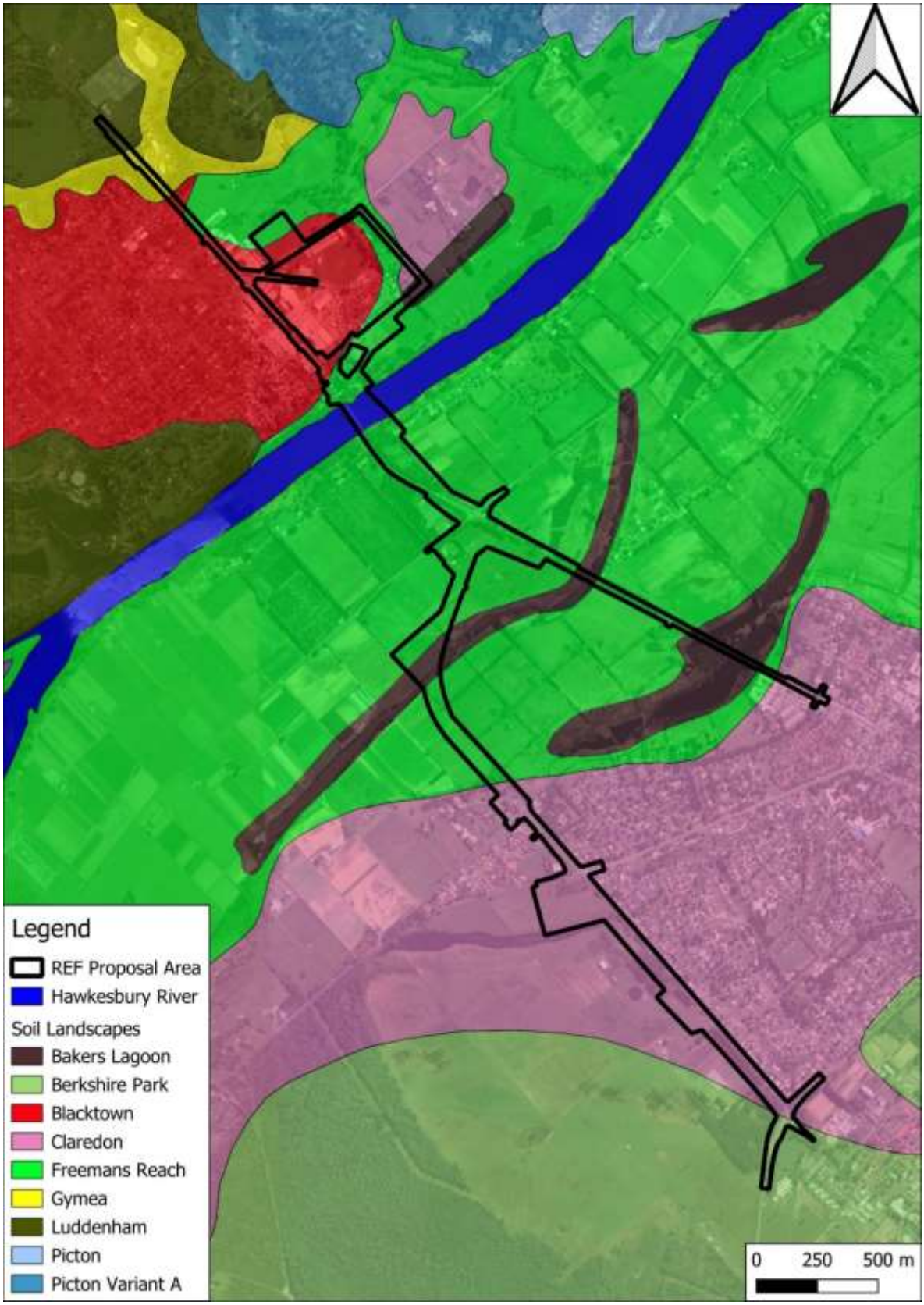

Figure 3-1 – Soil landscape units across the proposal (from NSW Government eSpade portal)

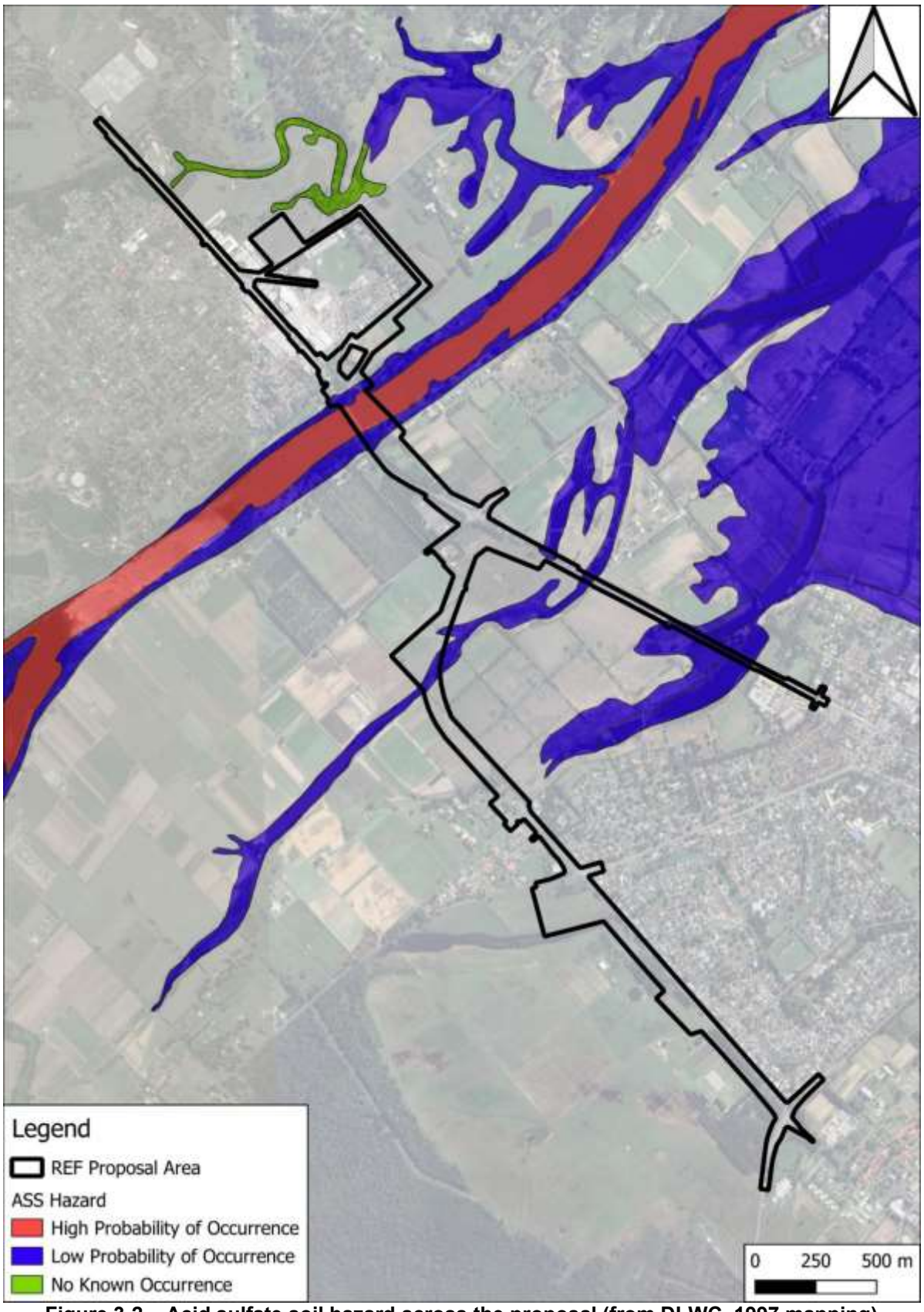

Figure 3-2 – Acid sulfate soil hazard across the proposal (from DLWC, 1997 mapping)

3.5 Salinity

The Salinity Potential in Western Sydney Map (DIPNR, 2003) shows the soils across the proposal area have a moderate salinity potential, except for an area around a natural floodplain lagoon (known as Pughs Lagoon) which occurs at the edge of the floodplain, at the foot of the natural jump-up separating the floodplain from the high terraces. In the area around the lagoon, the salinity potential is high, or is mapped as a salt affected area (Figure 3-3).

Areas classified as moderate risk for salinity are unlikely to show significant expressions of salinity (e.g. vegetation decline, excessive erosion, salt damage to built structures). However, excessive groundwater recharge in areas of moderate risk can cause or exacerbate surface expressions of salinity in high risk areas. The construction and operation of the proposal is unlikely to increase the amount of groundwater infiltration in those areas.

In areas classified as high risk for salinity, activities that modify the movement or relative height of groundwater could cause or exacerbate surface expressions of salinity. Subgrade compaction for road construction is a potential factor that could impact localised salinity.

To minimise the risk of salinity impacting on pavement stability, road furniture and concrete structures measures can be included such as:

- Planting of deep-rooted vegetation upslope of roads to help draw down groundwater tables.
- Use of drainage blankets in the road sub-base layer to help intercept elevated water tables.
- Design and construct concrete structures for aggressive soils.
- Include diversion and drainage structures to divert surface water away from road assets; and/or
- Planting of salt-tolerant species in areas of high risk.

Note that salinity is unlikely to be a significant constraint for construction-phase erosion and sediment control.

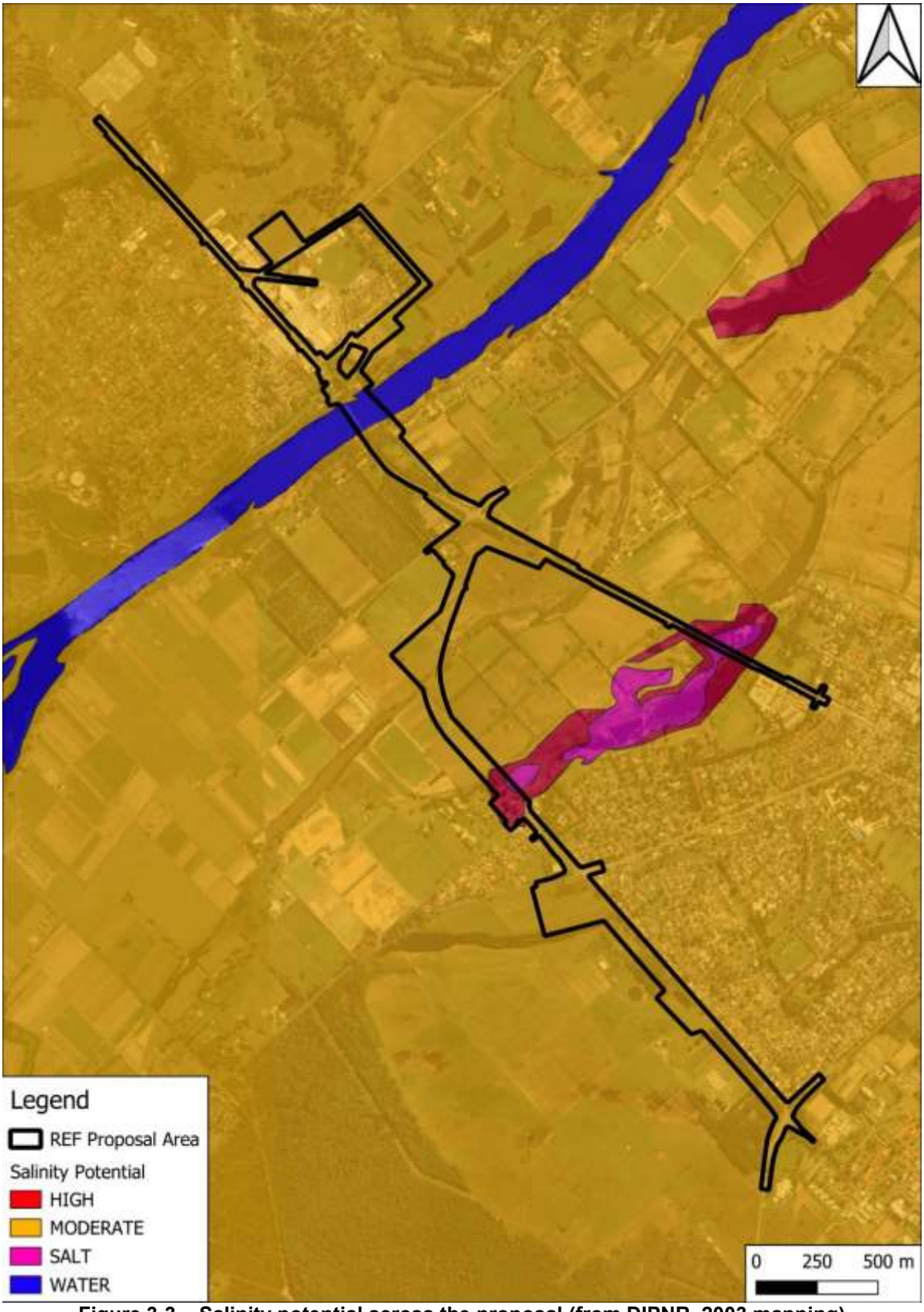

Figure 3-3 – Salinity potential across the proposal (from DIPNR, 2003 mapping)

3.6 Surface Water

3.6.1 Catchments and Receiving Waters

The proposal crosses the Hawkesbury River, and the entire proposal area lies in the catchment area for the Hawkesbury River (Figure 1-1 and Figure 1-2).

3.6.2 Existing Drainage

The existing road network includes a piped stormwater network only in the following areas:

- Along Bells Line of Road between the existing Hawkesbury River bridge and the bridge at Redbank Creek (Figure 1-1).
- Along the eastern side of Southee Road.

All other existing roads within the proposal boundary have swale drains or informal drainage.

3.6.3 Discharges During Construction

Construction-stage sediment basin discharges should achieve an appropriate water quality to ensure consistency with the Water Quality Objectives (WQOs) for the Hawkesbury River.

Typically, the turbidity threshold for the protection of aquatic ecosystems in lowland streams is 6 to 50 NTU. An assessment should be made during the detailed design for the proposal of the appropriate sediment basin discharge water quality.

3.7 Flooding

A significant proportion of the proposal area sits below the 1% AEP flood event level (WMA Water, 2022, TfNSW, 2022 and Infrastructure NSW, 2023), as shown in Figure 3-4.

The NSW Blue Book Volumes 1 and 2D (Landcom, 2004 and DECC, 2008) require temporary structures for sediment control (e.g. sediment basins, sediment fences) to be sited above the 2-year Average Recurrence Interval (ARI) event, which is equivalent to the 39.35% AEP event. The IECA (2008) Best Practice Erosion and Sediment Control guidelines require such structures to be sited above the 5-year ARI event, which is equivalent to the 18.13% AEP event.

Mapping from TfNSW (2022) showing the 20% AEP flood extent (which is very close to the 18.13% AEP) shows that only construction immediately either side of the Hawkesbury River is below that flood level (Figure 3-5). Mapping for the 2-year ARI (39.35% AEP) is not included in TfNSW (2022) or WMA Water, 2022).

As such, flooding is a significant constraint for erosion and sediment control associated with the bridge construction over the Hawkesbury River (including abutments, piling and ancillary facilities on both sides of the river). Erosion and sediment controls in that area should focus

on methods that are unlikely to be destroyed, severely compromised or which could cause downstream impacts in a minor (less than a 39.35% AEP) flood event. As such, structures such as mulch bunds, silt fences and coir logs should be avoided in the flood zone.

Outside of the area immediately either side of the proposed bridge, flooding is not a significant constraint for construction-phase erosion and sediment control. Those areas are all higher than the 39.35% AEP flood height.

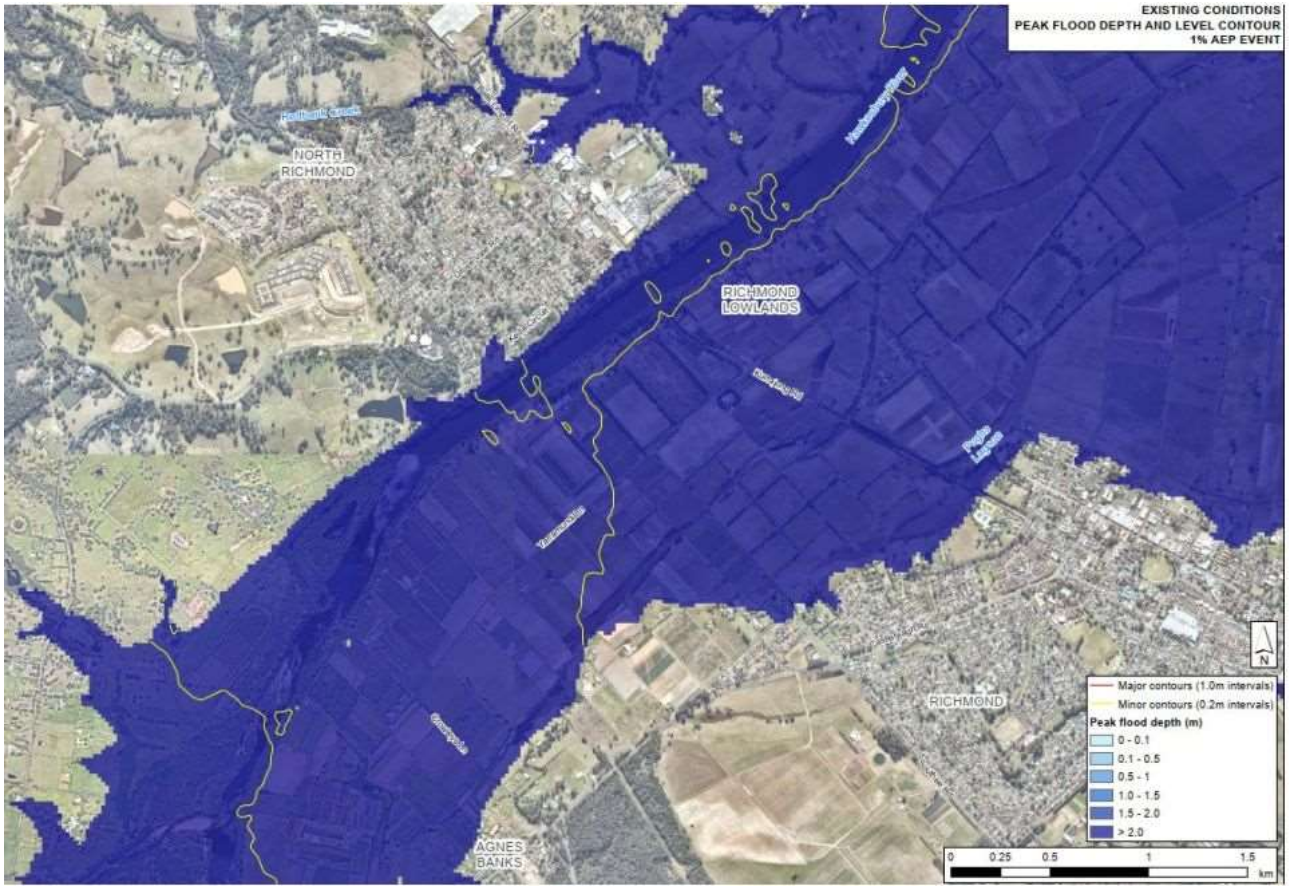

Figure 3-4 – 1% AEP flood extent (from TfNSW, 2022).

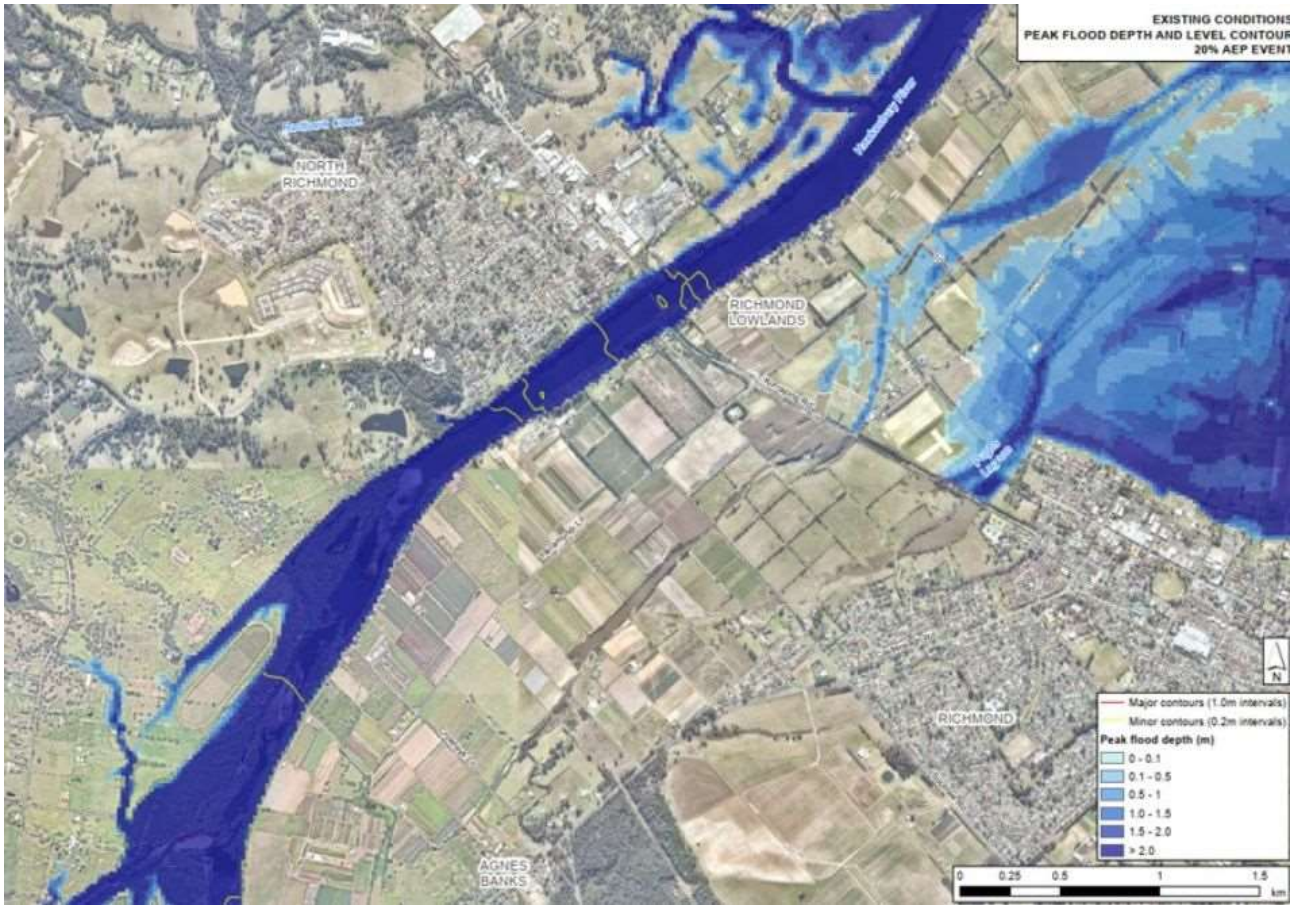

Figure 3-5 – 20% AEP flood extent (from TfNSW, 2022).

3.8 Groundwater

The presence and nature of groundwater is being assessed as part of the concept design, concurrently with the preparation of this ESMR. As such, if groundwater presents a significant constraint for construction-phase erosion and sediment control, that will be noted in the Erosion and Sedimentation Management Report (ESMR), along with identification of appropriate mitigation or management measures.

3.9 Biodiversity

The proposal lies in close proximity to lands mapped as coastal wetlands, as well as areas of ecological significance. These are unlikely to present significant constraints for construction-phase erosion and sediment controls. However, where works are in close proximity to the existing lagoons on Kurrajong Road, a high level of environmental protection is required because the lagoons flow into areas mapped as Coastal Wetlands (Figure 3-6).

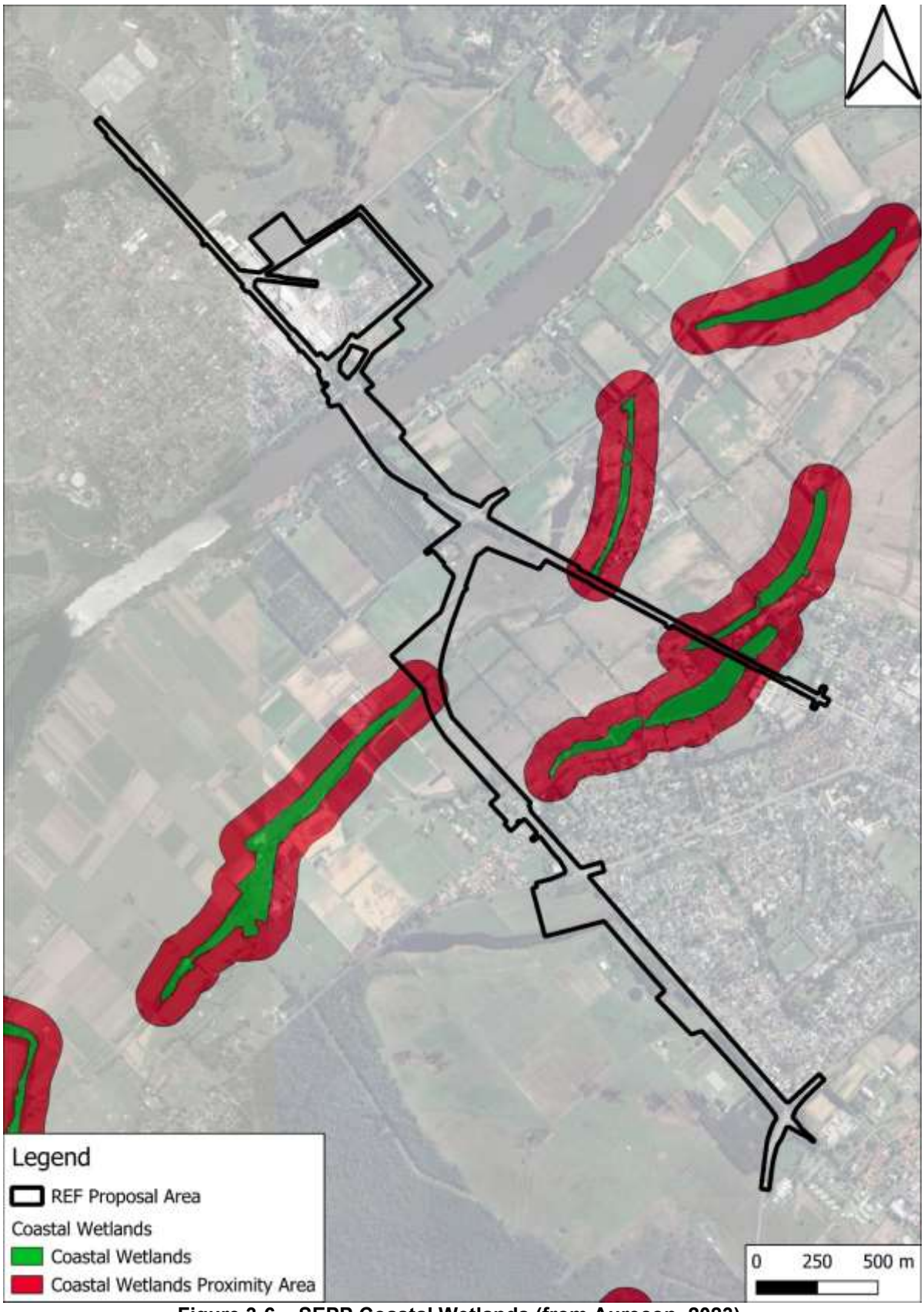

Figure 3-6 – SEPP Coastal Wetlands (from Aurecon, 2023).

3.10 Existing Services

Existing underground and overhead services and utilities are present within the proposal area. These will need to be considered when siting key construction-phase structures such as sediment basins.

Wherever possible, the design and positioning of underground utilities (including relocations) should aim to avoid sediment basins to help facilitate effective environmental management during construction.

3.11 Land Availability

Land availability is a common constraint for major road projects during construction, especially for:

- Establishing stockpiles;
- Establishing temporary facilities such as laydown areas and batch plants; or
- Constructing sediment basins.

Limited space in a narrow construction corridor can be compounded by topographical, environmental, ecological and heritage constraints, which can limit the siting of sediment control structures such as sediment basins.

The accompanying Concept ESCP (Appendix A) identifies the proposed locations for sediment basins and clean offsite and dirty onsite water drains.

3.12 Erosion Hazard

An evaluation of the erosion hazard was made using the approach in Chapter 4 of the Blue Book (Landcom, 2004). This process involves calculating the predicted annual average soil loss using the Revised Universal Soil Loss Equation (RUSLE) as follows:

$$A = R \times K \times LS \times P \times C$$

The values for the various factors in the RUSLE are shown in Table 3-4. Section 4.2 contains an assessment of each sub-catchment using the RUSLE.

Table 3-4 – RUSLE factors used for erosion hazard assessment

Parameter	Definition	Assumed or adopted value for this proposal
A	Total calculated soil loss (t/ha/yr)	Varies from 22 to 585 t/ha/yr. Also refer to Section 4.2.
R	Rainfall erosivity factor	2500 (Landcom, 2004).
K	Soil erodibility factor	0.059 (Refer to Section 3.3).
LS	Slope length and gradient factor	Varies from 0.1 (80m, 0.5%) to 3.05 (9m, 50%)
P	Conservation practice factor	Maximum of 1.3 assumed for this proposal.
C	Ground cover factor	Maximum of 1.0 assumed for this proposal.

4 PESA

4.1 Background

Transport Procedure PN143P requires all proposals be subject to a PESA, following the procedure in Attachment 1a of that document. The PESA applies "triggers" that, if exceeded, classify a proposal as high risk. Where a proposal is considered high risk preparation of an ESMR is required (this document).

4.2 Sub-Catchment Sediment Basin Assessment

Each sub-catchment to be disturbed for this proposal was assessed using the procedure detailed in Section 3.12 to determine which, if any, sub-catchments trigger the requirement for a sediment basin to comply with the NSW Blue Book (Landcom, 2004 and DECC, 2008). Table 4-1 details the assessment for each of the proposal sub-catchments; refer to accompanying Concept ESCP in Appendix A for the location of each sub-catchment.

Sediment basins have been included in the Concept ESCP (Appendix A) in all of the sub-catchments where sediment basins are triggered.

Table 4-1 – Assessment of each sub-catchment using the RUSLE process (from Landcom, 2004 and DECC, 2008).

Align-ment	Sub-catchment (refer to Appendix A)	Sub-catchment area (ha)	RUSLE calculation (t/ha/yr)	Sub-catchment erosion (t/yr)	Is a sediment basin required? *	Is a sediment basin shown on the concept ESCP?
MCA1	150W	0.23	247	56.9	N	N/A
	200W	0.1	334	33.4	N	N/A
	450E	0.17	216	36.8	N	N/A
	575E	0.15	216	32.4	N	N/A
	600E	0.11	22	2.4	N	N/A
	700E	0.5	101	50.5	N	N/A
	700W	0.56	101	56.5	N	N/A
	900E	0.09	22	1.9	N	N/A
	1450W	0.18	251	45.2	N	N/A
	1500E	5.83	538	2545.6	Y	Y
	1700E	1.14	538	613.5	Y	Y
	1750W	0.79	20	15.6	N	N/A
	1950W	0.15	585	87.7	N	N/A
	2170E	2.49	295	733.8	Y	Y
	2170W	0.72	334	240.4	Y	Y

Align-ment	Sub-catchment (refer to Appendix A)	Sub-catchment area (ha)	RUSLE calculation (t/ha/yr)	Sub-catchment erosion (t/yr)	Is a sediment basin required? *	Is a sediment basin shown on the concept ESCP?
	2200E	0.14	419	58.6	N	N/A
	2210E	0.13	419	54.4	N	N/A
	2250E	0.16	361	57.7	N	N/A
	2260E	0.06	110	6.6	N	N/A
	2350E	0.69	361	249	Y	Y
	2550E	0.75	65	48.5	N	N/A
	2600E	0.17	65	11.0	N	N/A
	2600W	1.24	122	151.2	N	N/A
	2610W	0.27	65	17.5	N	N/A
	2800W	0.36	37	13.3	N	N/A
	3150W	0.54	37	20	N	N/A
	3250W	0.5	37	18.5	N	N/A
	3350W	0.19	37	7	N	N/A
	3525W	0.41	101	41.4	N	N/A
	3750E	0.18	101	18.2	N	N/A
MCP1	2900E	3.11	361	1122.7	Y	Y
	2900W	0.51	419	213.7	Y	Y
	2950E	0.18	419	75.4	N	N/A
	2975E	0.13	419	54.5	N	N/A
	2975W	0.28	419	117.3	N	N/A
	3000W	0.12	531	63.7	N	N/A
	3075E	0.24	531	127.4	N	N/A
	3150W	1.53	101	154.5	N	N/A
	3200E	0.33	419	138.1	N	N/A
	3225W	0.19	531	100.8	N	N/A
	3700E	1.16	419	485.6	Y	Y
	3700W	1.44	419	603.4	Y	Y
	3750E	1.04	125	130	N	N/A
	3750W	1.69	228	385.3	Y	Y
	3900W	0.65	125	81.1	N	N/A

Align-ment	Sub-catchment (refer to Appendix A)	Sub-catchment area (ha)	RUSLE calculation (t/ha/yr)	Sub-catchment erosion (t/yr)	Is a sediment basin required? *	Is a sediment basin shown on the concept ESCP?
	4000W	0.4	125	50	N	N/A
	4400E	0.32	175	56.0	N	N/A
	4410E	0.1	361	36.1	N	N/A
	4450E	0.67	175	117.3	N	N/A
	4450W	0.54	125	67.4	N	N/A
	4550E	0.23	361	83.0	N	N/A
	4800E	0.3	361	108.3	N	N/A
	4850E	0.22	228	50.1	N	N/A
	4850W	0.33	125	41.2	N	N/A
	4875E	0.24	228	54.6	N	N/A
	4875W	0.65	125	81.1	N	N/A
	5050E	0.78	125	97.4	N	N/A
	5500E	0.65	78	50.8	N	N/A
	5550E	0.29	78	22.6	N	N/A
	5550W	1.14	78	89	N	N/A
	5600E	0.12	78	9.4	N	N/A
	5600W	0.12	78	9.4	N	N/A
MCW1	475S	0.72	37	26.6	N	N/A
	525N	0.3	37	11.1	N	N/A
Ancillary facilities	MCA1A	1.96	282	552.4	Y	Y
	MCA1B	0.37	282	104.3	N	N/A
	HP1	0.41	395	162	N	N/A
	HP2	0.36	335	120.6	N	N/A
	HP3	0.4	335	134	N	N/A
	HP4	2.03	683	1045	Y	Y
	MCP1A	5.15	125	642.8	Y	Y

* A basin is required if the sub-catchment area exceeds 2,500m^2 and the sub-catchment erosion hazard exceeds 200 t/yr. A bulk density of 1.3 has been conservatively adopted to convert 150m^3/year (the Blue Book threshold for a sediment basin to tonnes/year (to allow the use of the RUSLE, which gives an answer in tonnes/hectare/year).

4.3 Assessment

Table 4-2 below is the Preliminary Erosion and Sedimentation Assessment for this proposal as detailed in Attachment 1a and 1b of TfNSW Procedure PN 143P.

Table 4-2 – Preliminary Erosion and Sedimentation Assessment for this proposal.

Project name:	New Richmond Bridge, Stage 2	**Project location and size:**	Richmond, NSW Refer to Section 1.2 for details.
Estimated timing or duration of works:	Approximately 3 years for Stage 2A and a further 2 years (approx.) for Stage 2B.	**Description of works:**	Refer to Section 1.2.
Triggers		**Yes/No**	**Comments to support decision**
1. Does the complexity or size of the project result in it being inherently high risk as ongoing installation and maintenance of controls will require extensive coordinated resources?		Yes	The proposal lies partially on flood-prone lands, with mapped potential for acid sulfate soils and salinity. The proposal includes extensive construction and bridge works over and adjacent to the Hawkesbury River.
2. Assess the erosion hazard of each catchment area to be disturbed for the proposed project using Attachment 1b [see Figure 4-1]. Are any of the proposed construction areas defined as “High Erosion Hazard”?		Yes	Slopes along the banks of the Hawkesbury River exceed 10%, which is the threshold for High Erosion Hazard when the R-factor is 2500 (Table 3-4).
3. Are there known site constraints that limit the implementation of appropriate erosion and sedimentation control measures? For example (but not limited to), are sedimentation controls such as basins required in locations where land is not available?		Yes	Extensive ancillary facilities will be required on both sides of the river for bridge construction, necessitating significant disturbance in close proximity to the river. The steepness of the riverbanks will limit the feasibility to construct sediment basins in those locations.
4. Are there identified sensitive receiving environments that will receive stormwater discharge from the construction project? Examples of sensitive environments include: • Listed wetlands (SEPP 14) • State and National Parks • Littoral Rainforest (SEPP 26) • Drinking water catchments		Yes	The proposal would discharge to the Hawkesbury River. Parts of the proposal discharge into lagoons that are mapped as Coastal Wetlands or flow into areas mapped as Coastal Wetlands (Figure 3-6).

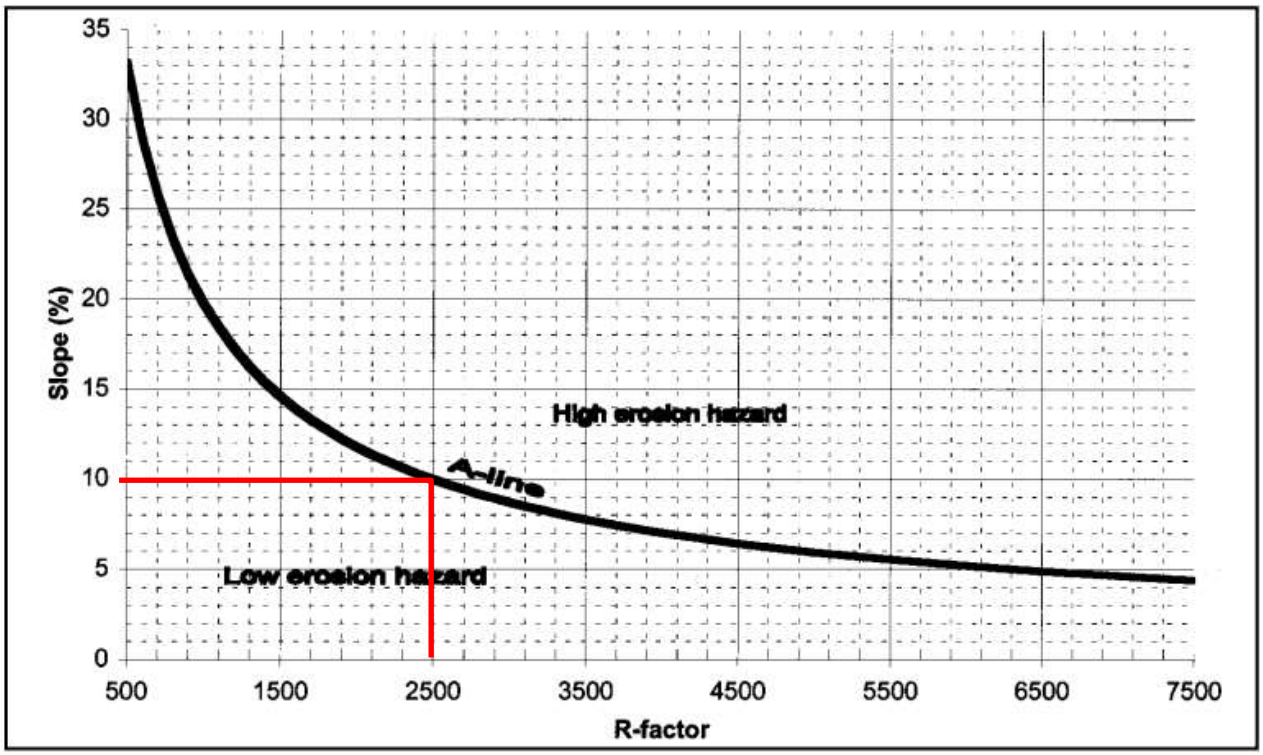

Figure 4-1 – Preliminary erosion hazard assessment for this proposal (from Attachment 1b of Transport Procedure PN 143P).

As identified above the proposal is High Risk due to the following factors:

- Steep topography either side of the Hawkesbury River.
- The complexity of the proposal and the prevailing environmental conditions, which result in it being inherently high risk as ongoing installation and maintenance of controls will require extensive coordinated resources. Challenges include:
  - topography (flood-prone lands),
  - the potential for acid sulfate soils,
  - the potential for salinity,
  - works over and adjacent to the Hawkesbury River.
- The proposal would discharge into the Hawkesbury River and into lagoons that are mapped as Coastal Wetlands, or into lagoons which flow into mapped Coastal Wetlands.

As such, this ESMR is required under TfNSW Procedure PN 143P.

5 MANAGEMENT MEASURES

5.1 Sediment Basins

5.1.1 Design Standards

Construction-phase sediment basins have been sized based on the following criteria (Landcom, 2004):

- Design rainfall depth: 29.5 mm (5-day, 85th percentile) for all areas;
- Basins designed for Type F/D (fine or dispersible) sediment;
- Volumetric runoff coefficient (Cv): 0.56 (Hydrologic Group D, assuming compacted clay soils) for all areas.

The size of the basin(s) will vary depending on sub-catchment size and conditions. Conceptual sizing of basins is included in the ESCP in Appendix A.

As much as possible construction stage sediment basins will be positioned within the permanent water quality control basins. Therefore, these permanent basins will need to be constructed as early works including the permanent outlet structures. However, the filtration devices within any bioretention basins should not be installed until the end of construction, once all surfaces within the relevant catchment areas are complete and stabilised/landscaped.

The initial assessment (detailed in Section 4.2) includes sediment basins in all sub-catchments where they are triggered. This is noted and discussed further in Section 5.3 (specifically in Table 5-1).

Outlet structures are to be provided from all sediment basins to spread out flows, encourage dissipation and minimise erosion. The permanent sediment basin spillways and dissipations structures (where applicable) should ideally be constructed early to help achieve this.

5.1.2 Fencing of Construction-Phase Basins

Given that the sediment basins shown on the ESCP in Appendix A all sit within the proposal area boundary, separate fencing is not likely to be necessary (because construction sites are not publicly accessible). However, the safety aspects of each sediment basin would need to be assessed on a case-by-case basis at the time of construction.

5.1.3 High-Efficiency Sediment Basins

High Efficiency Sediment Basins (HES basins) use automatic dosing of chemical coagulants or flocculants. In some cases, they also use an automatic discharge system. They provide a higher level of treatment than traditional Blue Book-style sediment basins, and can treat all runoff from a sub-catchment, even during prolonged or frequent rain events. Traditional

Blue Book-style sediment basins can only provide treatment for a nominated amount of rainfall within a catchment. Once they spill over, retention of sediment is limited.

HES basins are typically recommended in sub-catchments that are in close proximity to, or will discharge water to, a sensitive receiving environment. As noted in Section 3.9 and 4.3, the proposal discharges to lagoons that flow to mapped Coastal Wetlands, and also to the Hawkesbury River. As such, HES basins should be considered as part of planning for this proposal. This is noted and discussed further in Section 5.3.

5.2 Onsite and Offsite Water Separation

The proposal includes drainage to divert clean offsite water from upslope away from completed cut and fill batters. As much as is practicable, these drains would be installed early to aid efficient construction and minimise the risk of erosion. This is detailed on the ESCP in Appendix A. However, complex staging of the construction and earthworks would be required to allow for traffic flow because the proposal alignment overlies the existing road network for a significant part of its length.

As such, temporary drainage will be required in some locations to ensure that:

- Clean offsite water is bypassed through or around work areas and away from sediment control structures; and
- Dirty onsite water is diverted to sediment control structures such as sediment basins.

Conceptual locations for temporary drainage are detailed on the ESCP (Appendix A).

As much as possible, cross-formation culverts should be installed or extended early to assist with separating dirty onsite and clean offsite water during construction. In some locations temporary cross-drainage will be required to achieve adequate separation due to the prevailing topography and design of the road. Those locations are marked on the ESCP (Appendix A).

All temporary and permanent drainage devices implemented during construction will need to be stabilised and have suitable dissipation devices installed to minimise erosion as much as possible, spread out flows and encourage infiltration. Check dams may also be required within drains and any other concentrated flow areas to slow flows and minimise erosion.

In a number of locations the permanent drainage features sit close to the proposed formation, which will limit the ability to install or maintain erosion and sediment controls in those locations. These are noted in Section 5.3.

Recommendations and management measures for achieving onsite and offsite water separation are noted in Section 5.4 and on the ESCP in Appendix A.

5.3 Assessment of Feasibility of Erosion and Sediment Controls

In preparing the Concept ESCP (Appendix A), a review was conducted of the proposal design and site constraints to determine how they might impact on effective implementation of erosion and sediment control during construction.

Table 5-1 provides details of the principles of erosion and sediment control typically adopted on road proposals, along with an assessment of whether each can be effectively implemented on this proposal.

Where constraints to the effective implementation of typical erosion and sediment controls are identified in Table 5-1, details of proposed mitigation and/or management measures for each are contained in Table 5-2 and also on the Concept ESCP in Appendix A.

Table 5-1 – Assessment of typical erosion and sediment controls for the proposal

No	Erosion and sediment control principle	Typical requirements	Assessment of applicability to this proposal
1	Assess constraints and opportunities for erosion and sediment control during the planning/design phase.	Assess existing site conditions to determine how they might influence the selection, positioning, sizing, design and operation of erosion and sediment controls during construction.	This report includes an assessment of constraints and opportunities for erosion and sediment control. No further action required at this time.
2a	Plan early for erosion and sediment control.	On high risk sites, prepare concept plans for erosion and sediment control during the planning and design phase to determine feasibility for effective implementation during construction.	This report and the accompanying Concept ESCP (Appendix A) demonstrate early planning. No further action required at this time.
2b	Plan early for erosion and sediment control.	Prepare a Primary ESCP in accordance with DECC (2008) (Blue Book Volume 2D), accompanied by a series of Progressive ESCPs.	A Primary ESCP should be prepared prior to site disturbance, following the guidance in Blue Book Volume 2D (DECC, 2008). Given that works will require multiple stages, Progressive ESCPs should be prepared during construction showing the location of controls for each stage of work. This is noted in Table 5-2.
2c	Plan early for erosion and sediment control.	An up-to-date register of Progressive ESCPs should be maintained during construction.	Given that works will require multiple stages, it is recommended that a register of Progressive ESCPs be kept up to date. This is noted in Table 5-2.

No	Erosion and sediment control principle	Typical requirements	Assessment of applicability to this proposal
2d	Plan early for erosion and sediment control.	Erosion and sediment controls should be installed early in the construction process, generally as part of clearing and grubbing works.	There are significant topographic and traffic-staging limitations to the installation of erosion and sediment controls. As such, works will require multiple stages. Progressive ESCPs should be prepared during construction showing the location of controls for each stage of work. This is noted in Table 5-2.
3a	Minimise the extent and duration of disturbance.	Minimise the extent of disturbance in order to minimise biodiversity impacts and to minimise erosion.	As part of the process or preparing the Concept ESCP in Appendix A, clearing limits were reviewed to determine if erosion and sediment controls could be positioned within those boundaries. No additional clearing outside of the proposal boundaries is likely to be necessary to facilitate the installation of erosion and sediment controls.
3b	Minimise the extent and duration of disturbance.	Minimise the time and extent of disturbance in waterways, and schedule works for lower-risk periods as much as possible.	Typical controls for culvert construction can be employed, which include temporary diversion of offsite clean water around the construction zone. These are included in the Concept ESCP in Appendix A. No further assessment necessary.
3c	Minimise the extent and duration of disturbance.	Limit site access and haul roads to the minimum required for safe and efficient construction.	The existing road network can be used for access. No further assessment necessary.
4a	Manage soils, including conserving topsoil for later reuse in rehabilitation.	As much as possible, re-use site-won topsoil for rehabilitation purposes.	Topsoils are expected to be suitable for re-use for rehabilitation, although stockpile volumes could be significant. Ancillary facilities have been included in the proposal to allow for this. Weeds are common along the proposal route, and topsoils are expected to contain significant seedbank of weed species. This will necessitate weed management, and comments are included in Table 5-2.

No	Erosion and sediment control principle	Typical requirements	Assessment of applicability to this proposal
4b	Manage soils, including conserving topsoil for later reuse in rehabilitation.	Determine soil-related constraints that might impact on erosion and sediment control, water quality, or rehabilitation.	Subsoils are locally dispersive so should be managed using sediment basins. These have been included in the Concept ESCP in Appendix A. As identified in Section 3.5, salinity is a known constraint in localised areas of the proposal. This could impact on the stability of road pavements and infrastructure (e.g. footings), could impact on rehabilitation, and the construction of the proposal could cause or exacerbate salinity issues offsite. The road and landscaping design should take into account the potential for the project to be impacted by salinity or to exacerbate local salinity issues. Refer to Table 5-2 for details regarding management of potential salinity issues
5a	Control water flow on, through and off the site.	Control flows of water on, through and off the site. That includes separation of clean offsite water and dirty onsite water.	The management and separation of clean offsite water and dirty onsite water presents significant challenges due to limited space and construction staging to allow for traffic management. Temporary drainage will be required in numerous locations to divert offsite clean water away from construction areas or to direct onsite dirty water to sediment basins or other sediment traps. The current positioning of a number of permanent drainage structures will compromise the ability to install and maintain erosion and sediment controls during construction. Additionally, proposal boundary space constraints along MCA1 adjacent to the lagoons will limit the feasibility for effective controls for in-water works. Refer to Table 5-2 and to the Concept ESCP in Appendix A for locations and recommendations.

No	Erosion and sediment control principle	Typical requirements	Assessment of applicability to this proposal
5b	Control water flow on, through and off the site.	Stabilise concentrated flows using permanent and temporary ground covers, supplemented by the use of velocity controls such as check dams.	All temporary and permanent drainage devices implemented during construction will be stabilised and have suitable dissipation devices installed to minimise erosion as much as possible, spread out flows and encourage dissipation. Check dams will be installed as required within all concentrated flow areas. Refer to the Concept ESCP in Appendix A for recommendations. No further assessment necessary.
5c	Control water flow on, through and off the site.	Construct cross-alignment culverts early to allow for the passage of offsite clean water across the alignment. This aids with separation of offsite clean water and onsite dirty water.	Staging of the works to allow for traffic management restricts the ability to construct some cross-alignment culverts early. Cross-alignment clean water management will be challenging. Refer to Table 5-2 and to the ESCP in Appendix A for recommendations.
5d	Control water flow on, through and off the site.	Temporary waterway crossings are to be stable and must minimise impacts to the waterway.	Temporary waterway crossings would be constructed in accordance with Blue Book standard details. No further assessment is necessary.
5e	Control water flow on, through and off the site.	Discharges from the site are to be managed so as to minimise potential impacts to the receiving waters.	The typical Blue Book (Landcom, 2004) sediment basin discharge limit is 50mg/L. Given that discharges from the Proposal are into the Hawkesbury River (or its immediate tributaries) or lagoons mapped as Coastal Wetlands, such discharges would most likely exceed the turbidity objective for the local waterways. However, without proper assessment, this cannot be quantified. As such, an assessment of Construction Sediment Basin Discharge Impacts should be undertaken as part of the detailed design. This would determine the appropriate water quality criteria for sediment basin discharges. This is noted in Table 5-2.

No	Erosion and sediment control principle	Typical requirements	Assessment of applicability to this proposal
6a	Minimise erosion as much as possible.	Minimise erosion as much as possible, including the use of enhanced erosion controls on high risk sites.	Additional (enhanced) erosion controls (for example, providing temporary ground covers or soil binders on batters when rain is imminent) should be included in those areas of the proposal that discharge into the Hawkesbury River or the lagoons which connect to mapped Coastal Wetlands. The Concept ESCP in Appendix A shows this, and is also noted in Table 5-2.
6b	Minimise erosion as much as possible.	Stockpiles require stabilisation to minimise the risk of erosion.	There are no limitations to stockpiles being covered on this proposal. Standard Blue Book provisions can apply (i.e. covering stockpiles within 10 days of formation). No specific additional requirements and no further assessment necessary.
6c	Minimise erosion as much as possible.	Slope breaks should be included to reduce the erosion hazard on long, disturbed slopes prior to rainfall.	Most slopes are very gentle (less than 3% gradient). Areas steeper than this typically have short slopes of less than 80m. As such, slope breaks are unlikely to be necessary. No specific additional requirements and no further assessment necessary.
6d	Minimise erosion as much as possible.	Dust control should be undertaken to minimise dust impacts to the environment and to nearby receivers.	This is typically carried out using water carts. There are no significant constraints to typical dust suppression activities providing adequate water supplies are available. No specific additional requirements and no further assessment necessary.
7a	Maximise sediment retention onsite.	Provide sediment basins in all catchments where the erosion hazard warrants their use.	Sediment basins have been shown in all sub-catchments where they are triggered by the erosion hazard assessment (Section 4.2). Refer to the Concept ESCP in Appendix A for locations and details.
7b	Maximise sediment retention onsite.	Design and size sediment basins to achieve the desired water quality, based on the erosion hazard and sensitivity of the receiving waters.	Sediment basins have been shown in all sub-catchments where they are triggered by the erosion hazard assessment (Section 4.2). Refer to the Concept ESCP in Appendix A for locations and details. As noted in Section 5.1.3, HES basins should be considered in those sub-catchments in close proximity to the Hawkesbury River and to the lagoons. This is noted in Table 5-2 .

No	Erosion and sediment control principle	Typical requirements	Assessment of applicability to this proposal
7c	Maximise sediment retention onsite.	Sediment basin and sediment trap spillways should flow onto stable ground and/or existing drainage systems (natural or man-made). Dissipation structures must be installed in a manner to spread out and dissipate flows and minimise erosion.	Construction-phase sediment basins will utilise the positioning of the permanent water quality basins where possible. Where sediment basins and sediment traps are not in the position of permanent water quality basins, temporary construction phase sediment basins will be required. They will require temporary spillways that extend to stable ground and into existing drainage systems (natural or man-made). No specific additional requirements and no further assessment necessary.
7d	Maximise sediment retention onsite.	Minimise the risk of sediment tracking onto surrounding roads.	There are no significant constraints to the use of typical controls on this proposal to minimise sediment tracking. No specific additional requirements and no further assessment necessary.
7e	Maximise sediment retention onsite.	Position sediment basins and major sediment controls to avoid intercepting groundwater or being impacted by flooding or acid sulfate soils.	Sediment controls have been positioned to avoid intercepting groundwater, to be above the 39.35% AEP flood level, and to be in areas mapped as having no or low probability for acid sulfate soils. However, an intrusive assessment (including laboratory testing) should be undertaken prior to any ground disturbance in acid sulfate soils risk areas. This is noted in Table 5-2.
7f	Maximise sediment retention onsite.	Direct as much onsite dirty water to sediment controls as possible.	This is achievable in all locations except in the immediate flood zone adjacent to the Hawkesbury River. In that area, options for sediment control are extremely limited due to space and topography. As such, the proposal will need to adopt a focus on additional erosion controls instead in that area. Enhanced levels of erosion control rely primarily on the use of temporary ground covers over exposed areas whenever rain is imminent. Refer to the Concept ESCP in Appendix A and Table 5-2 for details.

No	Erosion and sediment control principle	Typical requirements	Assessment of applicability to this proposal
8a	Rehabilitate disturbed lands progressively, ensuring rehabilitation is effective to reduce the erosion hazard.	At the conclusion of works in any area, rehabilitation should occur efficiently to rapidly reduce the erosion hazard. Revegetation will rely on suitable growing media, species selection and ongoing maintenance.	Topsoils generally have adequate fertility and structure for reuse as part of site rehabilitation. However, weeds are common along the proposal route, and topsoils are expected to contain significant seedbank of weed species. This will necessitate weed management. Recommendations are included in Table 5-2.
8b	Rehabilitate disturbed lands progressively, ensuring rehabilitation is effective to reduce the erosion hazard.	Avoid creating steep batters that are difficult to revegetate, especially those with a north or westerly aspect.	Batters steeper than 3:1 limit the potential for certain revegetation techniques, especially on north- and west-facing batters where evapotranspiration rates are higher. Landscape design must be considerate of batter gradients and aspect. Refer to Table 5-2 for recommendations regarding batter revegetation and batter gradients.
8c	Rehabilitate disturbed lands progressively, ensuring rehabilitation is effective to reduce the erosion hazard.	Undertake maintenance of revegetation areas to promote growth and control weeds.	Weeds are common around the proposal area. As such, weed management is expected to be challenging during and after construction. This is noted in Table 5-2.
9	Conduct regular inspections of the site to identify potential problems and allow for rectification or repair.	Undertake regular inspections of erosion and sediment controls.	The requirement for documented inspections is typically included in Transport QA G36 and G38 specifications. No specific additional requirements for this proposal.
10	Maintain all erosion and sediment controls, including cleaning out sediment traps, until the upslope catchments are effectively rehabilitated.	Undertake maintenance of erosion and sediment controls including cleaning out (de-silting) and repairing controls as required.	The requirement to maintain and/or clean out erosion and sediment controls until the upslope catchments are rehabilitated is typically included in Transport QA G36 and G38 specifications. No specific additional requirements for this proposal.

5.4 Proposal-Specific Management Measures

Table 5-2 contains a summary of those locations and aspects that are considered high-risk or that are outside of typical best-practice for a road construction proposal such as this, as identified in Table 5-1.

These recommendations should be read in conjunction with the Concept ESCP in Appendix A.

Table 5-2 - Summary of proposal-specific recommendations

No	Location	Reason for adoption as a high-risk area/aspect	Reference from Table 5-1	Recommendation(s)
1	Whole proposal	Primary and progressive planning of erosion and sediment control measures will be required due to the staged nature of the works.	2b and 2d	Ensure that project specifications include a requirement for the contractor to prepare a Primary ESCP prior to site disturbance, plus Progressive ESCPs prior to commencement of any ground-disturbing works.
2	Whole proposal	Progressive planning of erosion and sediment control measures will be required due to the staged nature of the works.	2c	Ensure that project specifications include a requirement for the contractor to keep an up to date register of Progressive ESCPs onsite.
3	Whole proposal	Weeds are common across parts of the proposal alignment and on adjacent lands. As such, weed management is expected to be challenging during and after construction.	4a, 8a and 8c	It is recommended that project specifications include a requirement not to reuse topsoils in areas presently infested with weeds unless the weeds can be adequately controlled prior to the soils being reused on completed areas. A weed management plan should be included as part of the project specifications.
4	MCA1 chainage 3150 to 3550 And MCN1 chainage 3700 to 3900	These areas have been mapped as having a high risk of salinity. Compacted subgrades across high-risk salinity areas could exacerbate capillary draw on groundwater, bringing saline groundwater towards the surface. This could affect road pavements and road infrastructure. This could also impact on vegetation, especially on the upslope side of the project alignment.	4b	In the high-risk salinity areas, the following is recommended: • Planting of deep-rooted vegetation either side of the alignment to help draw down groundwater tables. • The use of drainage blankets in the road sub-base layer to help intercept elevated water tables. • Design and construct concrete structures for aggressive soils. • Include diversion and drainage structures to divert surface water away from road assets; and • Planting of salt-tolerant vegetation species through this area. This should be considered in the revegetation and landscaping plans.

No	Location	Reason for adoption as a high-risk area/aspect	Reference from Table 5-1	Recommendation(s)
5	Numerous locations: refer to the Concept ESCP in Appendix A	Temporary drainage will be required to divert offsite clean water away from work areas.	5a	Early installation of culverts. Provision of temporary drainage structures including temporary fabric flumes. Refer to the Concept ESCP in Appendix A for locations.
6	MCA1: Chainage 2780 to 2820 And Chainage 3280 to 3380 And Chainage 3450 to 3560 (approximately)	Works to extend batters and culverts into the lagoons will require establishing a coffer dam or sheet piling to allow the work area to be de-watered. A floating silt curtain will also be required. Proposal boundaries provide limited space to permit the installation of sediment controls (i.e. coffer dam or sheet piling) within the boundary.	5a	The proposal boundary on the westbound side severely restricts the feasibility of installing sediment controls along the edge of the work area. A very high focus on pre-rainfall enhanced erosion controls are proposed over all exposed surfaces in these areas.
7	MCA1: Chainage 1775 to 2200 (both sides of the alignment)	The permanent drainage sits close to the toe of the proposed fill batters. This will limit the feasibility to install and maintain erosion and sediment controls in between those drains and the earthworks during construction.	5a	Reposition the permanent drainage through this area to be closer to the proposal boundaries, providing at least 3m width in between the permanent drain and the toe of the batter. This should be considered as the Concept design progresses to 100% and beyond.
8	MCA1: Chainage 1800 to 2740 (westbound side of the alignment)	The permanent drainage sits close to the toe of the proposed fill batters. This will limit the feasibility to install and maintain erosion and sediment controls in between those drains and the earthworks during construction.	5a	Reposition the permanent drainage through this area to be closer to the proposal boundaries, providing at least 3m width in between the permanent drain and the toe of the batter. This should be considered as the Concept design progresses to 100% and beyond.

No	Location	Reason for adoption as a high-risk area/aspect	Reference from Table 5-1	Recommendation(s)
9	MCN1: Chainage 2350 to 3100 (both sides of the alignment)	The permanent drainage sits close to the toe of the proposed fill batters. This will limit the feasibility to install and maintain erosion and sediment controls in between those drains and the earthworks during construction.	5a	Reposition the permanent drainage through this area to be closer to the proposal boundaries, providing at least 3m width in between the permanent drain and the toe of the batter. This should be considered as the Concept design progresses to 100% and beyond.
11	MCN1: Chainage 3200 to 3750 (westbound side of the alignment)	The permanent drainage sits close to the toe of the proposed fill batters. This will limit the feasibility to install and maintain erosion and sediment controls in between those drains and the earthworks during construction.	5a	Reposition the permanent drainage through this area to be closer to the proposal boundaries, providing at least 3m width in between the permanent drain and the toe of the batter. This should be considered as the Concept design progresses to 100% and beyond.
12	MCN1: Chainage 3200 to 4110 (eastbound side of the alignment)	The permanent drainage sits close to the proposed alignment. This will limit the feasibility to install and maintain erosion and sediment controls in between those drains and the earthworks during construction.	5a	Reposition the permanent drainage through this area to be closer to the proposal boundaries, providing at least 3m width in between the permanent drain and the toe of the batter. This should be considered as the Concept design progresses to 100% and beyond.
13	MCN1: Chainage 3900 to 4150 (westbound side of the alignment)	The permanent drainage sits close to the proposed alignment. This will limit the feasibility to install and maintain erosion and sediment controls in between those drains and the earthworks during construction.	5a	Reposition the permanent drainage through this area to be closer to the proposal boundaries, providing at least 3m width in between the permanent drain and the toe of the batter. This should be considered as the Concept design progresses to 100% and beyond.
14	Numerous locations	Culvert construction might need to be staged to allow for traffic switches.	5c	Ensure that project specifications include a requirement for the contractor to prepare Progressive ESCPs for culvert works, detailing how clean offsite water and dirty onsite water will be managed and separated for each stage.

No	Location	Reason for adoption as a high-risk area/aspect	Reference from Table 5-1	Recommendation(s)
15	Whole proposal	Typical Blue Book (Landcom, 2004) discharges of 50mg/L from sediment basins might not meet the WQOs for the local waterways.	5e	An assessment of Construction Sediment Basin Discharge Impacts should be undertaken as part of the detailed design. This would determine the appropriate water quality criteria for sediment basin discharges. This should be included in PS311 for the detailed design of the proposal.
16	Immediate banks either side of the Hawkesbury River	Enhanced erosion controls (for example, providing temporary ground covers or soil binders on batters and landslips) should be provided in exposed areas adjacent to the Hawkesbury River or Coastal Wetlands where runoff won't report to sediment basins.	6a, 7f	Refer to the Concept ESCP in Appendix A for locations. Enhanced erosion controls are proposed over all exposed areas prior to forecast rainfall in those areas adjacent to the Hawkesbury River or the Coastal Wetlands that don't report to a sediment basin.
17	Sediment basins close to the Hawkesbury River and to mapped Coastal Wetlands	HES basins potentially provide an enhanced level of environmental protection compared to traditional Blue Book style sediment basins. This is relevant for areas in close proximity to sensitive receiving waters.	7b	HES basins should be considered in those sub-catchments in close proximity to the Hawkesbury River and to the lagoons. A requirement to determine the feasibility for HES basins should be included in PS311 for the detailed design of this proposal.
18	Sediment basins 1500E, 1700E, 2900E	These sediment basins sit in areas mapped as Low Probability for acid sulfate soils.	7e	An intrusive assessment (including laboratory testing) should be undertaken prior to any ground disturbance in acid sulfate soils risk areas.
19	Whole proposal	Batters steeper than 3:1 limits the potential for certain revegetation techniques, especially on north- and west-facing batters where evapotranspiration rates are higher.	8b	Landscape design must be considerate of batter gradients and aspect. Recommend the landscape design make reference to the Roads and Maritime (2015) "Guideline for Batter Surface Stabilisation using vegetation". This should be considered as the Concept design progresses to 100% and beyond.

6 CONCLUSIONS

Transport for NSW (Transport) proposes to upgrade Bells Line of Road / Kurrajong Road between Crooked Lane, North Richmond and Old Kurrajong Road, Richmond and construct a new bypass south of Richmond town centre. This is known as New Richmond Bridge and traffic improvements – Stage 2 (the proposal).

The purpose of this ESMR is to describe the existing environment with respect to construction-phase erosion and sediment control, document the potential impacts of the proposal on soil and water during the construction phase, and to detail measures to avoid, mitigate or manage the identified impacts.

- Section 1 provides a description of the proposal and explains the intent of this report.
- Section 2 describes the methods used to undertake the assessment.
- Section 3 identifies site conditions and identifies any potential constraints to construction-phase erosion and sediment control.
- Section 4 identifies design considerations for erosion and sediment control measures.
- Section 5 assesses the feasibility for establishing typical erosion and sediment control structures such as sediment basins, with a series of recommendations to manage or mitigate potential impacts relating to construction-phase erosion and sediment control.

Section 5 is accompanied by a Concept ESCP in Appendix A showing the recommended setup of key erosion and sediment control measures.

In preparing the ESCP in Appendix A, a review was conducted of the site conditions to determine how these might impact on effective implementation of erosion and sediment control during construction. The proposal is inherently high risk (for erosion and sediment control) due to:

- Steep topography either side of the Hawkesbury River.
- The complexity of the proposal and the prevailing environmental conditions, which present challenges for installation and maintenance of controls, necessitating coordinated resources. Challenges include:
    - topography (flood-prone lands),
    - the potential for acid sulfate soils,
    - the potential for salinity,
    - works over and adjacent to the Hawkesbury River.
- The potential for discharges into the Hawkesbury River, into areas mapped as Coastal Wetlands, and into lagoons that flow into mapped Coastal Wetlands.

The review in Table 5-1 identifies where key constraints limit the potential for effective implementation of erosion and sediment control.

Table 5-2 in Section 5 details a series of erosion and sediment control recommendations to address the inherent constraints identified in Table 5-1.

It is recommended that any future design of this proposal be considerate of the recommendations in Table 5-2.

7 REFERENCES

DECC (2008). *Managing Urban Stormwater: Soils and Construction. Volume 2D: Main Road Construction*. Department of Environment and Climate Change, Sydney.

Landcom (2004). *Managing Urban Stormwater: Soils and Construction.* Volume 1. NSW Government, Sydney.

NSW Government eSpade web portal (2023). www.espade.environment.nsw.gov.au

Transport for NSW (TfNSW) (2022). New Richmond Bridge Revised Preferred Option Report. October 2022. NSW Government.

WMA Water (2022). Richmond Bridge Duplication and Traffic Improvements – Flood Assessment. Final Report, July 2022.

8 APPENDICES

8.1 Appendix A: Concept Erosion and Sediment Control Plan (ESCP)

See overpage.

ALIGNMENT	CATCHMENT AND BASIN ID	Catchment area total (ha)	Catchment area disturbed (ha)	LS-factor*	Soil loss (t/ha/yr)	Catchment soil loss (t/yr)	Is a basin required?** Y/N	Is a sediment basin feasible? (Y/N) Refer to Plan for details	Sediment basin storage (soil) volume (m^3)	Sediment basin settling (water) volume (m^3)	Total sediment basin volume (m^3)	Comments or recommendations
MCA1	150W	0.23	0.23	1.29	247	56.9	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	200W	0.1	0.1	1.74	334	33.4	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	450E	0.17	0.17	1.13	216	36.8	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	575E	0.15	0.15	1.13	216	32.4	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	600E	0.11	0.11	0.11	22	2.4	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	700E	1.07	0.5	0.53	101	50.5	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	700W	0.81	0.56	0.53	101	56.5	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	900E	0.09	0.09	0.11	22	1.9	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	1450W	0.18	0.18	1.31	251	45.2	N	-	-	-	-	
	1500E	5.83	4.73	2.81	538	2545.6	Y	Y	326	963	1289	Note some works in this catchment will likelybe staged to maintain live traffic.
	1700E	1.14	1.14	2.81	538	613.5	Y	Y	79	188	267	
	1750W	0.79	0.79	0.10	20	15.6	N	-	-	-	-	Utilise permanent basin as construction-phase sediment trap.
	1950W	0.15	0.15	3.05	585	87.7	N	-	-	-	-	
	2170E	2.49	2.49	1.54	295	733.8	Y	Y	94	411	505	Note works in this catchment will likelybe staged to maintain live traffic.
	2170W	0.72	0.72	1.74	334	240.4	Y	Y	31	119	150	Note works in this catchment will likelybe staged to maintain live traffic.
	2200E	0.14	0.14	2.18	419	58.6	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	2210E	0.13	0.13	2.18	419	54.4	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	2250E	0.16	0.16	1.88	361	57.7	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	2260E	0.06	0.06	0.57	110	6.6	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	2350E	0.69	0.69	1.88	361	249.0	Y	Y	32	114	146	Note works in this catchment will likelybe staged to maintain live traffic.
	2550E	0.75	0.75	0.34	65	48.5	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	2600E	0.17	0.17	0.34	65	11.0	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	2600W	1.24	1.24	0.64	122	151.2	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	2610W	0.27	0.27	0.34	65	17.5	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	2800W	0.36	0.36	0.19	37	13.3	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	3150W	0.54	0.54	0.19	37	20.0	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	3250W	0.5	0.5	0.19	37	18.5	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	3350W	0.19	0.19	0.19	37	7.0	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	3525W	0.41	0.41	0.53	101	41.4	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	3750E	0.18	0.18	0.53	101	18.2	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
MCP1	2900E	3.11	3.11	1.88	361	1122.7	Y	Y	144	514	658	
	2900W	0.51	0.51	2.18	419	213.7	Y	Y	27	84	111	
	2950E	0.18	0.18	2.18	419	75.4	N	-	-	-	-	
	2975E	0.13	0.13	2.77	419	54.5	N	-	-	-	-	
	2975W	0.28	0.28	2.18	419	117.3	N	-	-	-	-	
	3000W	0.12	0.12	2.77	531	63.7	N	-	-	-	-	
	3075E	0.24	0.24	2.77	531	127.4	N	-	-	-	-	
	3150W	1.53	1.53	0.53	101	154.5	N	-	-	-	-	
	3200E	0.33	0.33	2.18	419	138.1	N	-	-	-	-	
	3225W	0.19	0.19	2.77	531	100.8	N	-	-	-	-	
	3700E	1.16	1.16	2.18	419	485.6	Y	Y	62	192	254	A swale or linear basin within the permanent catch drain is to to be uitlised in this catchments.
	3700W	1.44	1.44	2.18	419	603.4	Y	Y	77	238	315	A swale or linear basin within the permanent catch drain is to to be uitlised in this catchments.
	3750E	1.04	1.04	0.65	125	130.0	N	-	-	-	-	
	3750W	1.69	1.69	1.19	228	385.3	Y	Y	49	279	328	
	3900W	0.65	0.65	0.65	125	81.1	N	-	-	-	-	
	4000W	0.4	0.4	0.65	125	50.0	N	-	-	-	-	
	4400E	0.32	0.32	0.91	175	56.0	N	-	-	-	-	
	4410E	0.1	0.1	1.88	361	36.1	N	-	-	-	-	
	4450E	0.67	0.67	0.91	175	117.3	N	-	-	-	-	
	4450W	0.54	0.54	0.65	125	67.4	N	-	-	-	-	
	4550E	0.23	0.23	1.88	361	83.0	N	-	-	-	-	
	4800E	0.3	0.3	1.88	361	108.3	N	-	-	-	-	
	4850E	0.22	0.22	1.19	228	50.1	N	-	-	-	-	
	4850W	0.33	0.33	0.65	125	41.2	N	-	-	-	-	
	4875E	0.24	0.24	1.19	228	54.6	N	-	-	-	-	
	4875W	0.65	0.65	0.65	125	81.1	N	-	-	-	-	
	5050E	0.78	0.78	0.65	125	97.4	N	-	-	-	-	
	5500E	0.65	0.65	0.41	78	50.8	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	5550E	0.29	0.29	0.41	78	22.6	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	5550W	1.14	1.14	0.41	78	89.0	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	5600E	0.12	0.12	0.41	78	9.4	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	5600W	0.12	0.12	0.41	78	9.4	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
MCW1	475S	0.72	0.72	0.19	37	26.6	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
	525N	0.3	0.3	0.19	37	11.1	N	-	-	-	-	Note works in this catchment will likelybe staged to maintain live traffic.
Ancillary Facilities	MCA1A	1.96	1.96	1.47	282	552.4	Y	Y	71	324	395	
	MCA1B	0.37	0.37	1.47	282	104.3	N	-	-	-	-	
	HP1	0.41	0.41	2.06	395	162.0	N	-	-	-	-	
	HP2	0.36	0.36	1.75	335	120.6	N	-	-	-	-	
	HP3	0.4	0.4	1.75	335	134.0	N	-	-	-	-	
	HP4	2.03	1.53	3.56	683	1045.0	Y	Y	134	335	469	
	MCP1A	5.15	5.15	0.65	125	642.8	Y	Y	82	851	933	

*A composite LS-factor has been adopted, which has been determined based on variable catchment slope gradients and slope lengths.
R factor is 2500 for all basins
K factor is 0.059 for all basins
P factor is 1.3 for all basins
C factor is 1.0 for all basins
Cv is 0.56 for all basins
x-day, y-percentile rainfall event is 29.5mm for all basins
The sediment storage zone has been designed for 2 months for all basins.
** A sediment basin is required to comply with Blue Book (Landcom, 2004) standards if the catchment soil loss exceeds 200 t/yr.

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NEW RICHMOND BRIDGE – STAGE 2
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CONCEPT EROSION AND SEDIMENT CONTROL – CATCHMENT & BASIN ANALYSIS TABLE – SHEET 1 OF 38

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- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
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- Ø525 — PROPOSED STORMWATER DRAINAGE (PROVIDED BY AURECON)
- BASIN PB 1800W — PROPOSED PERMANENT BASIN (PROVIDED BY AURECON)

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0 5 10 15 20 25m
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NEW RICHMOND BRIDGE – STAGE 2
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CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 2 OF 38

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UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

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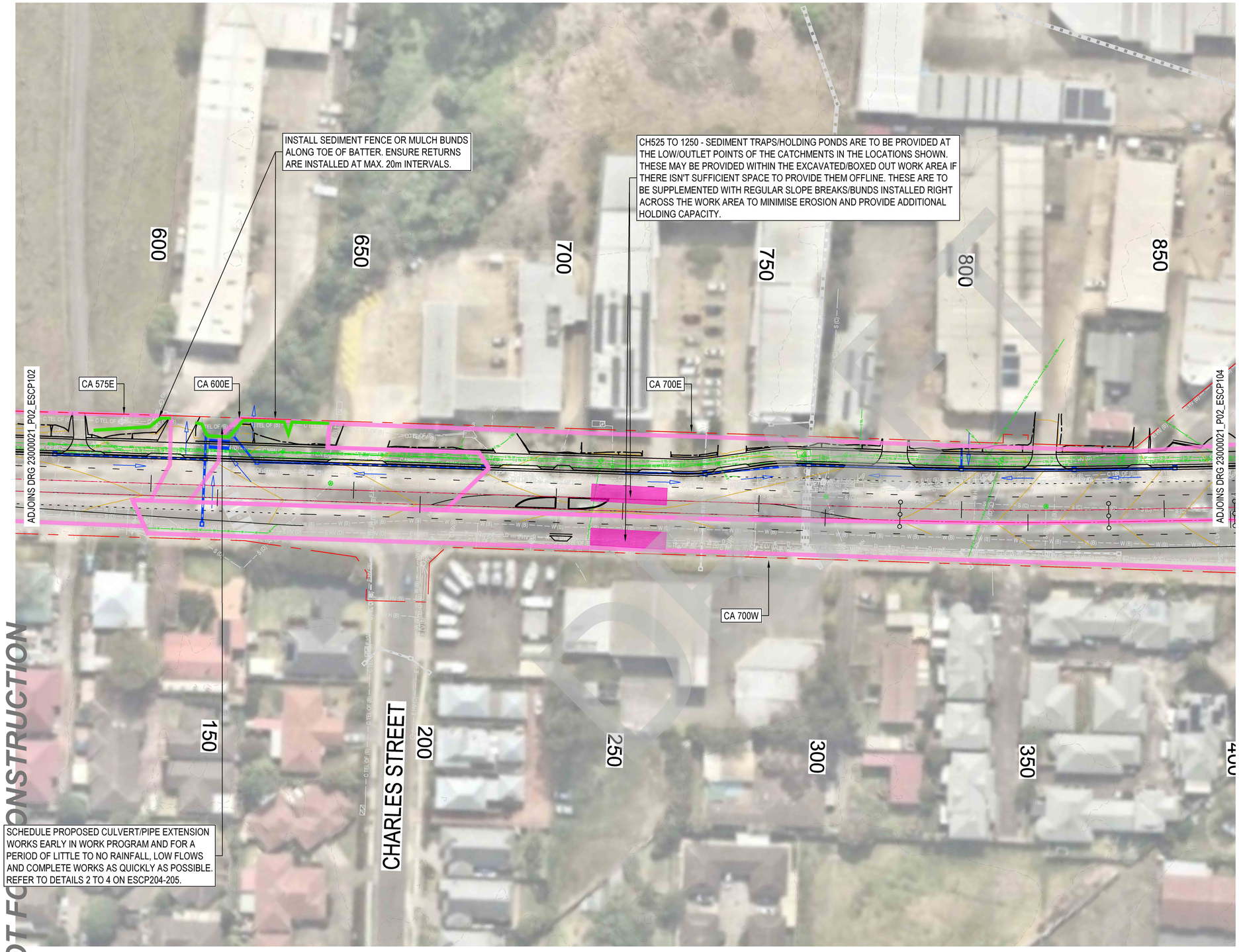

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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS	
DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500
CONCEPT	

North

CLIENT: aurecon

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PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL PLAN SHEET 4 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP103	C

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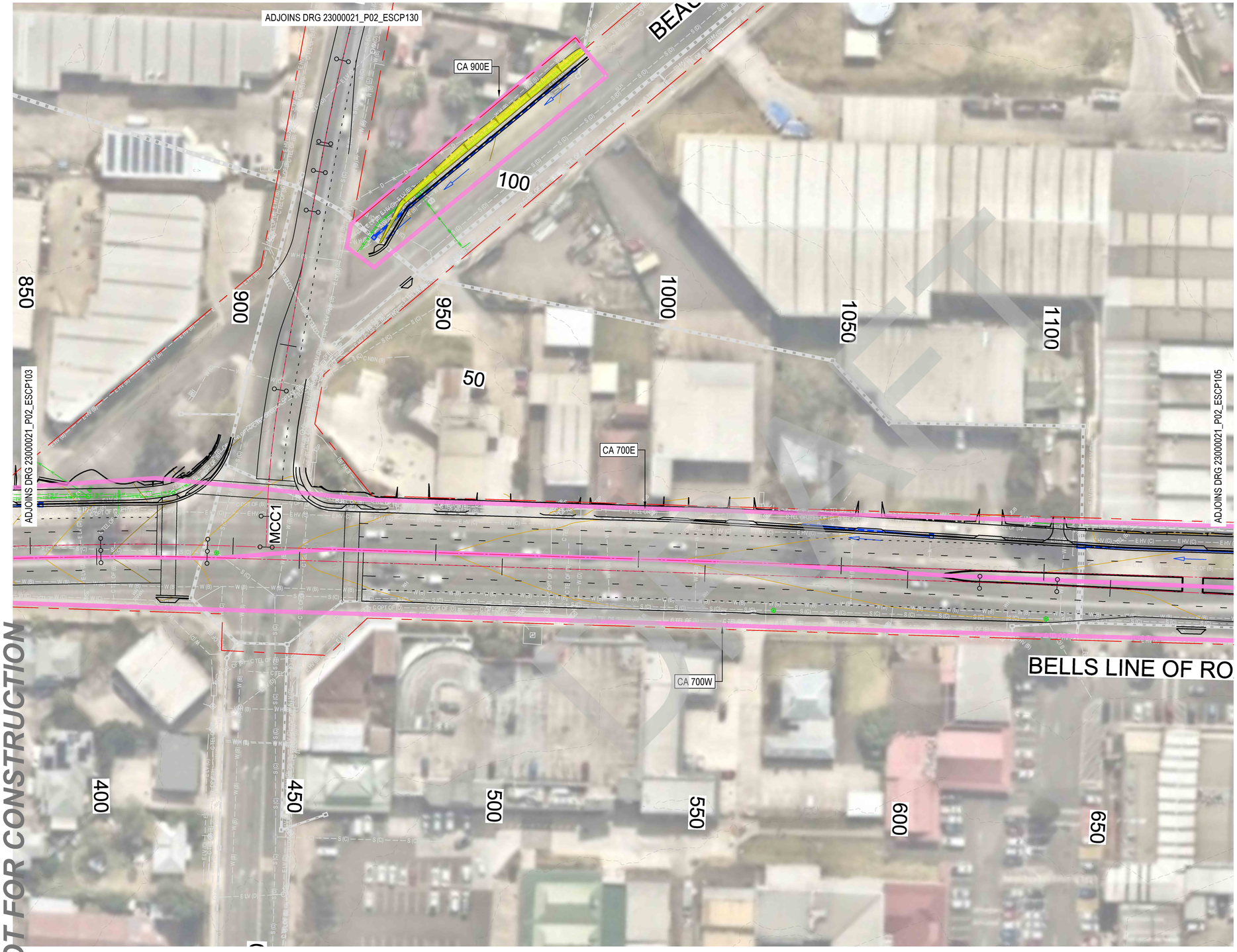

UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
- OFFSITE (CLEAN) WATER DIVERSION [2]
- ONSITE (DIRTY) WATER DIVERSION [2]
- SB8760W — SEDIMENT BASIN [1] (BLUE BOOK SD 6-4 ON ESCP201)
- SEDIMENT TRAP [2] (e.g. EXCAVATED SEDIMENT SUMP/TRAP, ROCK FILTER DAM, MULCH FILTER BUND, U-SHAPED SEDIMENT FENCE, HOLDING POND OR SIMILAR)
- TEMPORARY DIVERSION ACROSS WORKS AND/OR AROUND CULVERT WORKS [2]
- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CA 200W — CATCHMENT AREA
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- 100m BUFFER TO SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- Ø525 — PROPOSED STORMWATER DRAINAGE (PROVIDED BY AURECON)
- BASIN PB 1800W — PROPOSED PERMANENT BASIN (PROVIDED BY AURECON)

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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

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A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

North

CLIENT: aurecon

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PROJECT TITLE
NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE
CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 5 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP104	C

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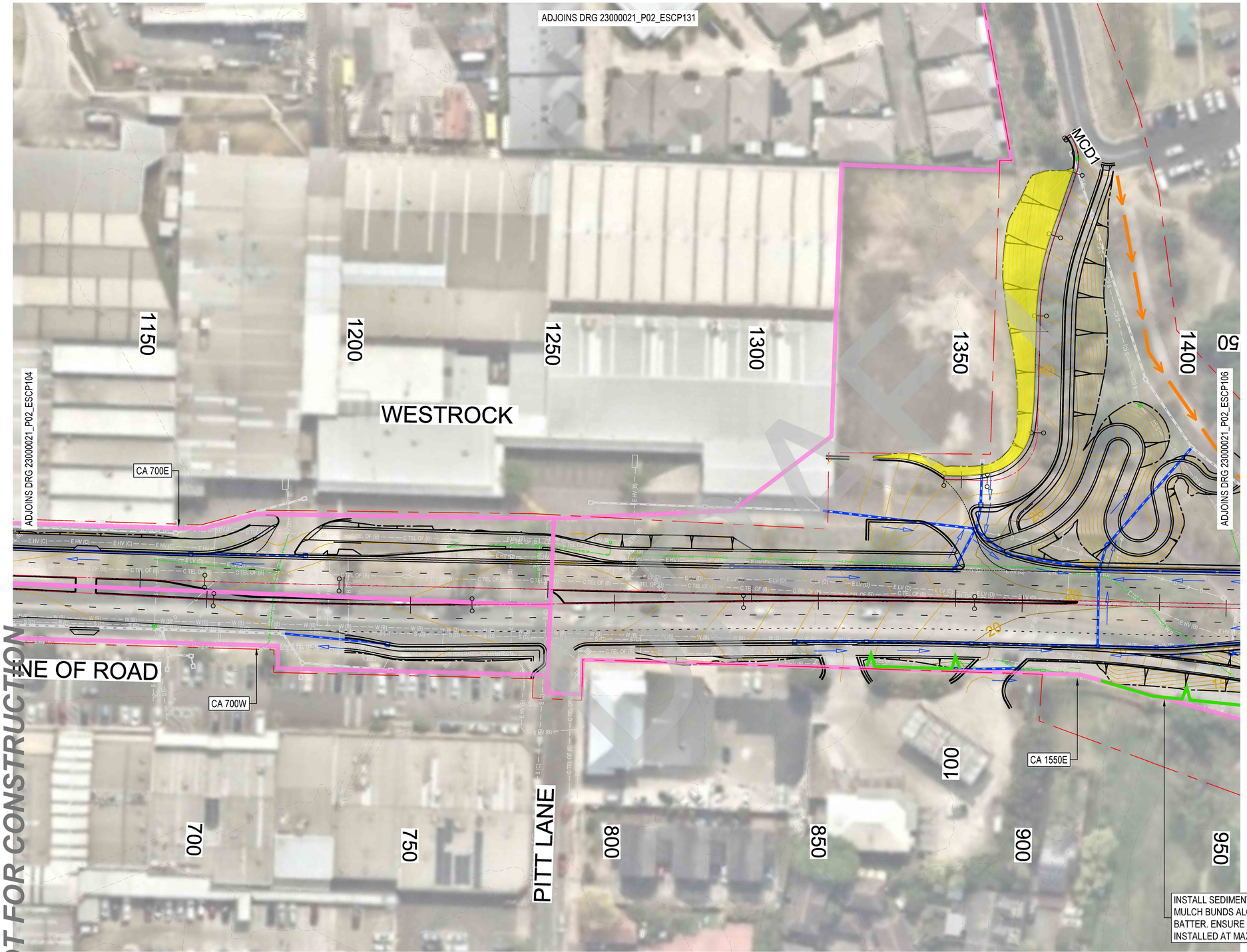

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
- OFFSITE (CLEAN) WATER DIVERSION [2]
- ONSITE (DIRTY) WATER DIVERSION [2]
- SB8760W — SEDIMENT BASIN [1] (BLUE BOOK SD 6-4 ON ESCP201)
- SEDIMENT TRAP [2] (e.g. EXCAVATED SEDIMENT SUMP/TRAP, ROCK FILTER DAM, MULCH FILTER BUND, U-SHAPED SEDIMENT FENCE, HOLDING POND OR SIMILAR)
- TEMPORARY DIVERSION ACROSS WORKS AND/OR AROUND CULVERT WORKS [2]
- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CA 200W — CATCHMENT AREA
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- 100m BUFFER TO SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- Ø525 — PROPOSED STORMWATER DRAINAGE (PROVIDED BY AURECON)
- BASIN PB 1800W — PROPOSED PERMANENT BASIN (PROVIDED BY AURECON)

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UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

NOT FOR CONSTRUCTION

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

North

CLIENT: aurecon

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PROJECT TITLE
NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE
CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 6 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP105	C

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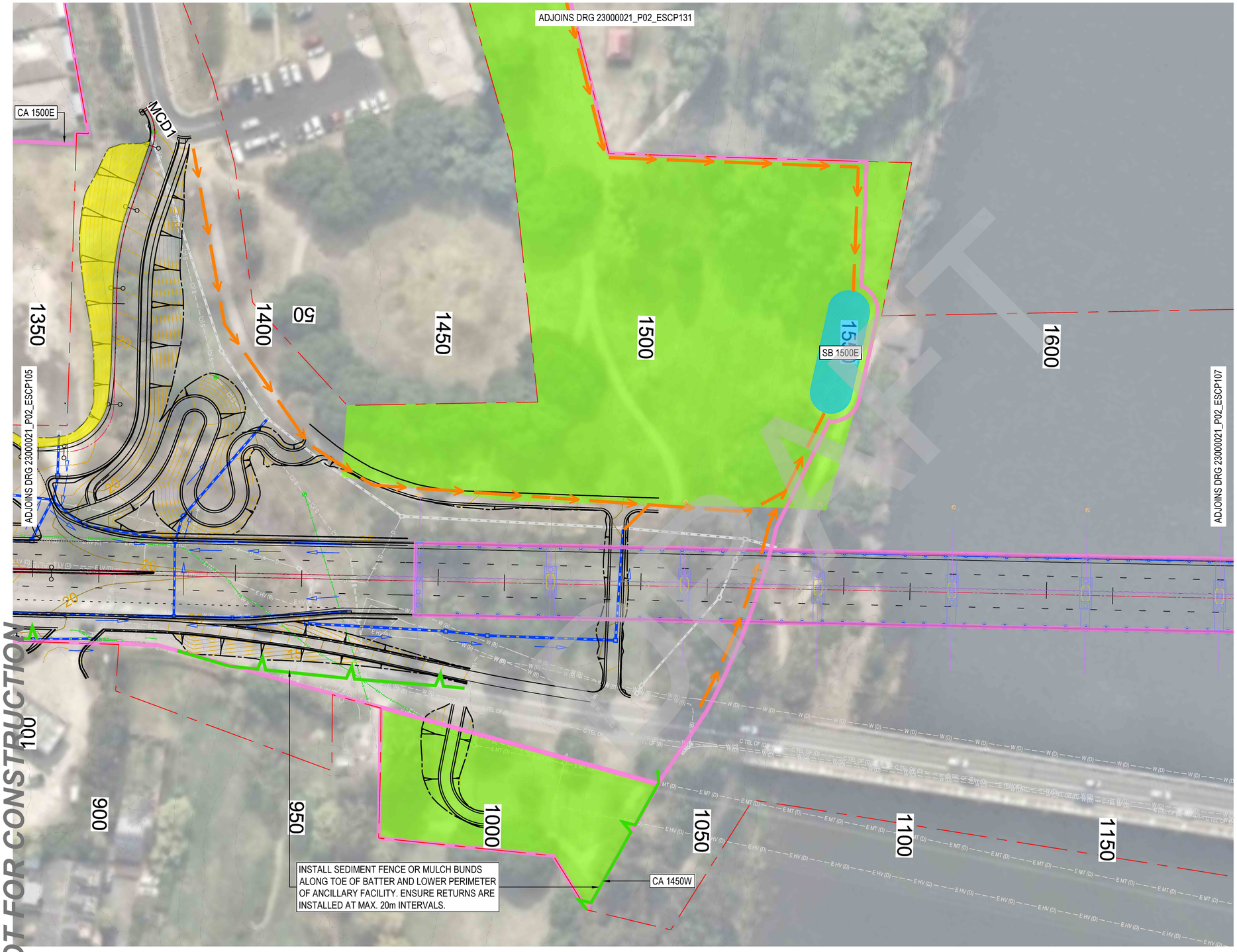
Plot Date: Monday, 2 September 2024 3:24:27 PM CAD File Name: L:\23000021 New Richmond Bridge Stage 2\Drawings\23000021_P02_ESCP_REV C.dwg



NOT FOR CONSTRUCTION

UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
- OFFSITE (CLEAN) WATER DIVERSION [2]
- ONSITE (DIRTY) WATER DIVERSION [2]
- SEDIMENT BASIN [1] (BLUE BOOK SD 6-4 ON ESCP201) — SB8760W
- SEDIMENT TRAP [2] (e.g. EXCAVATED SEDIMENT SUMP/TRAP, ROCK FILTER DAM, MULCH FILTER BUND, U-SHAPED SEDIMENT FENCE, HOLDING POND OR SIMILAR)
- TEMPORARY DIVERSION ACROSS WORKS AND/OR AROUND CULVERT WORKS [2]
- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CATCHMENT AREA — CA 200W
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- 100m BUFFER TO SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- PROPOSED STORMWATER DRAINAGE (PROVIDED BY AURECON) — Ø525
- PROPOSED PERMANENT BASIN (PROVIDED BY AURECON) — BASIN PB 1800W

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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

North

CLIENT: aurecon

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PROJECT TITLE
NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE
CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 7 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP106	C

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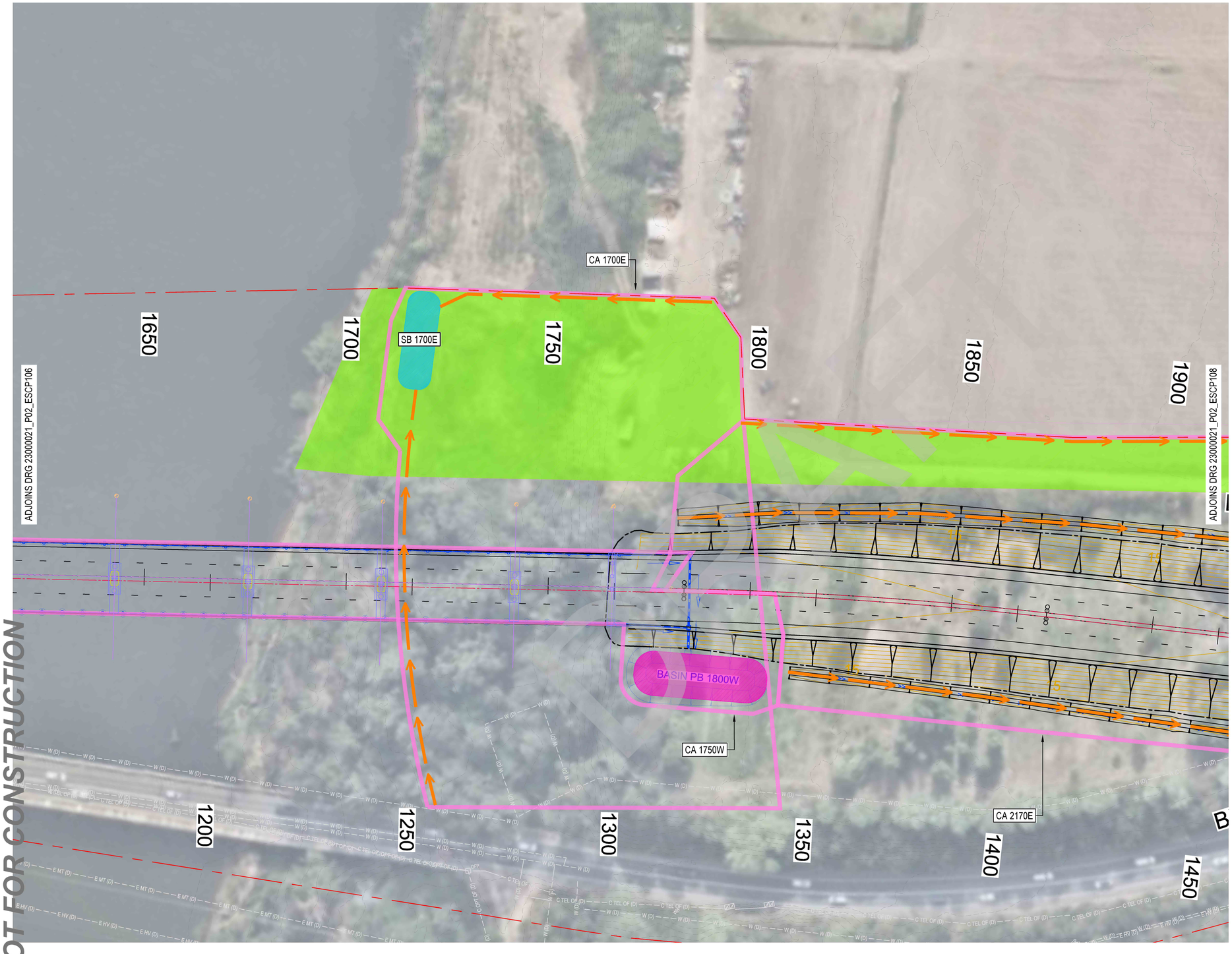
Plot Date: Monday, 2 September 2024 3:25:35 PM CAD File Name: L:\23000021 New Richmond Bridge Stage 2\Drawings\23000021_P02_ESCP_REV C.dwg



UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
- OFFSITE (CLEAN) WATER DIVERSION [2]
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- TEMPORARY DIVERSION ACROSS WORKS AND/OR AROUND CULVERT WORKS [2]
- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CA 200W — CATCHMENT AREA
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- 100m BUFFER TO SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- Ø525 — PROPOSED STORMWATER DRAINAGE (PROVIDED BY AURECON)
- BASIN PB 1800W — PROPOSED PERMANENT BASIN (PROVIDED BY AURECON)

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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
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A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

North

CLIENT: aurecon

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PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL PLAN SHEET 8 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP107	C

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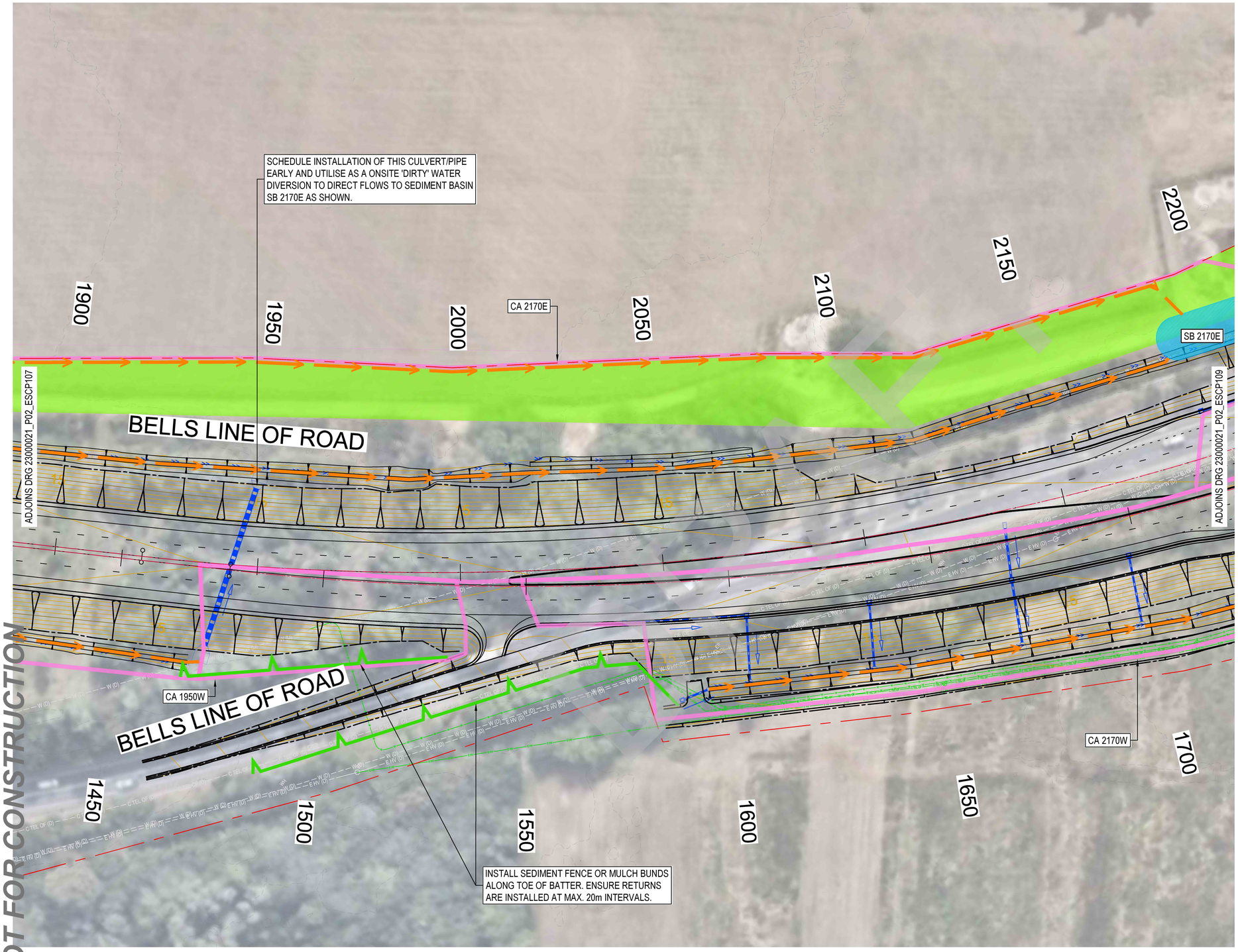
Plot Date: Monday, 2 September 2024 3:27:00 PM CAD File Name: L:\23000021 New Richmond Bridge Stage 2\Drawings\23000021_P02_ESCP_REV C.dwg



UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
- OFFSITE (CLEAN) WATER DIVERSION [2]
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- TEMPORARY DIVERSION ACROSS WORKS AND/OR AROUND CULVERT WORKS [2]
- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CA 200W — CATCHMENT AREA
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- 100m BUFFER TO SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- Ø525 — PROPOSED STORMWATER DRAINAGE (PROVIDED BY AURECON)
- BASIN PB 1800W — PROPOSED PERMANENT BASIN (PROVIDED BY AURECON)

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SCALE: 1:500 (A1 SHEET)

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A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS	
DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500
CONCEPT	

North

CLIENT: aurecon

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PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL PLAN SHEET 9 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP108	C

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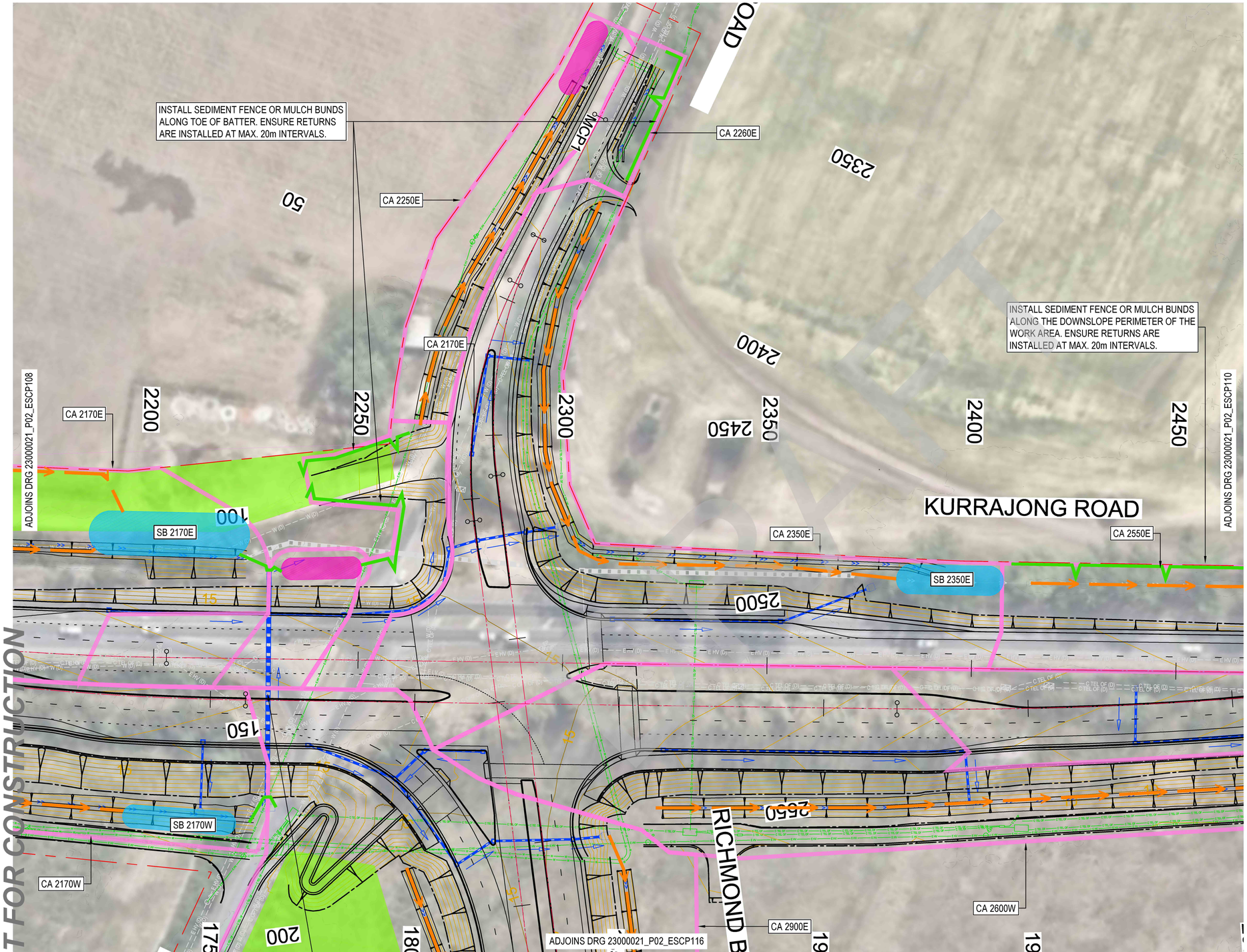

UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

SCHEDULE PROPOSED CULVERT/PIPE INSTALLATION WORKS AS EARLY WORKS AND UTILISE AS OFFSITE 'CLEAN' WATER DIVERSION.

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
- OFFSITE (CLEAN) WATER DIVERSION [2]
- ONSITE (DIRTY) WATER DIVERSION [2]
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- TEMPORARY DIVERSION ACROSS WORKS AND/OR AROUND CULVERT WORKS [2]
- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CA 200W — CATCHMENT AREA
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- 100m BUFFER TO SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- Ø525 — PROPOSED STORMWATER DRAINAGE (PROVIDED BY AURECON)
- BASIN PB 1800W — PROPOSED PERMANENT BASIN (PROVIDED BY AURECON)

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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

North

CLIENT: aurecon

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PROJECT TITLE
NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE
CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 10 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP109	C

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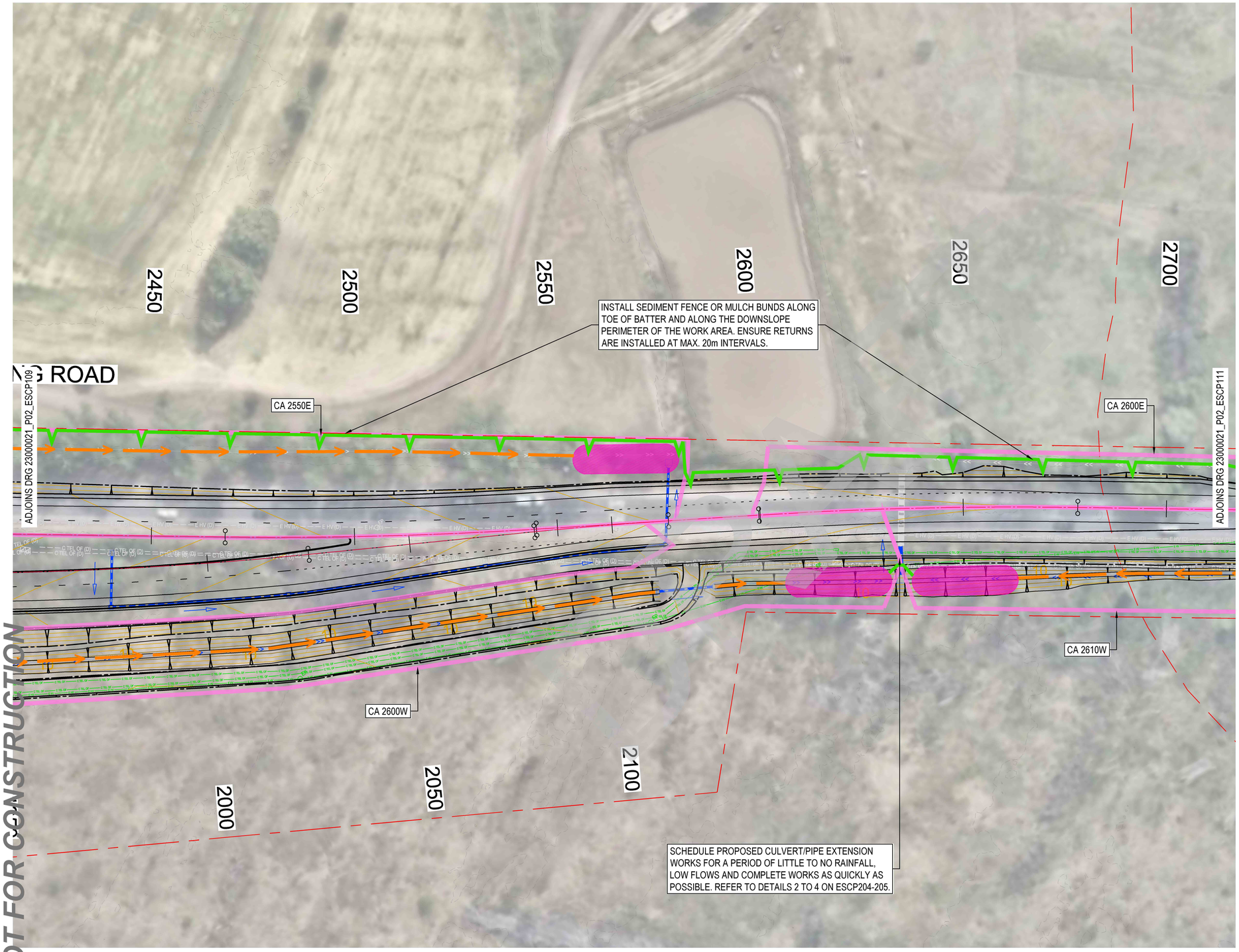

NOT FOR CONSTRUCTION

UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
- OFFSITE (CLEAN) WATER DIVERSION [2]
- ONSITE (DIRTY) WATER DIVERSION [2]
- SB8760W — SEDIMENT BASIN [1] (BLUE BOOK SD 6-4 ON ESCP201)
- SEDIMENT TRAP [2] (e.g. EXCAVATED SEDIMENT SUMP/TRAP, ROCK FILTER DAM, MULCH FILTER BUND, U-SHAPED SEDIMENT FENCE, HOLDING POND OR SIMILAR)
- TEMPORARY DIVERSION ACROSS WORKS AND/OR AROUND CULVERT WORKS [2]
- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CA 200W — CATCHMENT AREA
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- 100m BUFFER TO SEPP COASTAL WETLAND (PROVIDED BY AURECON)
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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

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A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

North

CLIENT

aurecon

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PROJECT TITLE

NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE

CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 11 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP110	C

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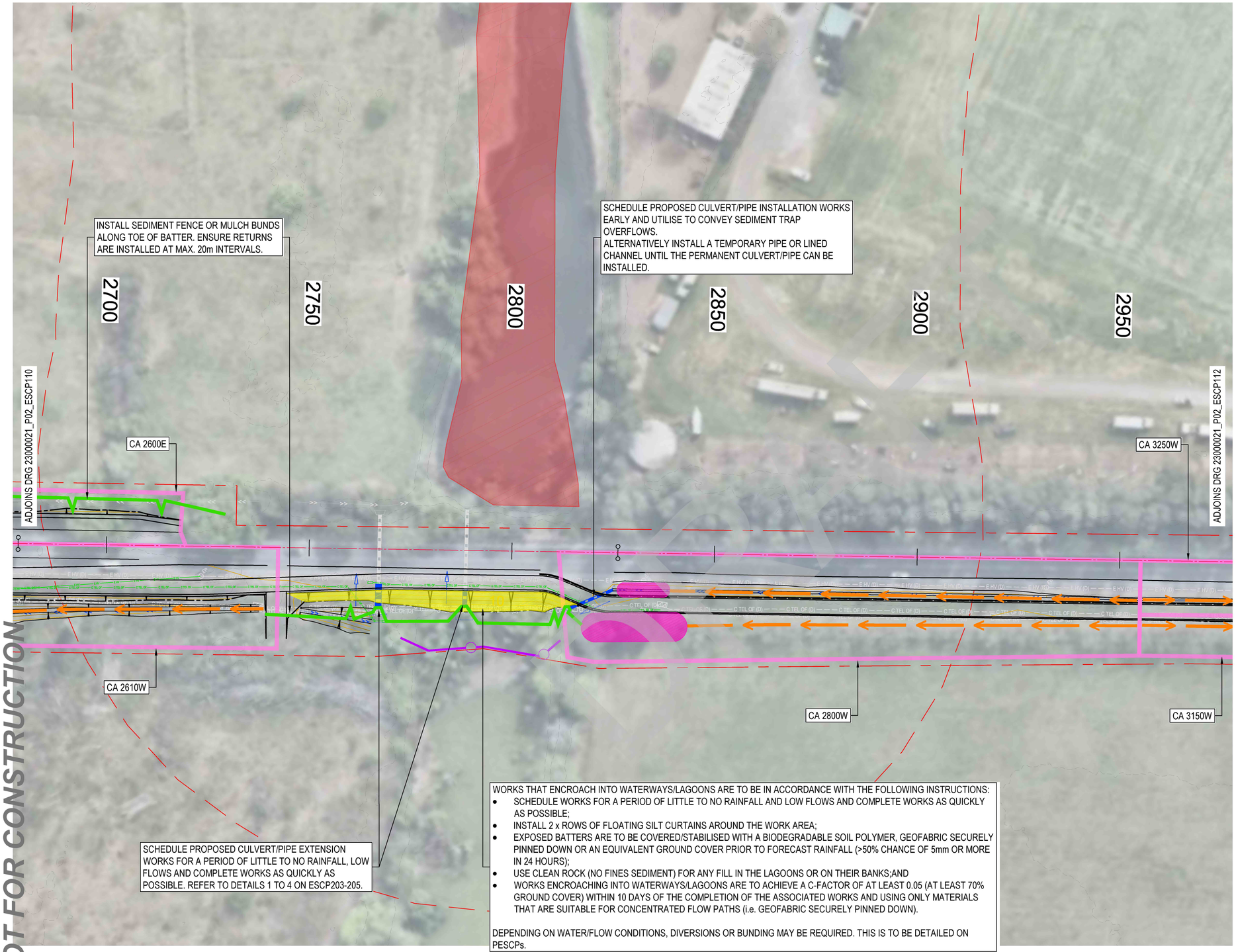

NOT FOR CONSTRUCTION

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
- OFFSITE (CLEAN) WATER DIVERSION [2]
- ONSITE (DIRTY) WATER DIVERSION [2]
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- EXISTING CONTOURS (0.5m INTERVALS)
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- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

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CLIENT: aurecon

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PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 12 OF 38

PROJECT NO.	SUB–PR NO.	DRAWING NO.	REV
23000021	P02	ESCP111	C

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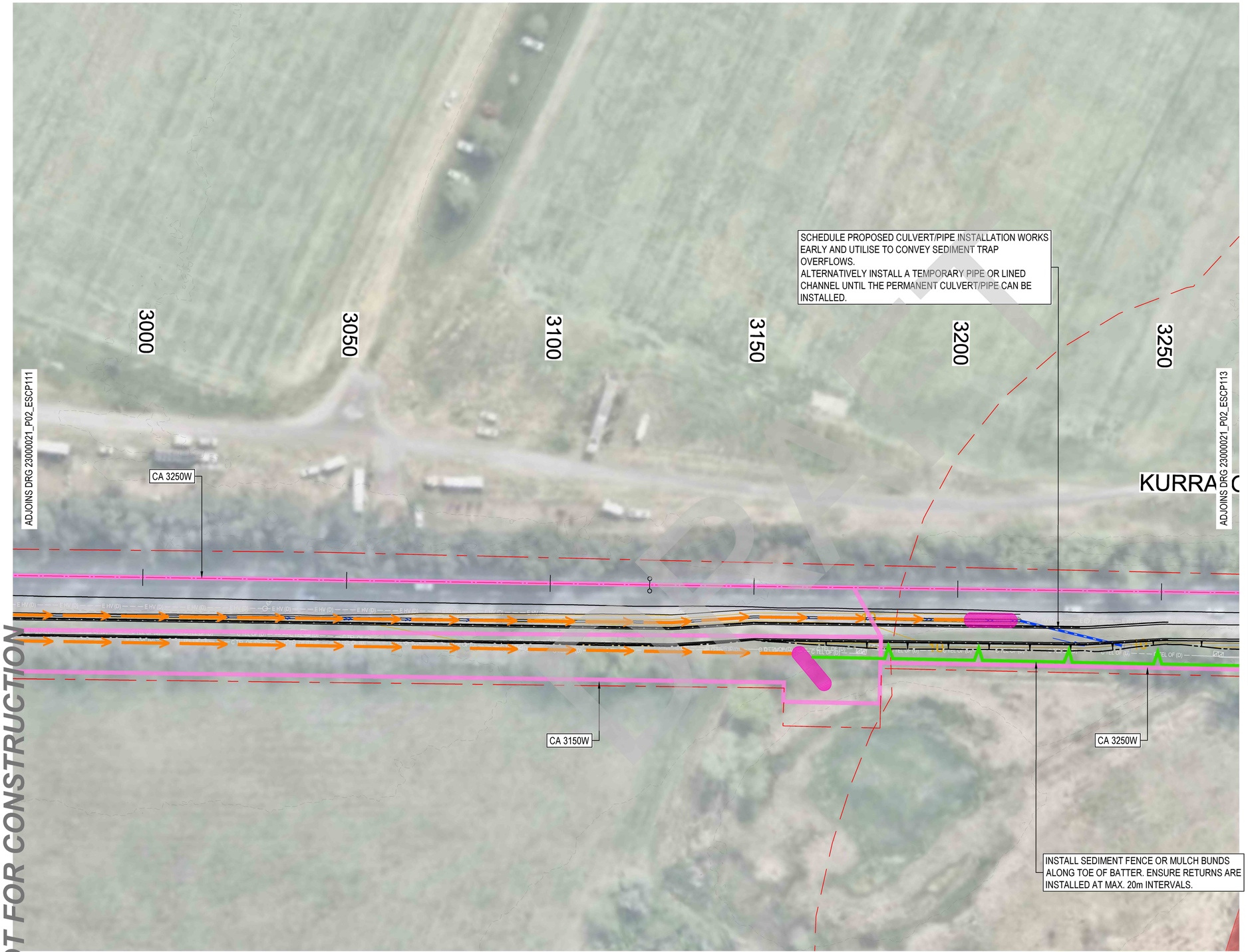

UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
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- CA 200W — CATCHMENT AREA
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

North

CLIENT: aurecon

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PROJECT TITLE
NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE
CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 13 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP112	C

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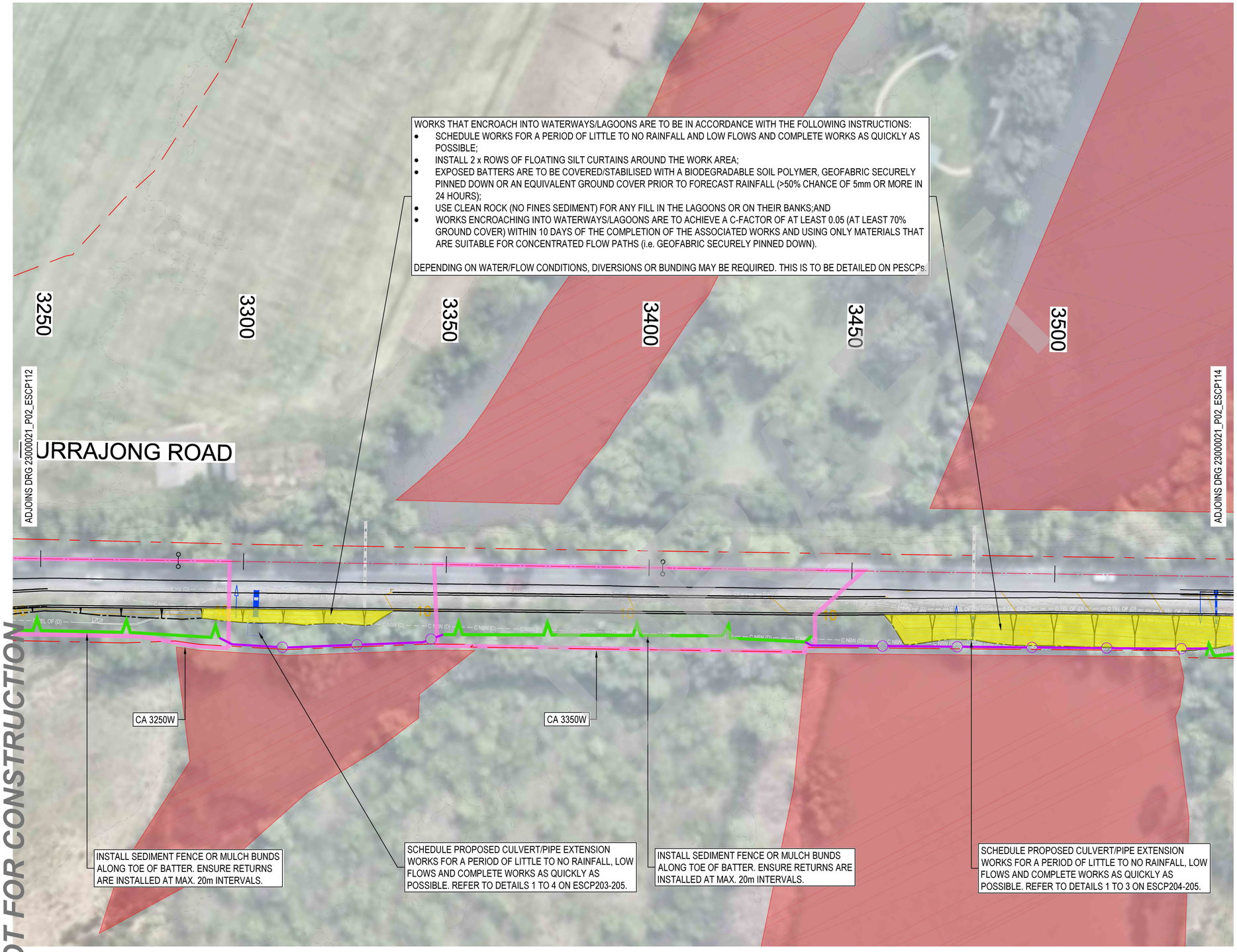
Plot Date: Monday, 2 September 2024 3:33:43 PM CAD File Name: L:\23000021 New Richmond Bridge Stage 2\Drawings\23000021_P02_ESCP_REV C.dwg



WORKS THAT ENCROACH INTO WATERWAYS/LAGOONS ARE TO BE IN ACCORDANCE WITH THE FOLLOWING INSTRUCTIONS:

- SCHEDULE WORKS FOR A PERIOD OF LITTLE TO NO RAINFALL AND LOW FLOWS AND COMPLETE WORKS AS QUICKLY AS POSSIBLE;
- INSTALL 2 x ROWS OF FLOATING SILT CURTAINS AROUND THE WORK AREA;
- EXPOSED BATTERS ARE TO BE COVERED/STABILISED WITH A BIODEGRADABLE SOIL POLYMER, GEOFABRIC SECURELY PINNED DOWN OR AN EQUIVALENT GROUND COVER PRIOR TO FORECAST RAINFALL (>50% CHANCE OF 5mm OR MORE IN 24 HOURS);
- USE CLEAN ROCK (NO FINES SEDIMENT) FOR ANY FILL IN THE LAGOONS OR ON THEIR BANKS;AND
- WORKS ENCROACHING INTO WATERWAYS/LAGOONS ARE TO ACHIEVE A C-FACTOR OF AT LEAST 0.05 (AT LEAST 70% GROUND COVER) WITHIN 10 DAYS OF THE COMPLETION OF THE ASSOCIATED WORKS AND USING ONLY MATERIALS THAT ARE SUITABLE FOR CONCENTRATED FLOW PATHS (i.e. GEOFABRIC SECURELY PINNED DOWN).

DEPENDING ON WATER/FLOW CONDITIONS, DIVERSIONS OR BUNDING MAY BE REQUIRED. THIS IS TO BE DETAILED ON PESCPs.

LEGEND

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NOT FOR CONSTRUCTION

UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
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A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

North

CLIENT

aurecon

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PROJECT TITLE

NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE

CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 14 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP113	C

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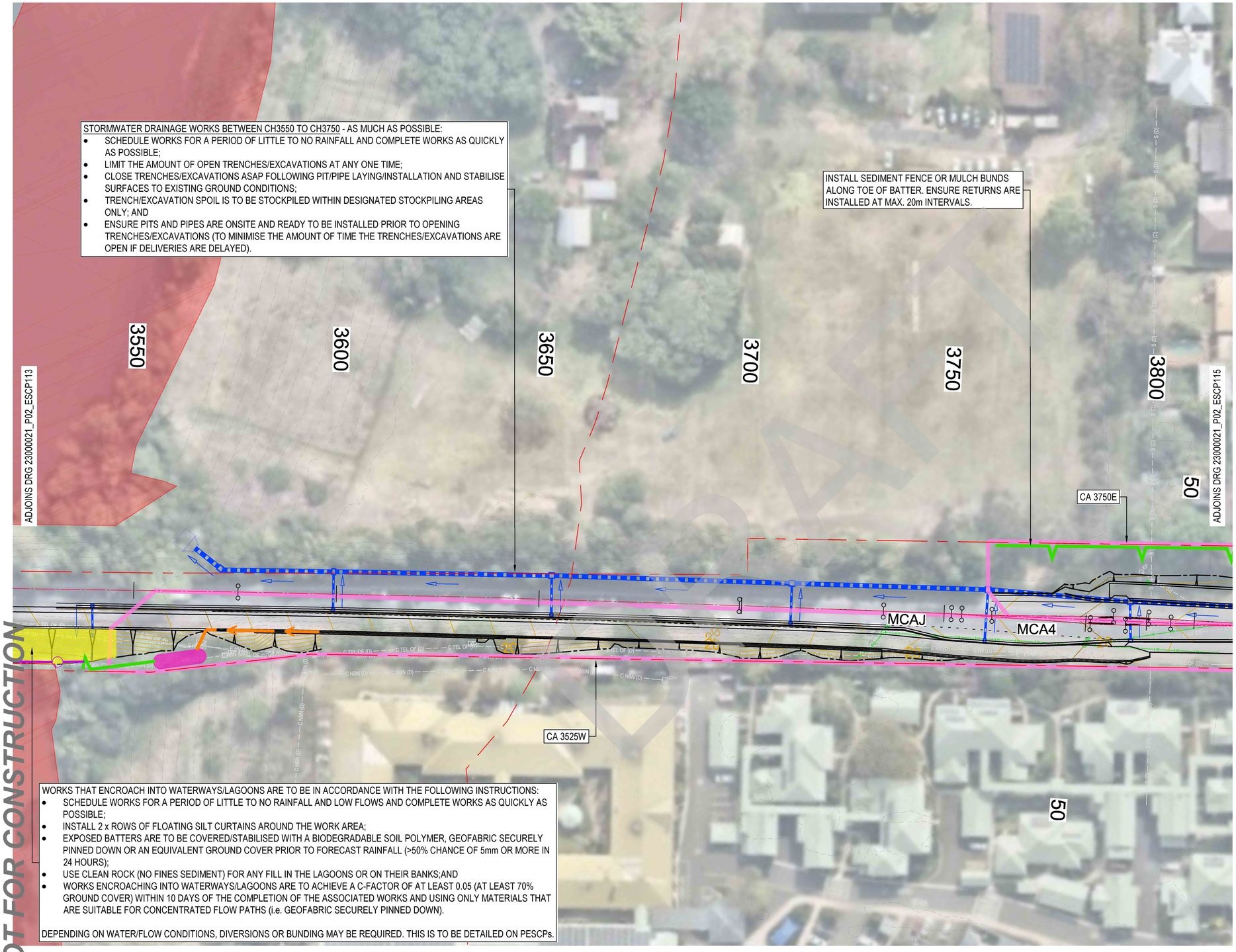

LEGEND

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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
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A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

North

CLIENT: aurecon

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PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL PLAN SHEET 15 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP114	C

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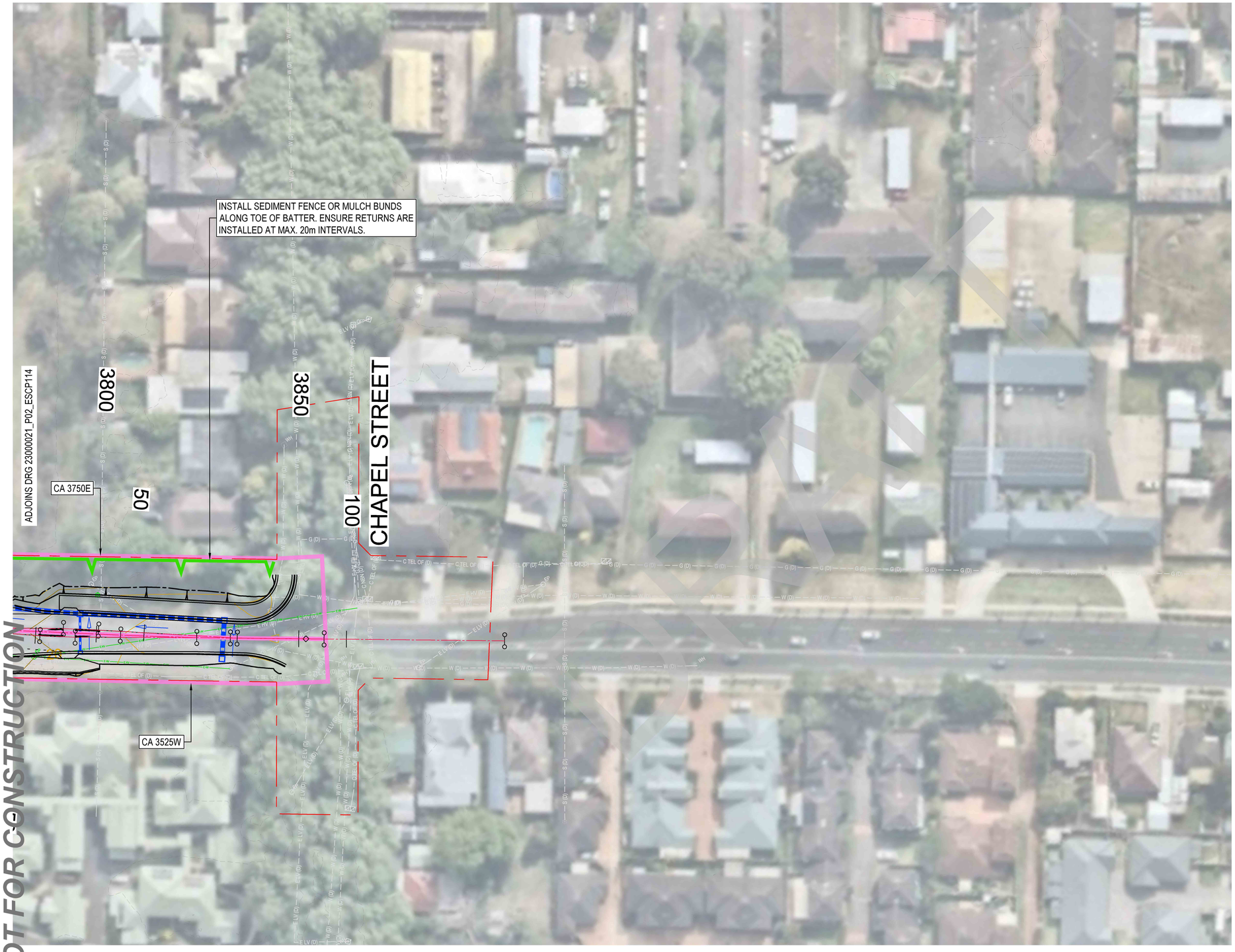

NOT FOR CONSTRUCTION

UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
- OFFSITE (CLEAN) WATER DIVERSION [2]
- ONSITE (DIRTY) WATER DIVERSION [2]
- SB8760W — SEDIMENT BASIN [1] (BLUE BOOK SD 6-4 ON ESCP201)
- SEDIMENT TRAP [2] (e.g. EXCAVATED SEDIMENT SUMP/TRAP, ROCK FILTER DAM, MULCH FILTER BUND, U-SHAPED SEDIMENT FENCE, HOLDING POND OR SIMILAR)
- TEMPORARY DIVERSION ACROSS WORKS AND/OR AROUND CULVERT WORKS [2]
- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CA 200W — CATCHMENT AREA
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- 100m BUFFER TO SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- Ø525 — PROPOSED STORMWATER DRAINAGE (PROVIDED BY AURECON)
- BASIN PB 1800W — PROPOSED PERMANENT BASIN (PROVIDED BY AURECON)

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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

North

CLIENT: aurecon

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PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 16 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP115	C

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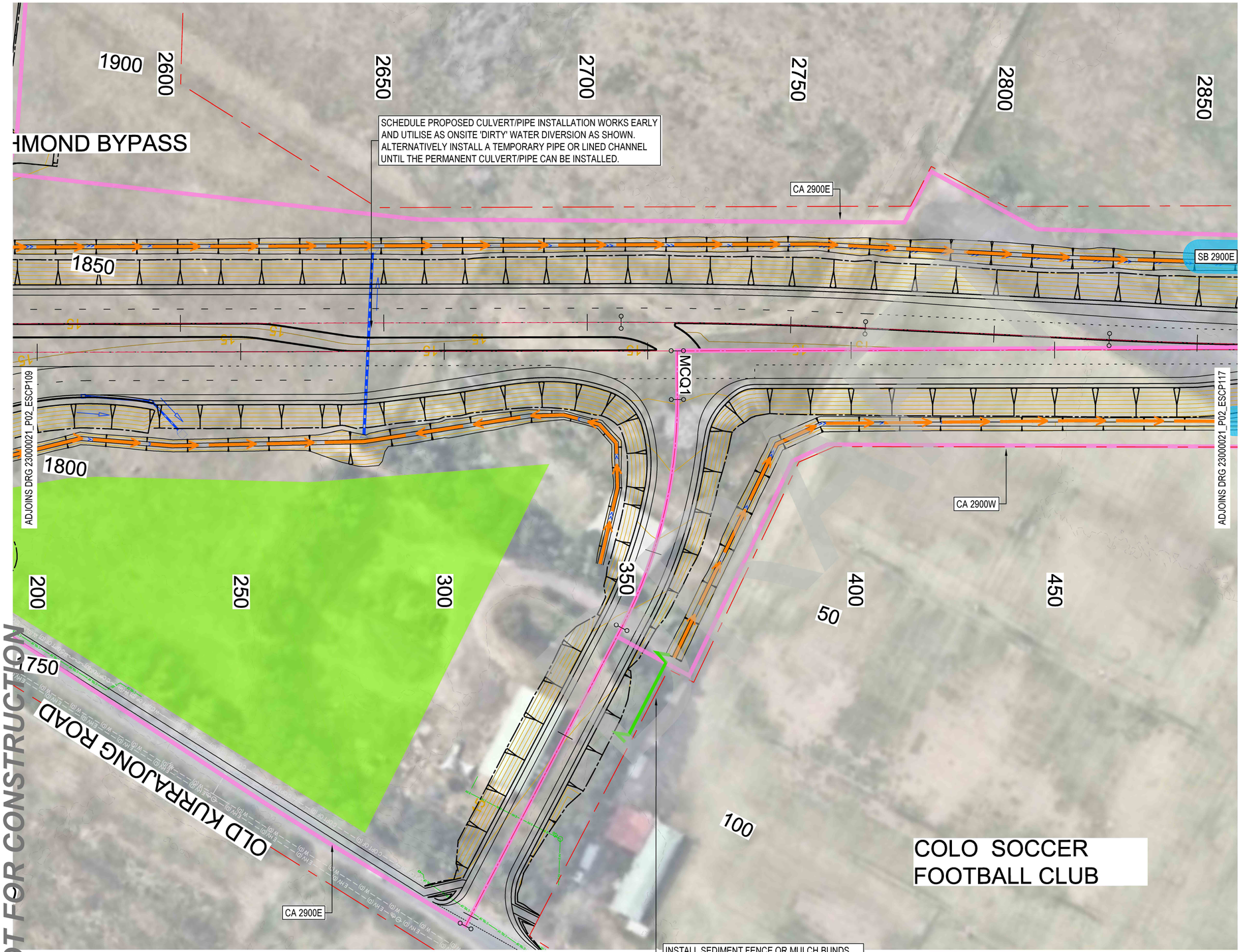
Plot Date: Monday, 2 September 2024 3:37:21 PM CAD File Name: L:\23000021 New Richmond Bridge Stage 2\Drawings\23000021_P02_ESCP_REV C.dwg



LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
- OFFSITE (CLEAN) WATER DIVERSION [2]
- ONSITE (DIRTY) WATER DIVERSION [2]
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- TEMPORARY DIVERSION ACROSS WORKS AND/OR AROUND CULVERT WORKS [2]
- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CA 200W — CATCHMENT AREA
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- 100m BUFFER TO SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- Ø525 — PROPOSED STORMWATER DRAINAGE (PROVIDED BY AURECON)
- BASIN PB 1800W — PROPOSED PERMANENT BASIN (PROVIDED BY AURECON)

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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS	
DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500
CONCEPT	

North

CLIENT: aurecon

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PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL PLAN SHEET 17 OF 38

PROJECT NO.	SUB–PR NO.	DRAWING NO.	REV
23000021	P02	ESCP116	C

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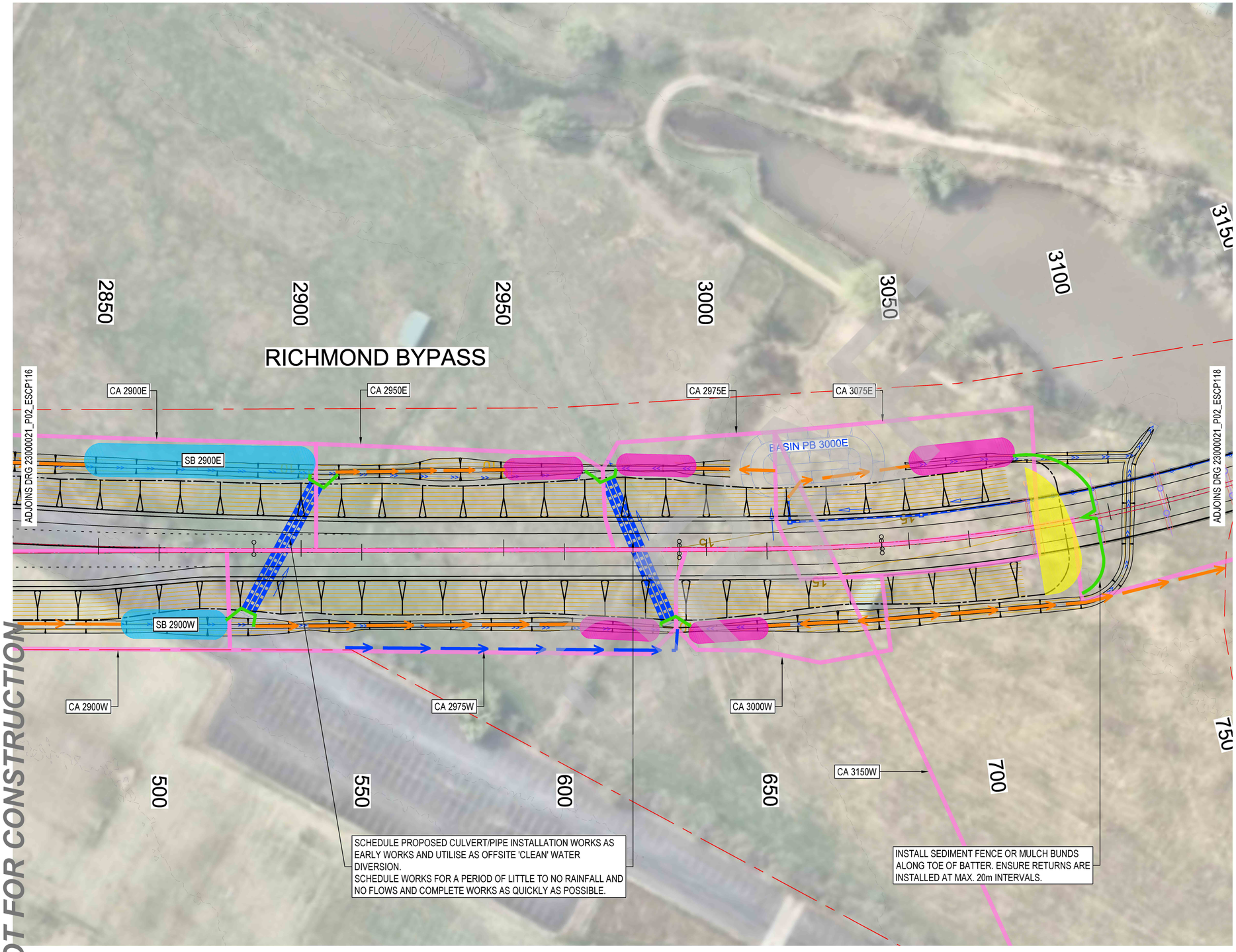

NOT FOR CONSTRUCTION

UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
- OFFSITE (CLEAN) WATER DIVERSION [2]
- ONSITE (DIRTY) WATER DIVERSION [2]
- SB8760W — SEDIMENT BASIN [1] (BLUE BOOK SD 6-4 ON ESCP201)
- SEDIMENT TRAP [2] (e.g. EXCAVATED SEDIMENT SUMP/TRAP, ROCK FILTER DAM, MULCH FILTER BUND, U-SHAPED SEDIMENT FENCE, HOLDING POND OR SIMILAR)
- TEMPORARY DIVERSION ACROSS WORKS AND/OR AROUND CULVERT WORKS [2]
- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CA 200W — CATCHMENT AREA
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- 100m BUFFER TO SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- Ø525 — PROPOSED STORMWATER DRAINAGE (PROVIDED BY AURECON)
- BASIN PB 1800W — PROPOSED PERMANENT BASIN (PROVIDED BY AURECON)

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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
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A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

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CLIENT: aurecon

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PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL PLAN SHEET 18 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP117	C

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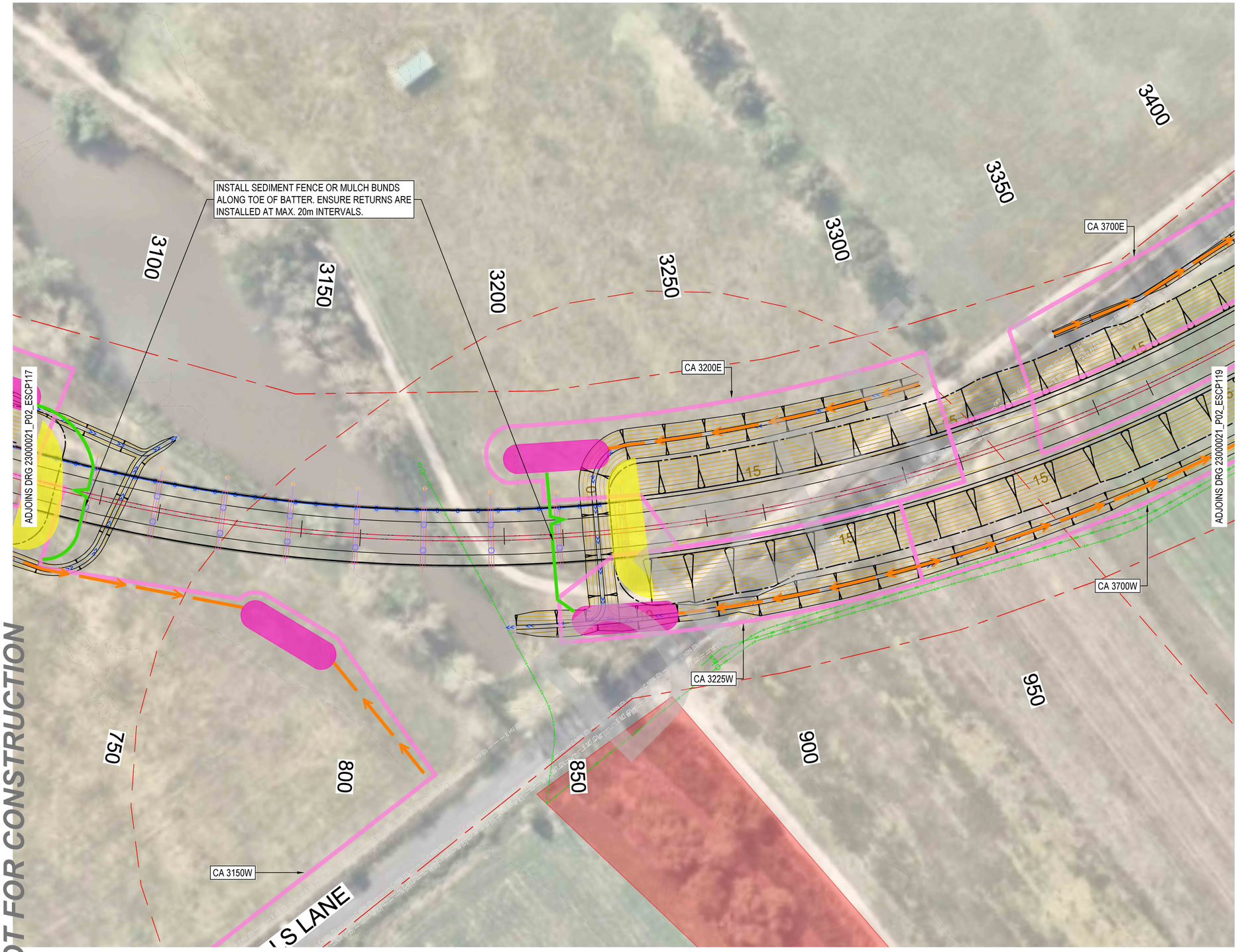
Plot Date: Monday, 2 September 2024 3:39:40 PM CAD File Name: L:\23000021 New Richmond Bridge Stage 2\Drawings\23000021_P02_ESCP_REV C.dwg



NOT FOR CONSTRUCTION

UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
- OFFSITE (CLEAN) WATER DIVERSION [2]
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- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CA 200W — CATCHMENT AREA
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- 100m BUFFER TO SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- Ø525 — PROPOSED STORMWATER DRAINAGE (PROVIDED BY AURECON)
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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS	
DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500
CONCEPT	

North

CLIENT: aurecon

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PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL PLAN SHEET 19 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP118	C

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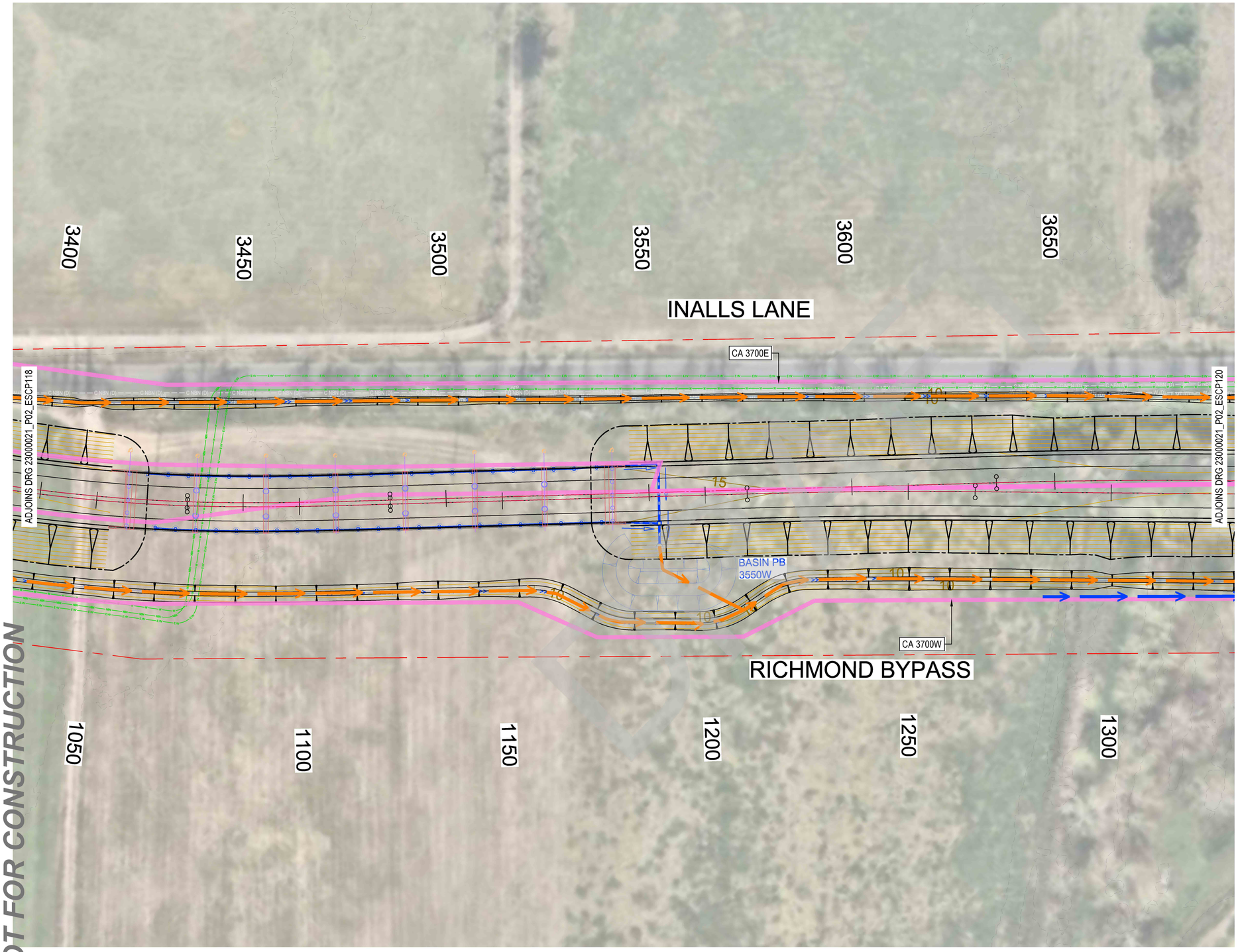
Plot Date: Monday, 2 September 2024 3:40:44 PM CAD File Name: L:\23000021 New Richmond Bridge Stage 2\Drawings\23000021_P02_ESCP_REV C.dwg



LEGEND

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- OFFSITE (CLEAN) WATER DIVERSION [2]
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- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CA 200W — CATCHMENT AREA
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
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UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

North

CLIENT: aurecon

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PROJECT TITLE
NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE
CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 20 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP119	C

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SCHEDULE PROPOSED CULVERT/PIPE INSTALLATION WORKS AS EARLY WORKS AND UTILISE AS OFFSITE 'CLEAN' WATER DIVERSION. REFER TO DETAIL 1 ON ESCP203.

INSTALL SEDIMENT FENCE OR MULCH BUNDS ALONG TOE OF BATTER. ENSURE RETURNS ARE INSTALLED AT MAX. 20m INTERVALS.

SCHEDULE PROPOSED CULVERT/PIPE INSTALLATION WORKS AS EARLY WORKS AND UTILISE AS ONSITE 'DIRTY' WATER DIVERSIONS.

3700 3750 3800 3850 3900 3950 1300 1350 1400 1450 1500 1550

CA 3700E CA 3750E CA 3700W CA 3750W CA 3900W

SB 3700E SB 3700W SB 3750W

MCU1 MCU4

DRIFT ROAD

ADJOINS DRG 23000021_P02_ESCP119

ADJOINS DRG 23000021_P02_ESCP121

SWALE OR LINEAR BASINS WITHIN THE PERMANENT CATCH DRAINS ARE TO BE UTILISED IN CATCHMENTS CA 3700E AND CA 3700W.

UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

NOT FOR CONSTRUCTION

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
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- ONSITE (DIRTY) WATER DIVERSION [2]
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- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

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A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

North

CLIENT

aurecon

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PROJECT TITLE
NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE
CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 21 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP120	C

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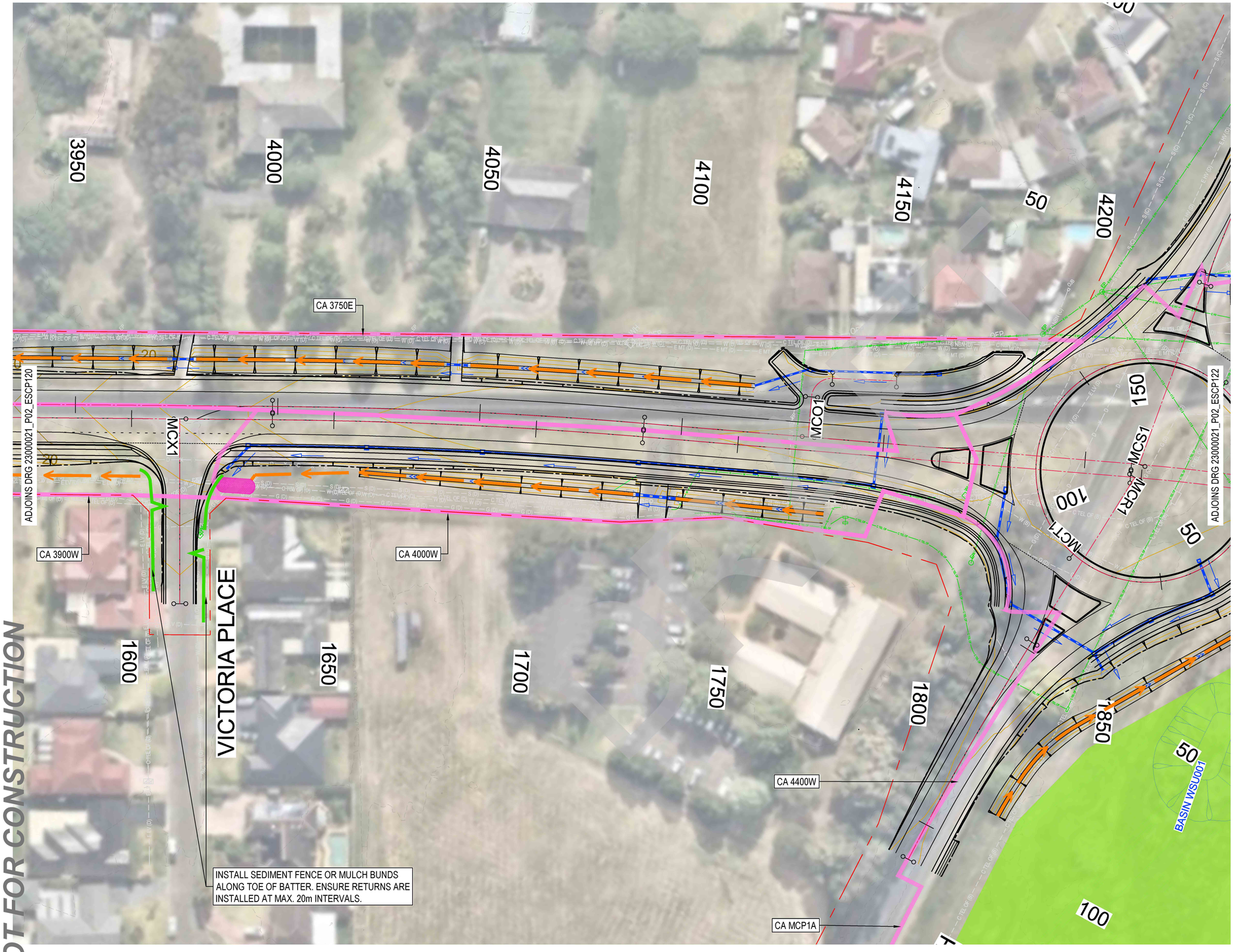

NOT FOR CONSTRUCTION

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
- OFFSITE (CLEAN) WATER DIVERSION [2]
- ONSITE (DIRTY) WATER DIVERSION [2]
- SB8760W — SEDIMENT BASIN [1] (BLUE BOOK SD 6-4 ON ESCP201)
- SEDIMENT TRAP [2] (e.g. EXCAVATED SEDIMENT SUMP/TRAP, ROCK FILTER DAM, MULCH FILTER BUND, U-SHAPED SEDIMENT FENCE, HOLDING POND OR SIMILAR)
- TEMPORARY DIVERSION ACROSS WORKS AND/OR AROUND CULVERT WORKS [2]
- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CA 200W — CATCHMENT AREA
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- 100m BUFFER TO SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- Ø525 — PROPOSED STORMWATER DRAINAGE (PROVIDED BY AURECON)
- BASIN PB 1800W — PROPOSED PERMANENT BASIN (PROVIDED BY AURECON)

[1] THE SEDIMENT BASIN FOOTPRINTS SHOWN ARE INDICATIVE ONLY AND MUST BE VERIFIED VIA SURVEY/MODELLING TO ACHIEVE THE REQUIRED SEDIMENT BASIN VOLUMES. SEDIMENT BASIN VOLUMES AND DESIGN DETAILS ARE PROVIDED WITHIN THE TABLE ON ESCP001.
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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

North

CLIENT: aurecon

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PROJECT TITLE
NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE
CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 22 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP121	C

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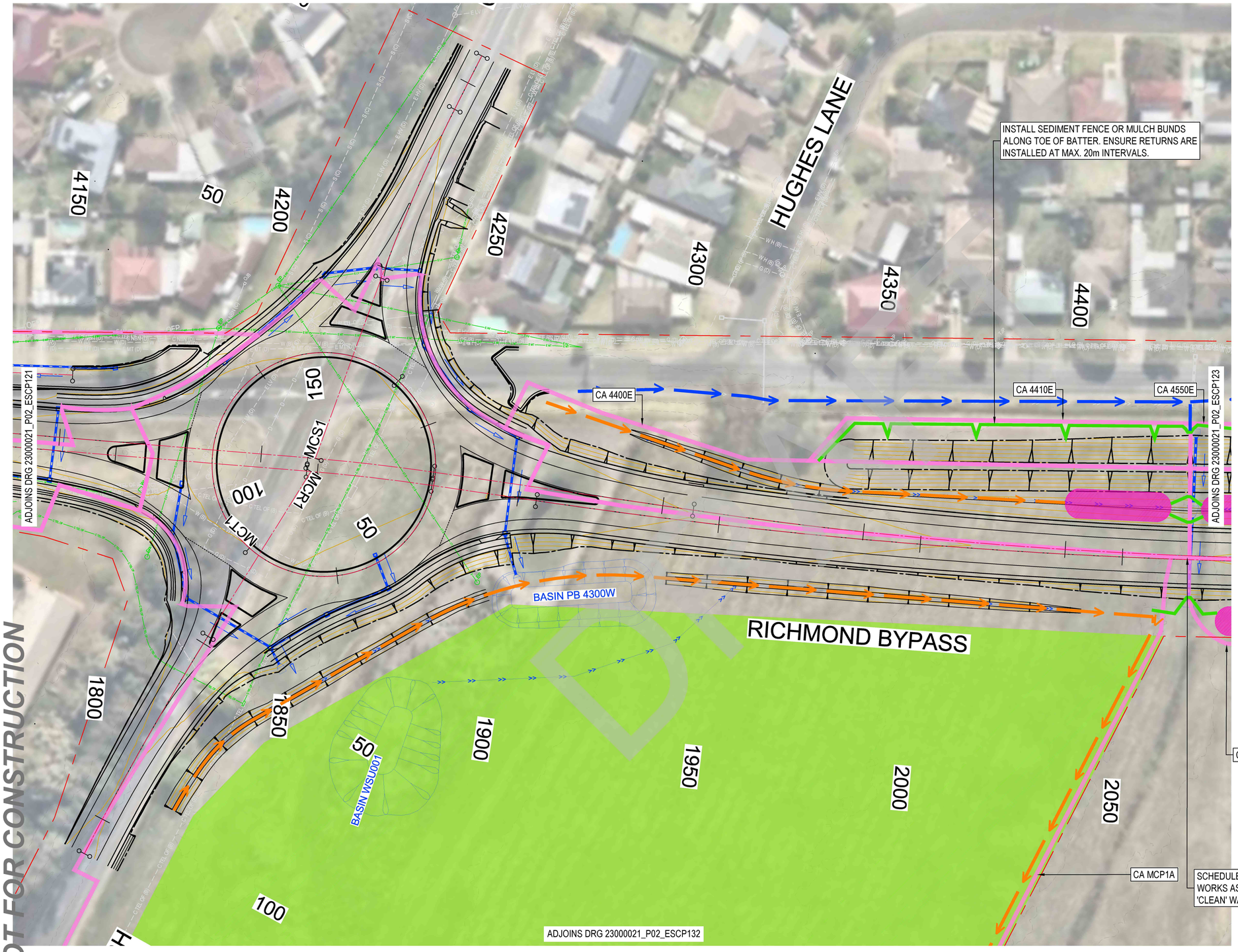

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
- OFFSITE (CLEAN) WATER DIVERSION [2]
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- SB8760W — SEDIMENT BASIN [1] (BLUE BOOK SD 6-4 ON ESCP201)
- SEDIMENT TRAP [2] (e.g. EXCAVATED SEDIMENT SUMP/TRAP, ROCK FILTER DAM, MULCH FILTER BUND, U-SHAPED SEDIMENT FENCE, HOLDING POND OR SIMILAR)
- TEMPORARY DIVERSION ACROSS WORKS AND/OR AROUND CULVERT WORKS [2]
- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CA 200W — CATCHMENT AREA
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- 100m BUFFER TO SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- Ø525 — PROPOSED STORMWATER DRAINAGE (PROVIDED BY AURECON)
- BASIN PB 1800W — PROPOSED PERMANENT BASIN (PROVIDED BY AURECON)

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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

North

CLIENT: aurecon

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PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 23 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP122	C

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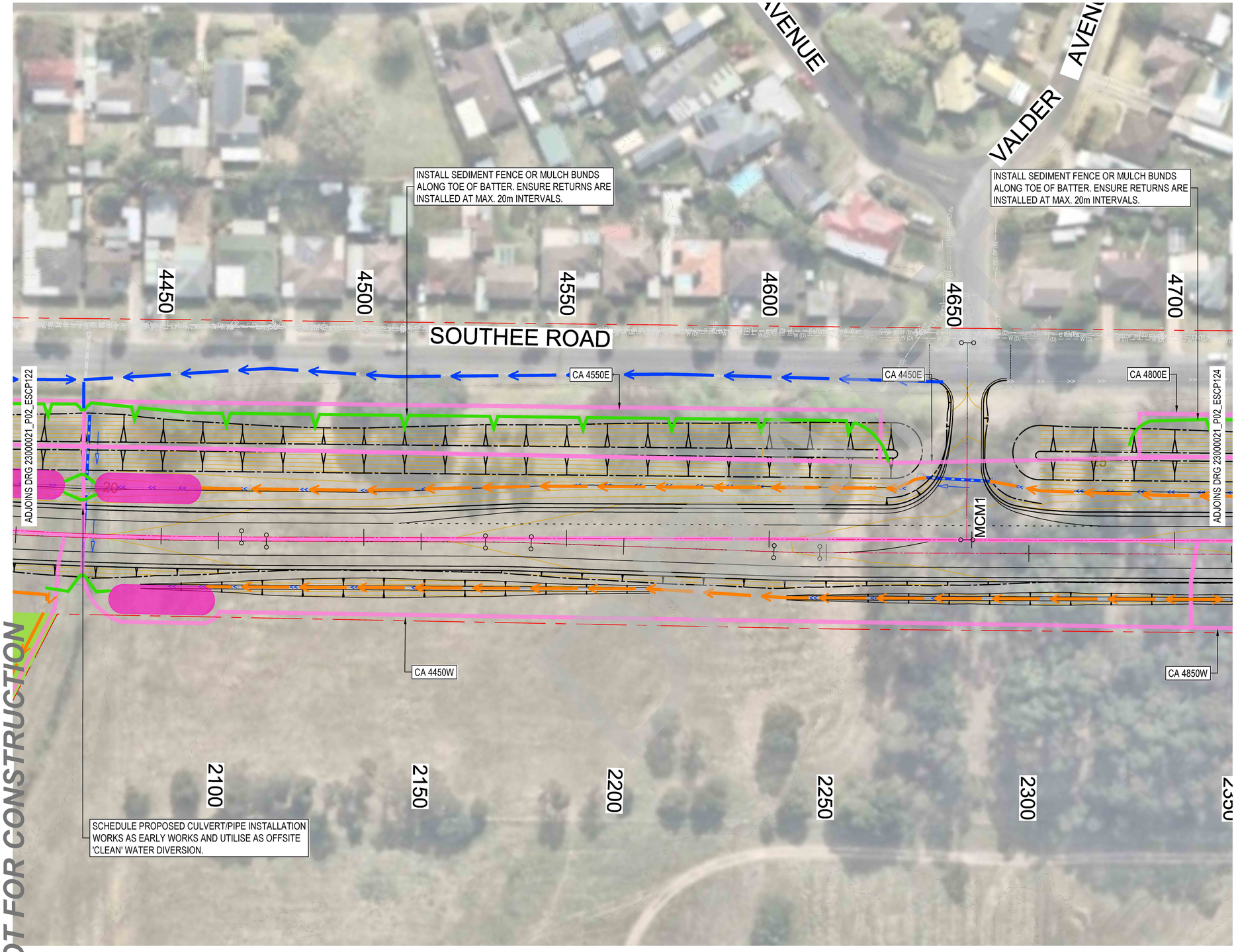

NOT FOR CONSTRUCTION

UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
- OFFSITE (CLEAN) WATER DIVERSION [2]
- ONSITE (DIRTY) WATER DIVERSION [2]
- SB8760W — SEDIMENT BASIN [1] (BLUE BOOK SD 6-4 ON ESCP201)
- SEDIMENT TRAP [2] (e.g. EXCAVATED SEDIMENT SUMP/TRAP, ROCK FILTER DAM, MULCH FILTER BUND, U-SHAPED SEDIMENT FENCE, HOLDING POND OR SIMILAR)
- TEMPORARY DIVERSION ACROSS WORKS AND/OR AROUND CULVERT WORKS [2]
- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CA 200W — CATCHMENT AREA
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- 100m BUFFER TO SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- Ø525 — PROPOSED STORMWATER DRAINAGE (PROVIDED BY AURECON)
- BASIN PB 1800W — PROPOSED PERMANENT BASIN (PROVIDED BY AURECON)

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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

North

CLIENT: aurecon

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PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL PLAN SHEET 24 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP123	C

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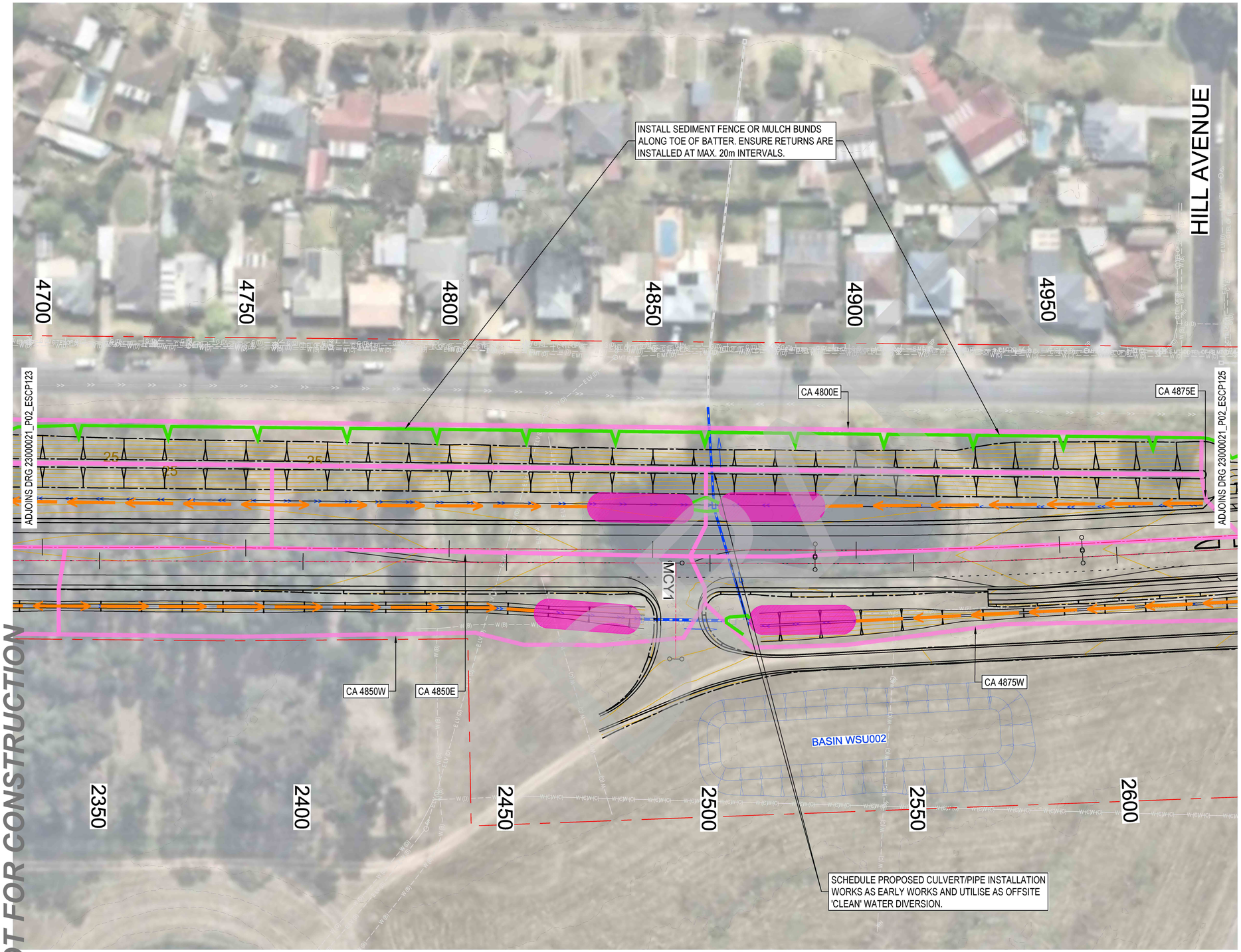

NOT FOR CONSTRUCTION

UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
- OFFSITE (CLEAN) WATER DIVERSION [2]
- ONSITE (DIRTY) WATER DIVERSION [2]
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- TEMPORARY DIVERSION ACROSS WORKS AND/OR AROUND CULVERT WORKS [2]
- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CA 200W — CATCHMENT AREA
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
- 100m BUFFER TO SEPP COASTAL WETLAND (PROVIDED BY AURECON)
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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS	
DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500
CONCEPT	

North

CLIENT: aurecon

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PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL PLAN SHEET 25 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP124	C

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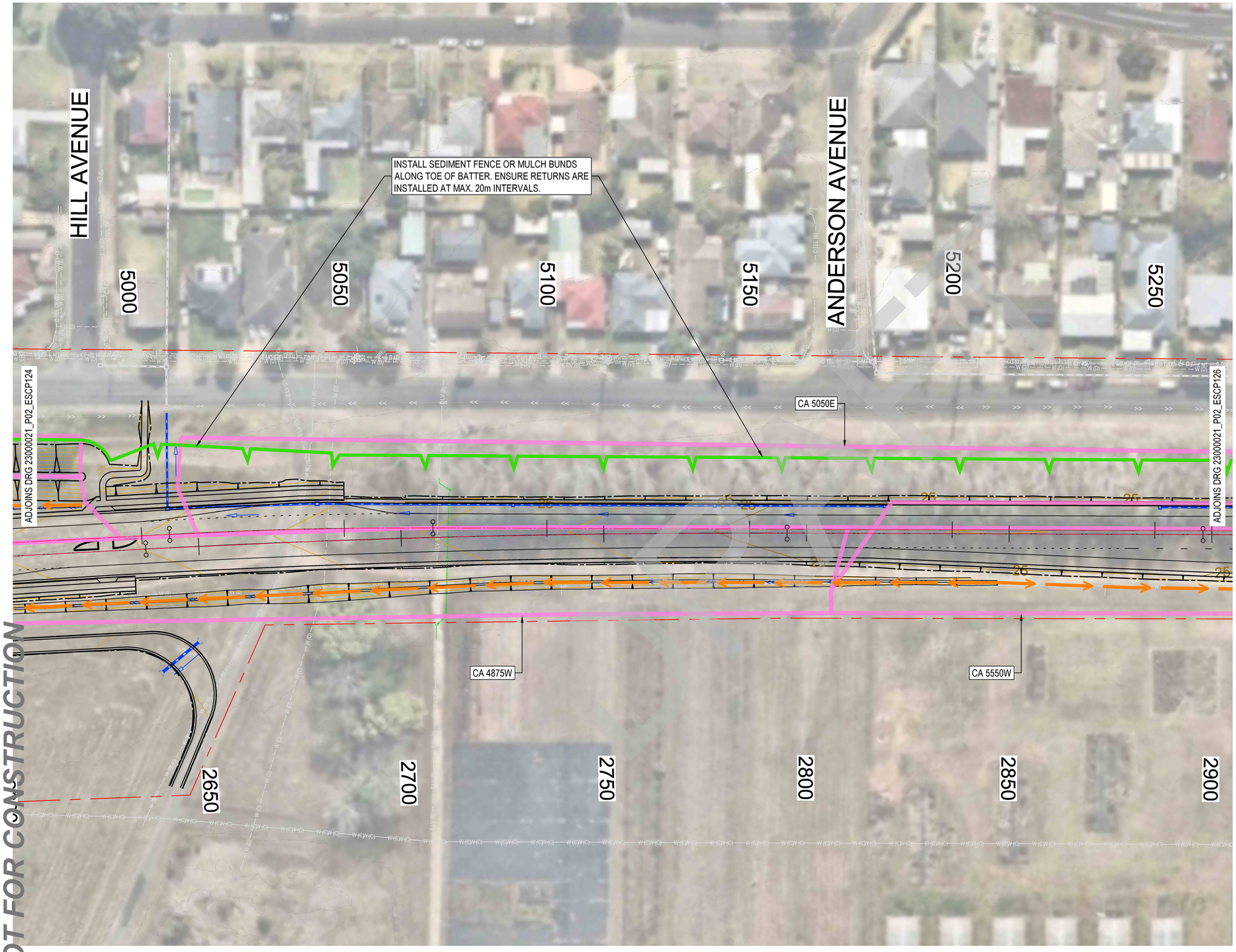

NOT FOR CONSTRUCTION

UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
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- TEMPORARY DIVERSION ACROSS WORKS AND/OR AROUND CULVERT WORKS [2]
- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CA 200W — CATCHMENT AREA
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
- TEMPORARY CLEAN WATER PIPE
- 2 x ROWS OF FLOATING SILT CURTAIN (IECA FSC-01 & 02 ON ESCP202)
- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

North

CLIENT: aurecon

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PROJECT TITLE
NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE
CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 26 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP125	C

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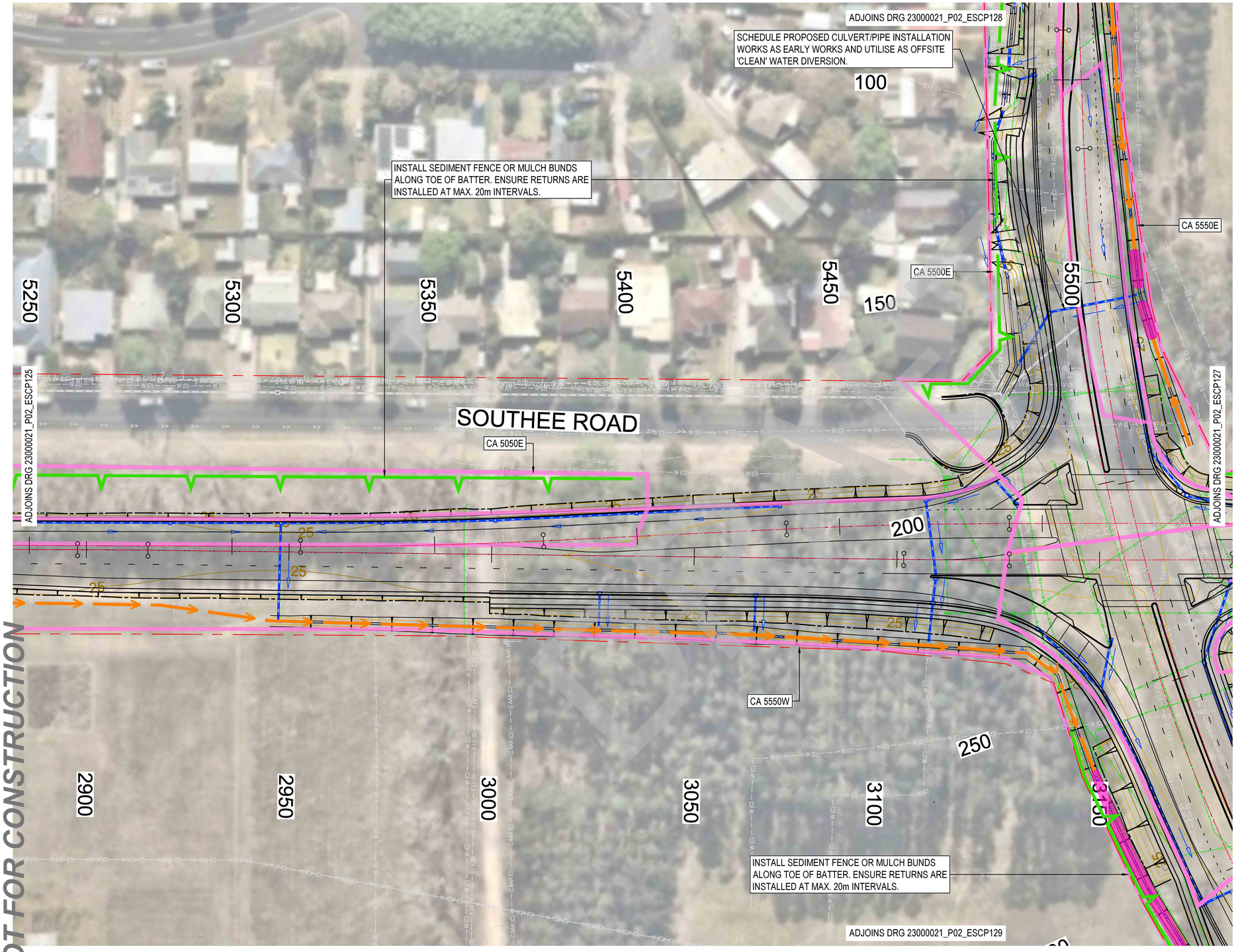

LEGEND

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- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CA 200W — CATCHMENT AREA
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- EXISTING CONTOURS (0.5m INTERVALS)
- PROPOSAL BOUNDARY (PROVIDED BY AURECON)
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- BASIN PB 1800W — PROPOSED PERMANENT BASIN (PROVIDED BY AURECON)

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UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

North

CLIENT: aurecon

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PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 27 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP126	C

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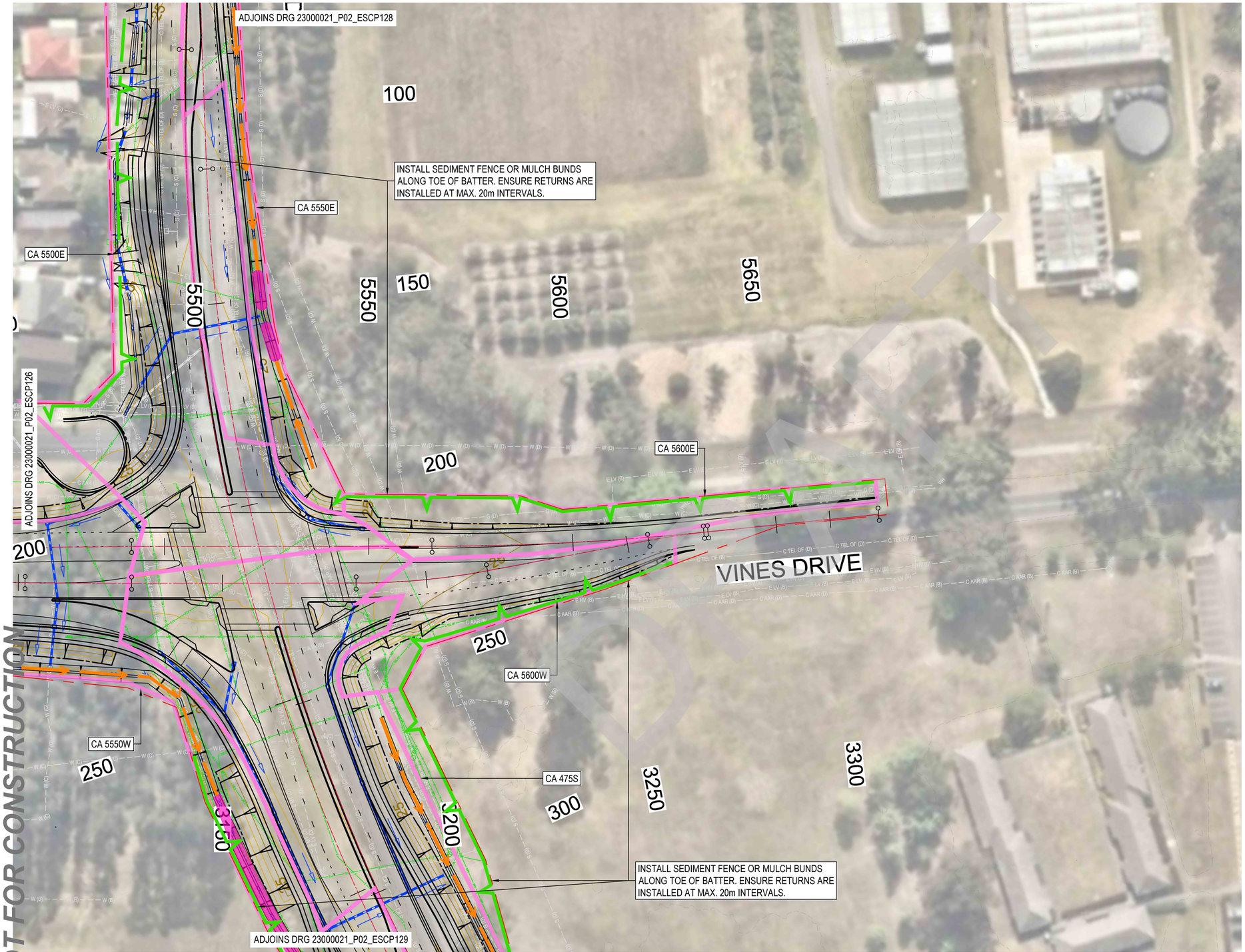

UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

LEGEND

- SEDIMENT FENCE (BLUE BOOK SD 6-8 ON ESCP201) OR MULCH BUND (IECA SD MB-01 ON ESCP202) [2]
- OFFSITE (CLEAN) WATER DIVERSION [2]
- ONSITE (DIRTY) WATER DIVERSION [2]
- SB8760W — SEDIMENT BASIN [1] (BLUE BOOK SD 6-4 ON ESCP201)
- SEDIMENT TRAP [2] (e.g. EXCAVATED SEDIMENT SUMP/TRAP, ROCK FILTER DAM, MULCH FILTER BUND, U-SHAPED SEDIMENT FENCE, HOLDING POND OR SIMILAR)
- TEMPORARY DIVERSION ACROSS WORKS AND/OR AROUND CULVERT WORKS [2]
- EXPOSED BATTERS TO BE STABILISED PRIOR TO RAINFALL [2]
- CA 200W — CATCHMENT AREA
- PROPOSED ANCILLARY FACILITY (PROVIDED BY AURECON)
- EXISTING CONTOURS (0.5m INTERVALS)
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- SEPP COASTAL WETLAND (PROVIDED BY AURECON)
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- BASIN PB 1800W — PROPOSED PERMANENT BASIN (PROVIDED BY AURECON)

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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

North

CLIENT: aurecon

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PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 28 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP127	C

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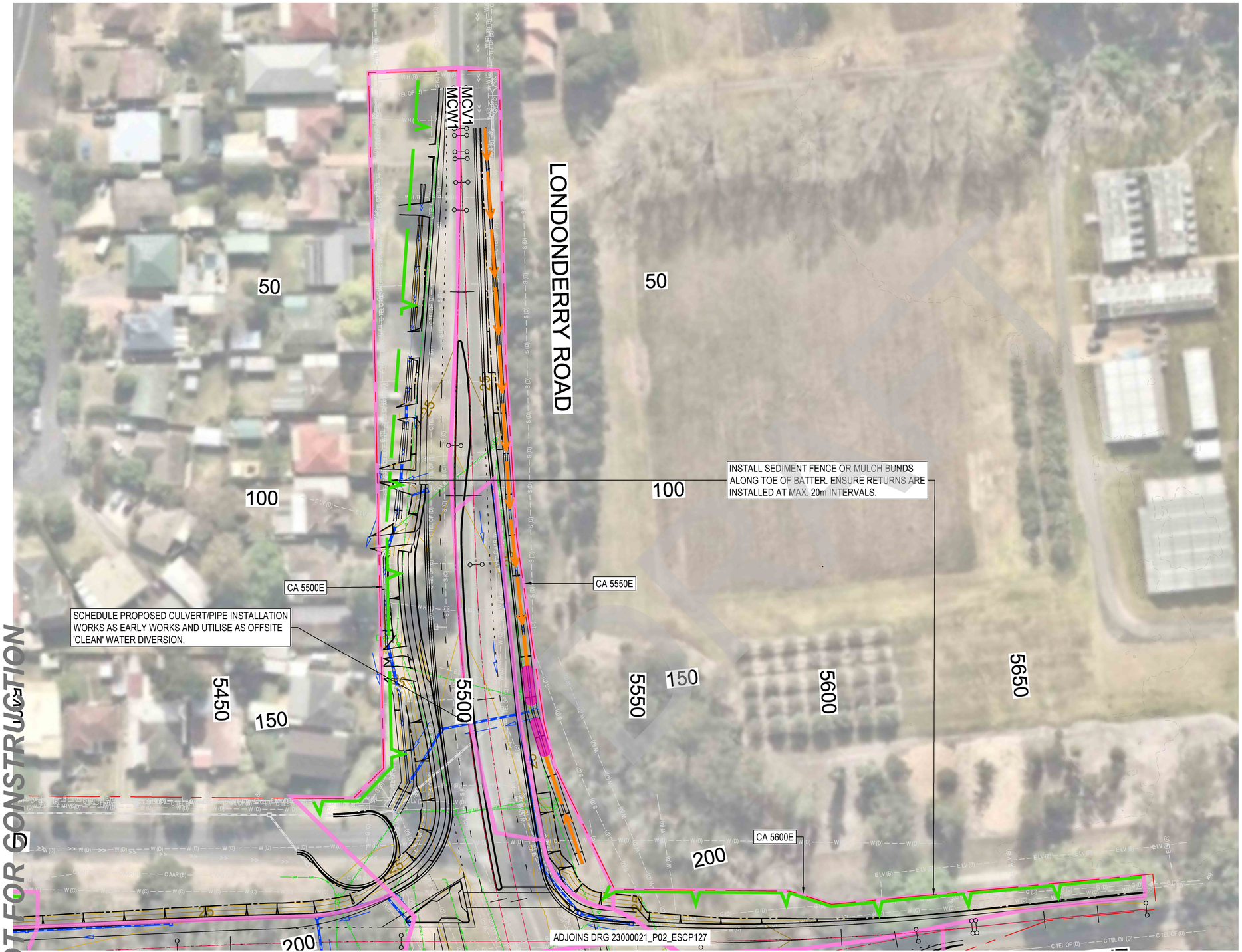

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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

NOT FOR CONSTRUCTION

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
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A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

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CLIENT: aurecon

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PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 29 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP128	C

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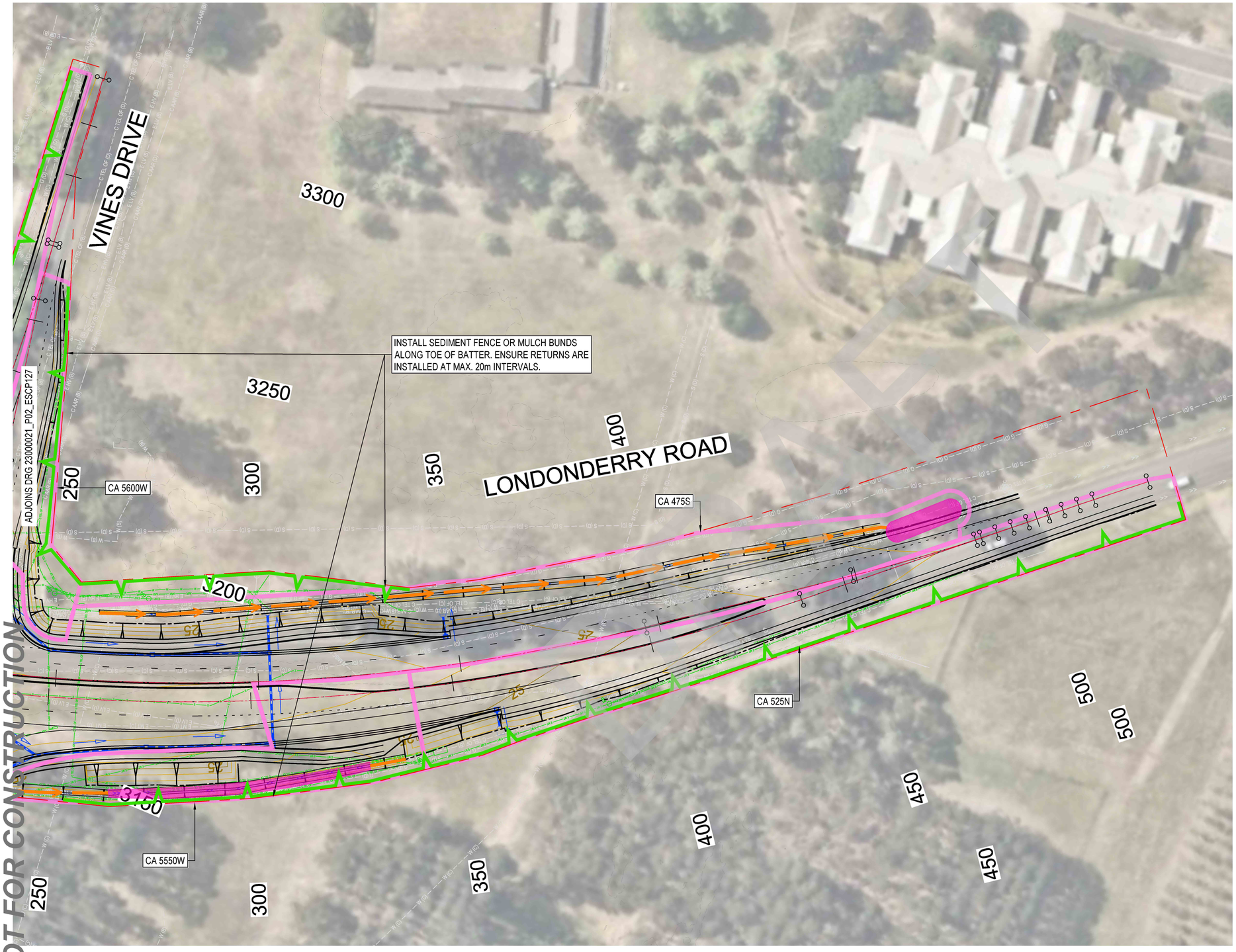

UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

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- EXISTING CONTOURS (0.5m INTERVALS)
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0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

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REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
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B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500

CONCEPT

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CLIENT: aurecon

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PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 30 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP129	C

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LEGEND

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UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

0 5 10 15 20 25m
SCALE: 1:500 (A1 SHEET)

NOT FOR CONSTRUCTION

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A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS	
DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	1:500
CONCEPT	

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CLIENT: aurecon

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PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL PLAN SHEET 31 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP130	C

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LEGEND

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UNDERLYING DRAINAGE DESIGN (80%) BY AURECON.

0 10 20 30 40 50m
SCALE: 1:1000 (A1 SHEET)

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
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DRAWN BY	L.O.
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PROJECT TITLE
NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE
CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 32 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP131	C

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0 5 10 15 20 25m
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PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
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DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL PLAN
SHEET 33 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP132	C

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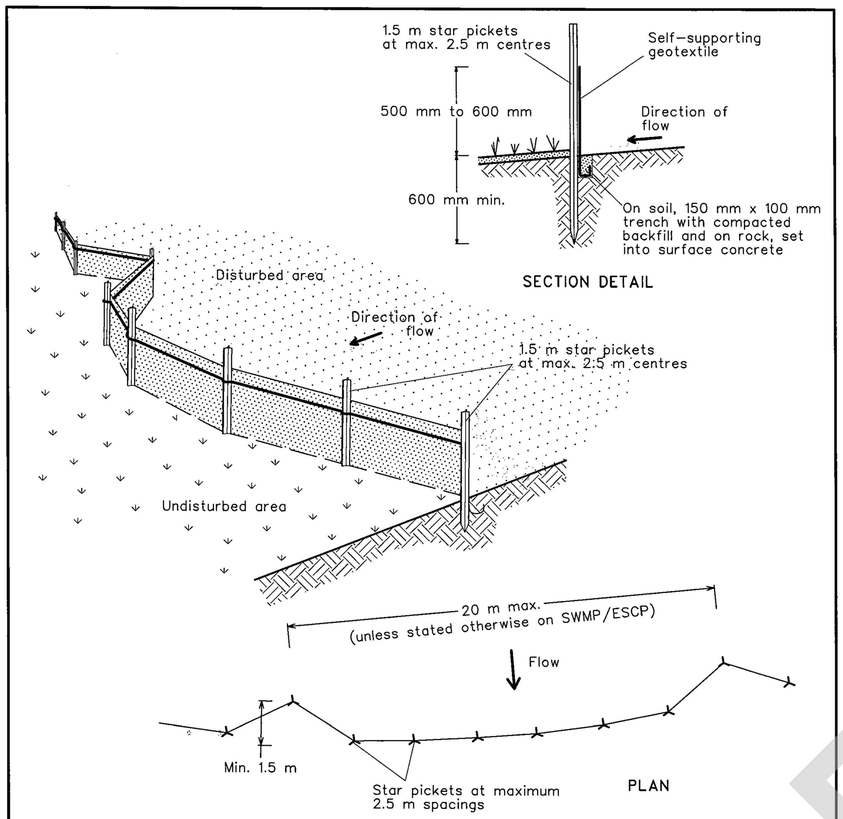
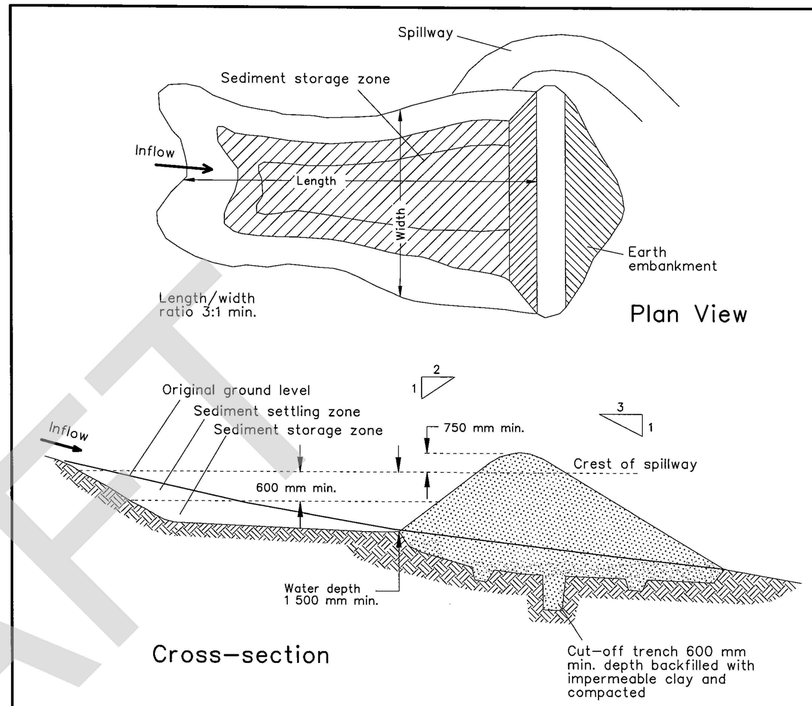


Construction Notes

1. Construct sediment fences as close as possible to being parallel to the contours of the site, but with small returns as shown in the drawing to limit the catchment area of any one section. The catchment area should be small enough to limit water flow if concentrated at one point to 50 litres per second in the design storm event, usually the 10-year event.
2. Cut a 150-mm deep trench along the upslope line of the fence for the bottom of the fabric to be entrenched.
3. Drive 1.5 metre long star pickets into ground at 2.5 metre intervals (max) at the downslope edge of the trench. Ensure any star pickets are fitted with safety caps.
4. Fix self-supporting geotextile to the upslope side of the posts ensuring it goes to the base of the trench. Fix the geotextile with wire ties or as recommended by the manufacturer. Only use geotextile specifically produced for sediment fencing. The use of shade cloth for this purpose is not satisfactory.
5. Join sections of fabric at a support post with a 150-mm overlap.
6. Backfill the trench over the base of the fabric and compact it thoroughly over the geotextile.

SEDIMENT FENCE — SD 6-8



Construction Notes

1. Remove all vegetation and topsoil from under the dam wall and from within the storage area.
2. Construct a cut-off trench 500 mm deep and 1,200 mm wide along the centreline of the embankment extending to a point on the gully wall level with the riser crest.
3. Maintain the trench free of water and recompact the materials with equipment as specified in the SWMP to 95 per cent Standard Proctor Density.
4. Select fill following the SWMP that is free of roots, wood, rock, large stone or foreign material.
5. Prepare the site under the embankment by ripping to at least 100 mm to help bond compacted fill to the existing substrate.
6. Spread the fill in 100 mm to 150 mm layers and compact it at optimum moisture content following the SWMP.
7. Construct the emergency spillway.
8. Rehabilitate the structure following the SWMP.

EARTH BASIN - WET — SD 6-4

(APPLIES TO 'TYPE D' AND 'TYPE F' SOILS ONLY)

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REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
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A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	N.T.S.

CONCEPT

North

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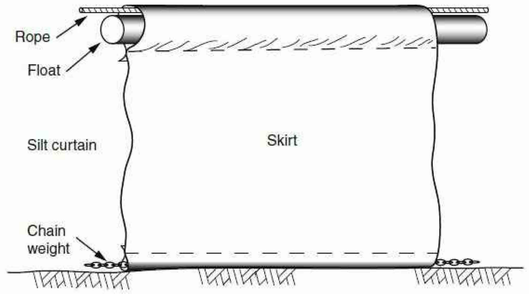
PROJECT TITLE: NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

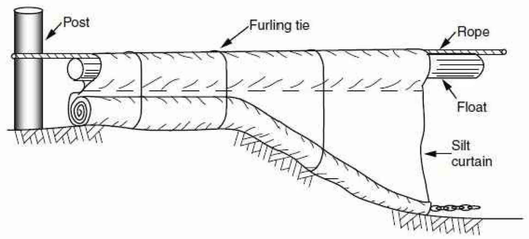
DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL – BLUE BOOK STANDARD DRAWINGS – SHEET 34 OF 38

PROJECT NO.	SUB–PR NO.	DRAWING NO.	REV
23000021	P02	ESCP201	C

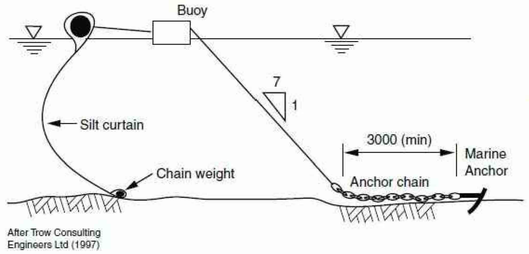
Plot Date: Monday, 2 September 2024 3:57:48 PM CAD File Name: L:\23000021 New Richmond Bridge Stage 2\Drawings\23000021_P02_ESCP_REV C.dwg



(a) Components of a floating silt curtain

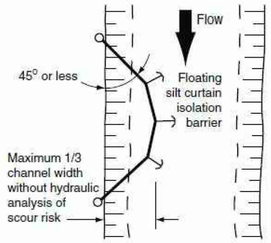


(b) Typical land anchorage system

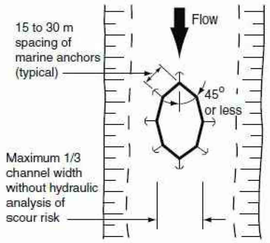


After Trow Consulting Engineers Ltd (1997)

(c) Typical marine anchorage system



(d) Typical installation of floating silt curtain



(e) Typical installation of floating silt curtain

Catchments & Creeks Pty Ltd

Drawn:	Date:		
GMW	Feb-10	Floating Silt Curtain	FSC-01

MATERIALS

SILT CURTAIN FABRIC: MANUFACTURED FROM A WOVEN GEOTEXTILE, CANVAS/TARP MATERIAL, OR A COMMERCIALLY AVAILABLE SILT CURTAIN SUCH AS NYLON REINFORCED POLYVINYL CHLORIDE (PVC) OR EQUIVALENT.

BALLAST CHAIN: 10 TO 13mm GALVANISED CHAIN WITH MINIMUM 1.9 TO 3.3kg/m WEIGHT.

LAND ANCHOR: MINIMUM 100mm DIAMETER TIMBER POST (OR EQUIVALENT).

MARINE ANCHOR: MINIMUM 5kg LIGHTWEIGHT (DANFORTH) TYPE ANCHOR WITH 10 TO 13mm NYLON TIE ROPE AND MINIMUM 3m LENGTH OF 8mm GALVANISED CONNECTING CHAIN.

INSTALLATION

1. PRIOR TO COMMENCING ANY WORKS, OBTAIN ALL NECESSARY APPROVALS AND PERMITS REQUIRED TO CONDUCT THE NECESSARY WORKS INCLUDING PERMITS FOR THE DISTURBANCE OF RIPARIAN AND AQUATIC VEGETATION, AND THE CONSTRUCTION OF ALL PERMANENT OR TEMPORARY INSTREAM BARRIERS AND INSTREAM SEDIMENT CONTROL MEASURES.

2. PRIOR TO THE INSTALLATION, CHECK WEATHER REPORTS FOR A SUITABLE WINDLESS, CALM DAY. DO NOT PROCEED WITH THE INSTALLATION UNLESS SAFE TO DO SO.

3. REFER TO APPROVED PLANS FOR LOCATION AND DIMENSIONAL DETAILS. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, DIMENSIONS OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

4. CLEAR THE IMMEDIATE LAUNCHING AREA OF ROCK AND DEBRIS. AVOID DISTURBING GROUNDCOVER VEGETATION.

5. LAYOUT A PLASTIC LAUNCHING PAD (SPILLWAY) AT RIGHT ANGLES TO THE WATERCOURSE BANK AND PEG OR ANCHOR IT DOWN. THIS IS TO PROTECT THE CURTAIN AND REDUCE FRICTION WHEN LAUNCHING.

6. UNFOLD THE CURTAIN IN AN OPEN AREA PRIOR TO ITS INSTALLATION. ENSURE THE BARRIER IS FABRICATED WITH SUFFICIENT DIMENSIONS TO BE IN GOOD CONTACT WITH THE BOTTOM OF THE CHANNEL. THE DEPTH OF THE BARRIER SHOULD BE APPROXIMATELY 10% GREATER THAN THE WATER DEPTH TO ENSURE IT RESTS ON THE BED.

7. IDEALLY, THE LENGTH OF THE BARRIER IS 10 TO 20% LONGER THAN THE MEASURED LENGTH OF THE PROPOSED ENCLOSURE.

8. UNFOLD THE FIRST CURTAIN PANEL ON THE SLIPWAY.

9. INSERT THE FLOATS BOTH ENDS FOR EASE OF INSTALLATION.

10. PULL THROUGH THE STEEL CHAIN IN THE BOTTOM SLEEVE USING THE DRAW CORD.

11. PULL THROUGH THE ROPE USING THE DRAW CORD.

12. PRIOR TO DEPLOYING THE BARRIER, GATHER UP THE CURTAIN AND TIE THE CURTAIN WITH LIGHTWEIGHT STRAPS OR ROPE EVERY 1 TO 1.5m. THE AIM OF THIS IS TO ENABLE THE CURTAIN TO BE SET IN PLACE IN THE WATER EASILY WITHOUT THE CURTAIN BEING DRAGGED ALONG THE CHANNEL BED.

13. SET THE UPSTREAM BANK ANCHOR POINT AND TIE OFF ONE END OF THE BARRIER, ENSURING NO WATER WILL BE ABLE TO FLOW INTO THE UPSTREAM END.

14. DEPLOY THE BARRIER FROM THE END OF A BOAT. FASTEN THE FREE END OF THE BARRIER TO THE DOWNSTREAM ANCHOR POINT, THEN ANCHOR THE BARRIER AT INTERMEDIATE POINTS.

15. TAPER THE ENDS OF THE BARRIER TO THE SHAPE OF THE SHORELINE, OTHERWISE TIE THE ENDS OF THE BARRIER WITH FURLING STRAPS SO THE DEPTH OF THE BARRIER CAN BE ADJUSTED TO THE SHAPE OF THE BANK.

16. AFTER THE BARRIER HAS BEEN ANCHORED, CHECK TO SEE THAT THE SKIRT IS NOT TWISTED AROUND THE FLOTATION UNITS. WHEN THE BARRIER IS PROPERLY DEPLOYED, CUT THE TIE ROPES AND LET THE BALLAST WEIGHTS SINK TO THE BED.

17. ENSURE THE SKIRT (AT MAXIMUM WATER LEVEL) IS FREE OF LARGE PLEATS THAT MAY COLLECT SEDIMENT CAUSING THE BARRIER TO BE PULLED UNDER THE WATER SURFACE.

MAINTENANCE

1. INSPECT THE SILT CURTAIN DAILY FOR DAMAGE.

2. ENSURE THE TOP OF THE BARRIER REMAINS ABOVE THE WATER SURFACE, AND THE CURTAIN IS FREE OF TEARS OR GAPS.

3. ENSURE THE BARRIER REMAINS IN THE SPECIFIED LOCATION.

4. CHECK FOR TURBIDITY LEAKS.

5. CHECK ALL ANCHOR POINTS.

6. REPAIR OR REPLACE ANY TORN SEGMENTS.

7. CHECK FOR SEDIMENT BUILD-UP ON THE BOTTOM OF THE SKIRT THAT MAY BEGIN TO PULL THE CURTAIN UNDER THE WATER.

8. DISPOSE OF ANY EXCESSIVE SEDIMENT OR DEBRIS DEPOSITS IN A MANNER THAT WILL NOT CREATE AN EROSION OR POLLUTION HAZARD.

9. REPAIR ANY PLACES IN THE ISOLATION BARRIER THAT HAVE WEAKENED OR THAT HAVE BEEN SUBJECTED TO DAMAGE FROM INFLOWS OR OVERTOPPING WATER.

REMOVAL

1. THE SILT CURTAIN SHOULD BE REMOVED AS SOON AS POSSIBLE AFTER IT IS NO LONGER NEEDED.

2. IF EXCESSIVE SEDIMENT OR DEBRIS HAS COLLECTED AROUND THE BARRIER, THEN REMOVE SUCH MATERIAL BEFORE THE BARRIER IS REMOVED AND DISPOSE OF SUCH MATERIAL PROPERLY.

3. ENSURE THE CHANNEL WATER CONTAINED WITHIN THE ENCLOSURE HAS ACHIEVED A SUITABLE WATER QUALITY BEFORE REMOVING THE SILT CURTAIN.

4. ENSURE THE RELEASE OF SEDIMENT AND THE DAMAGE TO THE CHANNEL'S BED AND BANKS IS MINIMISED DURING REMOVAL OF THE SILT CURTAIN.

5. IF IT IS NOT FEASIBLE TO WAIT FOR ADEQUATE SETTLEMENT OF SUSPENDED SEDIMENTS, THEN WHERE PRACTICABLE, PUMP THE SEDIMENT-LADEN WATER TO AN OFF-STREAM DE-WATERING SEDIMENT CONTROL SYSTEM FOR TREATMENT. THIS TREATMENT AREA SHOULD IDEALLY BE LOCATED AT LEAST 50m FROM THE CHANNEL.

6. REMOVE ALL CONSTRUCTION MATERIALS, EXCESSIVE SEDIMENT DEPOSITS AND DEBRIS AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

7. RESTORE THE WATERCOURSE CHANNEL TO ITS ORIGINAL CROSS-SECTION, AND SMOOTH AND APPROPRIATELY STABILISE AND/OR REVEGETATE ALL DISTURBED AREAS.

Catchments & Creeks Pty Ltd

Drawn:	Date:		
GMW	Feb-10	Floating Silt Curtain	FSC-02

MATERIALS

(i) MULCH MUST COMPLY WITH THE REQUIREMENTS OF AS4454.

(ii) MAXIMUM SOLUBLE SALT CONCENTRATION OF 5dS/m.

(iii) MOISTURE CONTENT OF 30 TO 50% PRIOR TO APPLICATION.

INSTALLATION

1. REFER TO APPROVED PLANS FOR LOCATION AND EXTENT. IF THERE ARE QUESTIONS OR PROBLEMS WITH THE LOCATION, EXTENT, MATERIAL TYPE, OR METHOD OF INSTALLATION CONTACT THE ENGINEER OR RESPONSIBLE ON-SITE OFFICER FOR ASSISTANCE.

2. WHEN SELECTING THE LOCATION OF A MULCH FILTER BERM, TO THE MAXIMUM DEGREE PRACTICAL, ENSURE THE BERM IS LOCATED:

(i) TOTALLY WITHIN THE PROPERTY BOUNDARIES;

(ii) ALONG A LINE OF CONSTANT ELEVATION (PREFERRED, BUT NOT ALWAYS PRACTICAL);

(iii) AT LEAST 1m, IDEALLY 3m, FROM THE TOE OF A FILL EMBANKMENT;

(iv) AWAY FROM AREAS OF CONCENTRATED FLOW.

3. ENSURE THE BERM IS INSTALLED IN A MANNER THAT AVOIDS THE CONCENTRATION OF FLOW ALONG THE BERM, OR THE UNDESIRABLE DISCHARGE OF WATER AROUND THE END OF THE BERM.

4. ENSURE THE BERM HAS BEEN PLACED SUCH THAT PONDING UP-SLOPE OF THE BERM IS MAXIMISED.

5. ENSURE BOTH ENDS OF THE BERM ARE ADEQUATELY TURNED UP THE SLOPE TO PREVENT FLOW BYPASSING PRIOR TO WATER PASSING OVER THE BERM.

6. ENSURE 100% CONTACT WITH THE SOIL SURFACE.

7. WHERE SPECIFIED, TAKE APPROPRIATE STEPS TO VEGETATE THE BERM.

MAINTENANCE

1. DURING THE CONSTRUCTION PERIOD, INSPECT ALL BERMS AT LEAST WEEKLY AND AFTER ANY SIGNIFICANT RAIN. MAKE NECESSARY REPAIRS IMMEDIATELY.

2. REPAIR OR REPLACE ANY DAMAGED SECTIONS.

3. WHEN MAKING REPAIRS, ALWAYS RESTORE THE SYSTEM TO ITS ORIGINAL CONFIGURATION UNLESS AN AMENDED LAYOUT IS REQUIRED OR SPECIFIED.

4. REMOVE ACCUMULATED SEDIMENT IF THE SEDIMENT DEPOSIT EXCEEDS A DEPTH OF 100mm OR 1/3 THE HEIGHT OF THE BERM.

5. DISPOSE OF SEDIMENT IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

REMOVAL (IF REQUIRED)

1. WHEN DISTURBED AREAS UP-SLOPE OF THE BERM ARE SUFFICIENTLY STABILISED TO RESTRAIN EROSION, THE BERM MAYBE REMOVED.

2. REMOVE ANY COLLECTED SEDIMENT AND DISPOSE OF IN A SUITABLE MANNER THAT WILL NOT CAUSE AN EROSION OR POLLUTION HAZARD.

3. REHABILITATE/REVEGETATE THE DISTURBED GROUND AS NECESSARY TO MINIMISE THE EROSION HAZARD.

Recommended maximum berm spacing

Land slope	Max spacing
< 2%	30 m
5%	25 m
10%	15 m
20%	8 m

Figure 1 - Typical placement of mulch filter berm

Catchments & Creeks Pty Ltd

Drawn:	Date:		
GMW	Apr-10	Mulch Filter Berms	MB-01

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CONCEPT	

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PROJECT TITLE

NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE

CONCEPT EROSION AND SEDIMENT CONTROL – IECA STANDARD DRAWINGS – SHEET 35 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
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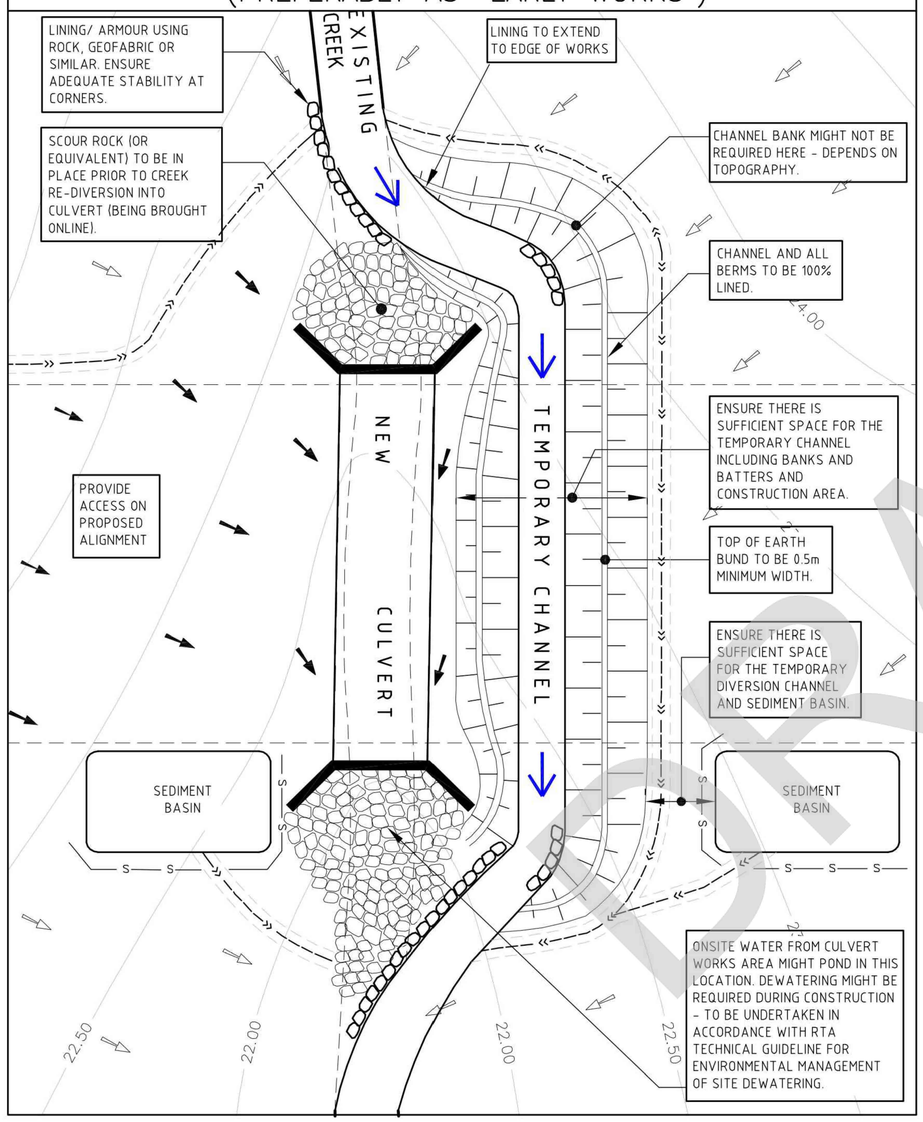
NEW ONLINE CULVERT (PREFERABLY AS "EARLY WORKS")



SWMP – ONLINE CULVERT CONSTRUCTION AND CREEK STABILISATION WORKS

NEW ONLINE CULVERT - CONSTRUCTION NOTES

THESE STEPS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW.

Stage 1: Temporary Channel Construction
- Establish diversion drains for offsite water.
- Construct and line the temporary channel including rock armouring at the existing creek and temporary channel junctions.
- Construct and line temporary earth bunds.
- Divert creek flows into this channel. Work downstream to upstream.

Stage 2: Culvert Construction Works
- Construct the new culvert including the stabilised culvert inlet and outlets.
- Stabilise the culvert construction works area once culvert construction works are complete.

Stage 3: Final diversion and Rehabilitation Works
- Divert creek flows into new culvert.
- Temporary channel and bunds to be decommissioned without allowing sediment downstream to creek and the disturbed area stabilised.
- Diversion drains for offsite water can be redirected to inlet of new culvert on upstream site or can be removed and rehabilitated.

OTHER NOTES

1. This design assumes that culvert construction is part of the 'early works' for the site.
2. Temporary channel to be sized and lined as per the requirements in Table 6.1 (DECC, 2008) and Table 5.2 (Landcom, 2004).
3. Ideally schedule works to periods when rainfall erosivity is low (Refer to Table 4.3 - Landcom, 2004)
4. Only undertake in-stream works (e.g. placement of rock) during periods of zero or very low flow and only when the 24 hour weather forecast suggests a significant rain event is not likely.
5. Ensure suitable temporary groundcover materials (e.g. geofabric or black plastic) are located on site for rapid stabilisation of exposed soils within in-stream locations if an unexpected rain or flow event occurs.
6. No culvert works are to occur until creek flows are successfully diverted into the stabilised temporary channel.
7. Culverts are to be completed before being allowed to convey flows. This includes all inlet and outlet protection, wingwalls etc.
8. Stabilisation, as defined by the Blue Book, means achieving:
   - For concentrated flows- At least 70% vegetation cover (or equivalent) within 10 days AND using only materials that are suitable in concentrated flow conditions (refer to Tables A3 and D1 in the Blue Book for suitability).
   - For all other areas- At least 60% vegetation cover (or equivalent) in 20 days AND 70% in 2 months.
9. A management regime should be in place to address the risk of these works creating a flooding issue due to constriction of the channel during construction.
10. If temporary access is required across the existing creek or a diversion channel, use a temporary water crossing - see standard drawing 5-1 in Blue Book Vol 1 (Landcom, 2004).
11. Minimise the time that soil is exposed to erosion.

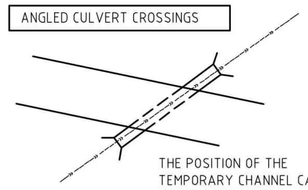
STANDARD DRAWINGS FROM VOL 1 OF THE BLUE BOOK (LANDCOM, 2004) USED HERE:

Sediment fence: SD 6-8
High flow earth bank (diversion drain): SD 5-6
Energy dissipater: SD 5-8
Temporary waterway crossing: SD 5-1

AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

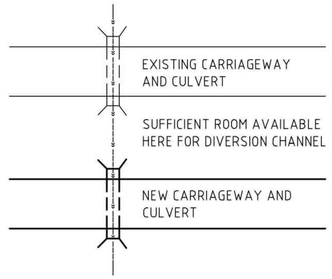
THIS SCENARIO ALSO APPLIES TO:

ANGLED CULVERT CROSSINGS



THE POSITION OF THE TEMPORARY CHANNEL CAN BE DETERMINED BY THE PREVAILING TOPOGRAPHY

DIVIDED CULVERT EXTENSION



THE APPLICATION OF THIS SCENARIO TO DIVIDED CULVERT EXTENSIONS IS DEPENDENT ON WHETHER THERE IS ENOUGH AVAILABLE SPACE. IF SPACE IS LIMITED PART OF THE TEMPORARY CHANNEL CAN BE CONSTRUCTED OUT OF SHEET PILING OR SIMILAR OR ALTERNATIVELY THE SITE SHOULD BE STABILISED AS FOR A CONTINUOUS ONLINE CULVERT EXTENSION

LEGEND

- S S S SEDIMENT FENCE (SD 6-8)
- DIVERSION DRAIN FOR 'OFFSITE' WATER (SD 5-6)
- SURFACE CONTOURS
- 'ONSITE' FLOWS
- 'OFFSITE' FLOWS
- CREEK/CHANNEL FLOWS
- CUT/FILL BATTER
- ROCK DISSIPATION/ STABILISATION STRUCTURES (SD 5-8)

NOTE THAT NOT ALL ONSITE WATER MANAGEMENT AND SEDIMENT CONTROLS ARE SHOWN HERE.

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PROJECT TITLE

NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE

CONCEPT EROSION AND SEDIMENT CONTROL – DETAIL 1
SHEET 36 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP203	C

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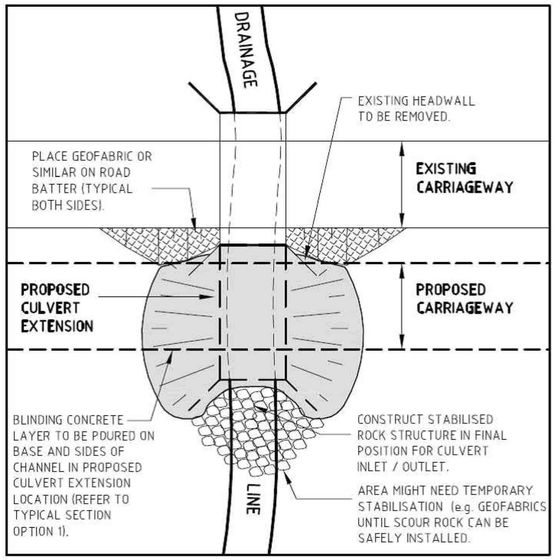
CONTINUOUS CULVERT EXTENSION (ONLINE) OPTION 1



SITE STABILISATION PROCEDURE

CONSTRUCTION NOTES

WORKS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW

Prior to undertaking any construction or earthworks ensure suitable temporary groundcover materials (e.g. geofabric or black plastic) are located on site for rapid stabilisation of exposed soils if an unexpected rain or flow event occurs.

1. Watch the weather forecast for a dry period (a period longer than the time required to complete earthworks up to the required level).
2. When a dry period is forecast, undertake earthworks quickly (preferably in less than three days).
3. Pour blinding concrete layer and lay rock inlet / outlet.
4. Lay geofabric (or similar) on existing road batter.

(Ensure steps 2, 3 and 4 occur within the forecast period of dry weather and no flow)

5. Complete culvert construction works over the top of the blinding concrete layer.
6. Maintain the blinding layer until the culvert extension is complete and stabilised. once flows are secure within the new culverts, excess blinding can be removed if desired.

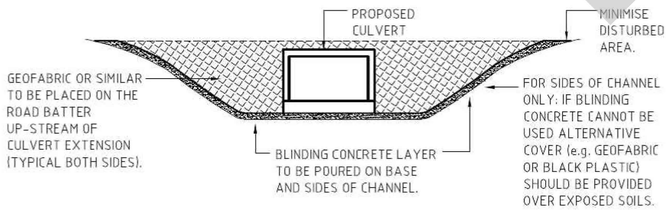
At any time during steps 1 – 4 where a significant rain or flow event is forecast or if the site is left unattended for prolonged periods temporary groundcover should be applied to all exposed soils in the works area.

ENSURE THAT 'OFFSITE' CREEK FLOWS DO NOT COME INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

NOTE: MAINTAIN OR INSTALL TEMPORARY GROUND COVER THROUGH FLOW AREA ANYTIME FLOWS ARE IMMINENT.

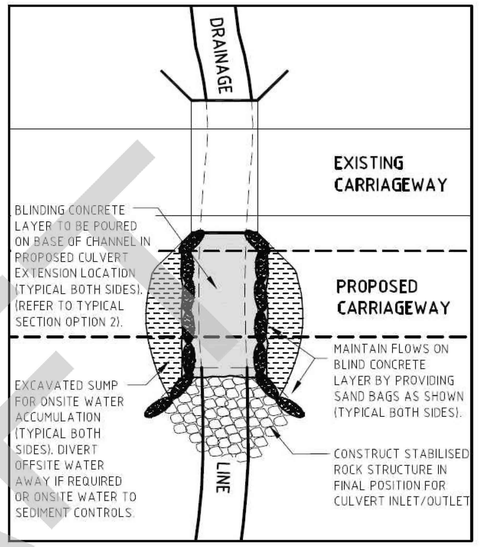
OTHER NOTES

- For divided culvert extensions this stabilisation method could also be applied or alternatively the flows could be diverted as for a new online culvert.
- Note that this method is not suitable for perennial creeks unless additional measures (e.g. pumping or coffer dams) can be reliably included as well.
- This method might not be appropriate where there is a significant depth of unsuitable soil material to be removed.
- For systems with very minor flows in dry periods, temporary damming of flows might be required to hold water back for the nominated work period until the blinding concrete layer and rock is placed.
- Note that not all onsite water management and sediment controls are shown here.



TYPICAL SECTION – OPTION 1

CONTINUOUS CULVERT EXTENSION (ONLINE) OPTION 2



SITE STABILISATION PROCEDURE

CONSTRUCTION NOTES

WORKS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW

Prior to undertaking any construction or earthworks ensure suitable temporary groundcover materials (e.g. geofabric or black plastic) are located on site for rapid stabilisation of exposed soils if an unexpected rain or flow event occurs.

1. Watch the weather forecast for a dry period (a period longer than the time required to complete earthworks up to the required level).
2. When a dry period is forecast, undertake earthworks quickly (preferably in less than three days).
3. Pour blinding concrete layer and lay rock inlet / outlet.
4. Position sand bags on the blind concrete layer.

(Ensure steps 2, 3 and 4 occur within the forecast period of dry weather and no flow)

5. Complete culvert construction works over the top of the blinding concrete layer. Take care not to disturb the integrity of the blinding layer.
6. Maintain the sandbag walls on the base slab if a flow event occurs.

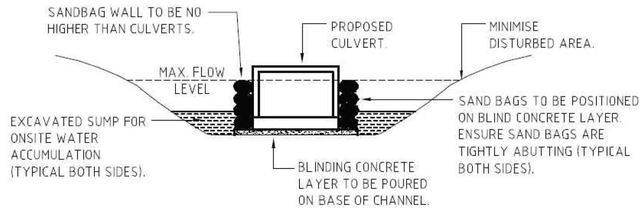
At any time during steps 1 – 4 where a significant rain or flow event is forecast or if the site is left unattended for prolonged periods temporary groundcover should be applied to all exposed soils in the works area.

ENSURE THAT 'OFFSITE' CREEK FLOWS DO NOT COME INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

NOTE: MAINTAIN OR INSTALL TEMPORARY GROUND COVER THROUGH FLOW AREA ANYTIME FLOWS ARE IMMINENT.

OTHER NOTES

- For divided culvert extensions this stabilisation method could also be applied or alternatively the flows could be diverted as for a new online culvert.
- Note that this method is not suitable for perennial creeks unless additional measures (e.g. pumping or coffer dams) can be reliably included as well.
- This method might not be appropriate where there is a significant depth of unsuitable soil material to be removed.
- For systems with very minor flows in dry periods, temporary damming of flows might be required to hold water back for the nominated work period until the blinding concrete layer and rock is placed.
- Note that not all onsite water management measures and sediment controls are shown here.



TYPICAL SECTION – OPTION 2

NOT FOR CONSTRUCTION

DRAFT

REV	DATE	DES.	DRN.	APP.	REVISION DETAILS
C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS

DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	N.T.S.

CONCEPT

North

CLIENT

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PROJECT TITLE

NEW RICHMOND BRIDGE – STAGE 2
HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE

CONCEPT EROSION AND SEDIMENT CONTROL – DETAILS 2 & 3
SHEET 37 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
23000021	P02	ESCP204	C

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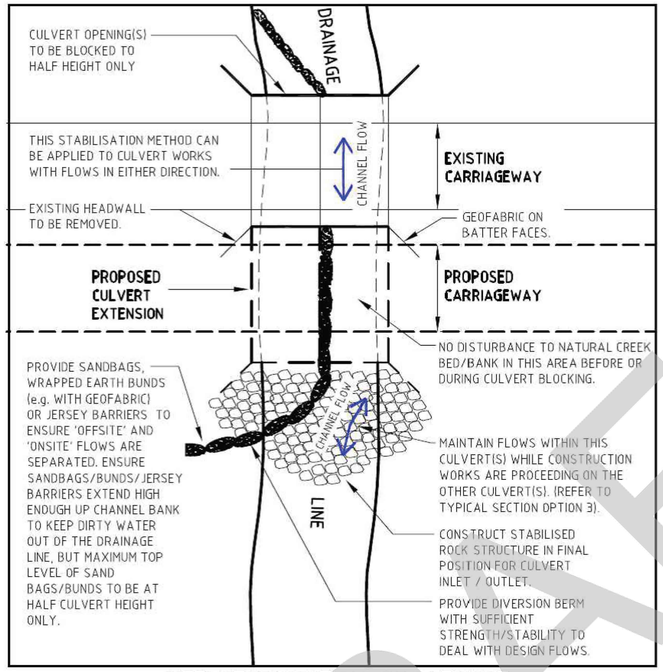
CONTINUOUS CULVERT EXTENSION (ONLINE)
OPTION 3



OTHER NOTES

- This option will only work when existing ground surface level can be maintained in at least one culvert cell. Therefore this method might not work for deep excavations requiring benching.
- Suitable for use in perennial streams providing in-stream works are conducted when flows are minimal.
- However, regardless of scheduling and timing the adopted controls need to be considerate of the risk of significant flows at any time.
- Note that not all water management and sediment controls are shown here.

AT ALL TIMES DURING WORKS, ENSURE THAT 'OFFSITE' WATER IS PASSED AROUND OR THROUGH THE SITE WITHOUT COMING INTO CONTACT WITH EXPOSED SOIL OR 'ONSITE' WATER

SITE STABILISATION PROCEDURE

CONSTRUCTION NOTES

WORKS TO BE UNDERTAKEN IN THE ORDER GIVEN BELOW

Prior to undertaking any construction or earthworks ensure suitable temporary groundcover materials (e.g. geofabric or black plastic) are located on site for rapid stabilisation of exposed soils if an unexpected rain or flow event occurs.

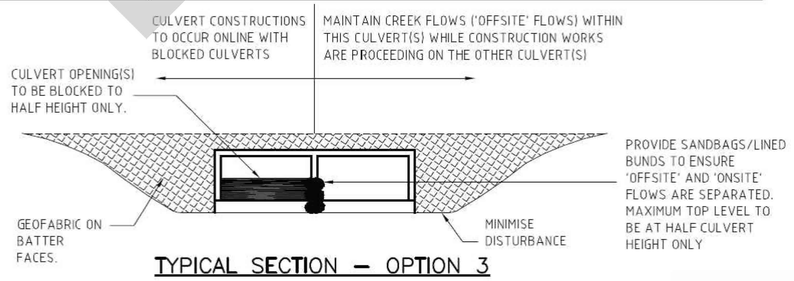
Stage 1.

1. Monitor creek flows ensuring flows levels are not too high.
2. Position sandbags/bunds around culvert works area and block existing culvert end to half culvert height only.
3. Undertake culvert extension construction works only on the blocked side of the culvert(s).
4. Complete inlet/outlet protections.

Stage 2

5. Divert the creek flows into the newly constructed culvert extension by blocking off the alternate side using a half-height wall/bund.
6. Complete the culvert extension on the other side including the stabilised inlet/outlet.

At any time where a significant rain or flow event is forecast or if the site is left unattended for prolonged periods temporary groundcover should be applied to all exposed soils in the works area.



TYPICAL SECTION – OPTION 3

DRAFT

NOT FOR CONSTRUCTION

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C	02/09/24	L.O.	L.O.	A.T.	FINAL ISSUE – 80% CONCEPT DESIGN
B	23/07/24	L.O.	L.O.	A.T.	ISSUED FOR TfNSW REVIEW – 80% CONCEPT DESIGN
A	12/07/24	L.O.	L.O.	A.T.	ISSUED FOR REVIEW – 80% CONCEPT DESIGN

DRAWING STATUS	
DESIGN BY	L.O.
DRAWN BY	L.O.
FINAL APPROVAL	A.T.
SCALE: (on A1 Original)	N.T.S.
CONCEPT	

North

CLIENT: aurecon

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HAWKESBURY CITY COUNCIL
CONCEPT DESIGN

DRAWING TITLE: CONCEPT EROSION AND SEDIMENT CONTROL – DETAIL 4
SHEET 38 OF 38

PROJECT NO.	SUB-PR NO.	DRAWING NO.	REV
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